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Do tires wear out faster
on electric vehicles?

See the Feature article by
Jeanna Van Rensselar on Page 26.

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Changing the boss's perception

Make the performance review a conversation and watch productivity soar.

By Michael P. Duncan

You may have just had your annual performance review with your boss and perhaps your subordinates (if you are a supervisor). I used to dread these but not so much anymore.

If you think about it, you really don't get many chances during the year to tell your boss or your subordinates one on one what you did, how they did, how the team and company performed versus objectives and goals, and what we intend to or need to do tomorrow to succeed.

Performance reviews do not need to be stressful or judgmental; rather, they should be insightful and acknowledge the contribution you as an individual have made to the team and organization. Your boss should be coaching you, and you need to coach the boss during this review.

I remind my team that "we" win or lose together and that "we" need to get the most productivity out of each other. The performance review should be a positive and productive experience for both parties involved. The best reviews are those not dwelling too much about what has happened (past) but what will happen (focus on the future).

Most people dread the review process because they are unaware of what their boss is going to say or what aspect of their performance they will review. To help mitigate the suspense, stress and anxiety of a review, ask your boss ahead of time what she is most interested in discussing. Perhaps ask your boss for a list of questions he would like to know more detail about during the review.

I like the following questions:¹

- What accomplishment(s) from the last year are you most proud of?
- What performance objectives and goals do you have for the next year?
- What development/training goals would you like to set for the next year?



Performance reviews should be positive and productive for both parties.

- What obstacles stand in your way?
- What impact has your performance had on the team? The organization?
- How can I improve as your manager?

In addition, if your company has a self-review form, fill it out and provide to your boss before the meeting. Bosses don't remember everything their employees do (especially old bosses like me), so now is your chance to remind them.

A performance review is a perception of how the boss views your progress, efforts and contributions. Sometimes you need to change your boss's perception of your performance. Remember, it takes 10 of your best days at work to change the boss's perception of one bad day at work.

Also, before going to your boss with a request for a raise, make sure you can back

it up with evidence like:

- You had exceptional accomplishments in the past year.
- You have additional responsibilities.
- You consistently worked long hours to achieve the team's or company's goal—no "eight and skate."
- You achieve your goals and objectives on time and on budget.
- You solve problems (implement positive change) rather than just point them out.
- You fixed a broken process within your organization.
- You continue to make yourself better by learning new things and keeping an open mind.
- You do what is needed before anyone asks you to do it.
- You take vacations but you don't take days off when you are at work.
- You bring positive energy to the team and your work.
- You share your knowledge with the team.
- You cross the finish line.

Some companies are doing away with annual performance reviews and just having "conversations." Some are doing them more often (twice a year or even quarterly). Whatever your review period is, it is important to make sure your perception, the boss's perception and your subordinate's perception are similar. Feedback on performance, setting and achieving realistic objectives and goals are key to a healthy and productive organization.

Finally, your boss would likely welcome a list of future goals and objectives from you ahead of time to help focus and prioritize during the review. 🌈

Mike Duncan is executive vice president of technology of Daubert Chemical Co. in Chicago. You can reach him at mduncan@daubert.com.

REFERENCE

1. Available at www.quantumworkplace.com/future-of-work/13-performance-review-tips-that-actually-improve-employee-performance.

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The model of reliability

Built better or designed to fail?



By Evan Zabawski

By the strictest definition, reactive maintenance, also known as run to failure, is not really maintenance at all; it is simply a repair or replacement. It is meant for small, non-critical, inconsequential assets that are unlikely to fail and are often redundant. Assets matching this criterion that are run without any maintenance, like a lightbulb, fit the bill or rather the curve.

Asset failures conform to a model called a Weibull distribution, a plot of probability of failure over time/cycles that can resemble a bell curve. Incandescent light bulbs rarely fail upon installation or within the first few hours, nor do they last thousands of hours, the bulk fail between the expected lifespan of 1,000 hours and 2,000 hours, giving the distribution a very well-defined peak.

Interestingly, in the 1920s the average light bulb lifespan ranged from 1,500 hours to more than 2,500 hours, but a meeting of representatives from the major bulb manufacturers on Dec. 23, 1924, in Geneva introduced an industrial strategy now known as planned obsolescence. Forming a cartel to increase profits for all, bulb factories had to submit bulbs to a central testing facility in Switzerland to ensure compliance to a regulated 1,000-hour life,

facing fines for longer or shorter lifespans that could upset the market balance. The cartel's influence lasted only into the 1930s, but the codified lifespan remains unchanged today.

Just how long could an incandescent light bulb last if the cartel had not exerted its influence? The firemen at Fire Station No. 6 in Livermore, Calif., would tell you more than a million hours. They have a lightbulb manufactured around 1898 that was installed in 1901 and is still burning to this day (four interruptions amounting to about 200 hours total have interrupted its otherwise continuous operation).

The Palace Theatre in Fort Worth, Texas, has a light bulb that has been burning since 1908, but this is only the second example from billions and billions of installed incandescent light bulbs. Examples like these suggest "they don't make them like they used to." The inference being that goods are no longer made to the same standard or quality and therefore (even

purposely) do not last as long, but is this true?

The most reflexive example to suggest this is true is the automobile. While it is quick to point out that some vehicles older than 20 years are still in driving condition, there are two key factors to suggest cars are not exemplifying the axiom. Principally, a car represents availability bias—a tendency to estimate probability based on the ease with which an example comes to mind.

Using Ford's Model T as an example, we know that approximately 15 million of these cars were built between 1908 and 1927, yet records show that only 200,000 were registered in the U.S. in 1949. This hints at how few vehicles last more than 20-40 years; not a quantity statistically significant enough to suggest the ubiquitous car was built better in days gone by.

The other factor is that most of these cars were not run to failure; a majority likely failed due to outside factors like accidental damage. Also, many

of the survivors underwent extensive preservative maintenance or even restoration, evidenced by an estimate from the curator of transportation at The Henry Ford Museum who said that there were "still probably 10,000 to 15,000 on the road" in 2018.

Conversely, most of these are not driven daily and do not serve as a fair comparator to modern vehicles. The median age for a daily-driven vehicle in the U.S. is currently 11.8 years old. It's an all-time high, having increased 20% in the last 15 years, but the number more than 20 years old remains a low percentage.

Does a lack of change in life expectancy indicate cars are built with the same planned obsolescence as light bulbs? In a way, yes. However, their well-defined life expectancy is not evidence of planned failure or obsolescence for profit but rather a designed upgrade cycle for evolving emission and safety standards. Cars today are built better than ever; the focus is on the life expectancy of the passenger, not the vehicle. 🌍

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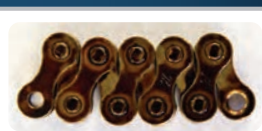
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 Solid Varnish	↓ Post-bake hanging performance	 Dark Viscous Liquid
 No Extension Chain Seized		 Full Extension - 2 sec.

Community + collaboration = member value

An STLE success formula for 75 years.

By Edward P. Salek, CAE
Executive Director



Books and movies about science or technology romanticize the myth of the lone genius, that man or woman making a breakthrough discovery working alone in a laboratory or workshop. Think Albert Einstein or maybe Steve Jobs in a more recent context.

While there's no denying that these inspiring storylines do exist, new research emphasizes that the innovation more often happens when people work together in a community. Why does community and collaboration matter so much?

A survey of professional society members, conducted by the technical journal publisher Wiley, notes, "Aside from how good it feels to make connections, research communities are also spaces to share information that could lead to the next great breakthrough." The value is enhanced when that collaboration supports information sharing with the widest possible community, including people from many different countries.

Over the last five years of the survey, belonging to a community (and the opportunities that come with it) consistently ranks as one of the most important benefits of membership. That's likely because most

members (85%) also believe that creating a research community is a key part of a society's role.

The Wiley study concludes, "Collaboration is at the heart of what society members want; 88% told us societies should promote greater collaboration between their members conducting research."

STLE's efforts to serve the tribology and lubricants community, which have been a priority for 75 years, continue to emphasize this benefit in 2020. This year's STLE Annual Meeting, May 3-7 in Chicago, where we'll celebrate our diamond anniversary, features a record 500 technical presentations. Reflecting STLE's international scope, about half of those presenters come from 30 countries outside the U.S.

Other places where STLE is supporting research through information exchange and community building include our Tribology Transactions journal, the Tribology Frontiers Conference and regular STLE local section meetings throughout the U.S. and Canada.

Collaborative relationships between societies in the same or similar disciplines also increase research activity and member value, according to the Wiley research. This

finding tracks with STLE's strategic vision statement, which commits the organization "to be a leader in the global network of individuals, institutions, societies and corporate entities with a common interest in advancing the science of tribology and the practice of lubrication engineering."

STLE's many collaborative relationships with complementary technical groups in the U.S. and around the world are too numerous to list here. But worth noting is our role as a supporter of the September 2021 World Tribology Congress in Lyon, France. With more than 1,500 people expected to attend, this may be the ultimate example of collaborative tribology research.

We know this activity is of value to members, and we view it as a motivator for individuals to join STLE. We are a welcoming community that encourages all non-members to investigate the value of being a participant in a vibrant research community. That's the best way to discover that genius doesn't need to be a solitary exercise! 🌍

You can reach Certified Association Executive Ed Salek at esalek@stle.org.

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Willingness to use self-autonomous vehicles

By Dr. Neil Canter
Contributing Editor



Figure 1. A new study determined that drivers facing more congestion on highways are willing to use ride-hailing services as long as the vehicle uses a driver.

Figure courtesy of the University of Washington.

KEY CONCEPTS

Surveyed respondents determined their value of travel time when driving themselves versus other means.

Respondents achieved a 13% reduction in value of travel time when using a ride-hailing service that grew to 45% when reminded they can multitask.

Respondents were not as comfortable using a driverless ride-hailing service.

Measuring the true value of travel time.

As technology changes continue to improve the drivability of an automobile, we consumers now have more choices for how to get from Point A to Point B. New propulsion systems are under development such as lithium-ion batteries, and electronics are increasingly being used to automatically adjust the temperature in the automobile to meet our preferences.

These improvements have led to the use of a greater number of automobiles on the roads, particularly in urban environments, increasing the prospects for congestion (see Figure 1). One particular challenge as a driver is to figure out a way to move through an intersection without being held up by a red light.

A previous TLT article¹ discussed a newly developed Green Light Optimal Speed Advisory system that used a series of mobile phones placed on the windshield by drivers to enable users to adjust the speed of their automobiles to pass through intersections. An additional benefit of using this system in urban environments was a 20% increase in fuel economy.

The number of choices for consumers to get to a specific destination have increased with the proliferation of ride-hailing services (RHS) and the prospect that driverless vehicles may become commonplace in the near future. These factors have increased the choices consumers have to determine the value of travel time (VOTT).

Don MacKenzie, associate professor of civil and environmental engineering and also the leader of the Sustainable Transportation Lab at the University of Washington in Seattle, Wash., says, "VOTT can really be called the cost of travel time. This term basically reflects the monetary value of time spent traveling in an automobile. Included in the cost is the time taken away from productive tasks, as well as the burden of

stress from driving."

Past work has been conducted to evaluate how consumers feel about being driven by another individual or how using a self-autonomous vehicle will impact VOTT. MacKenzie says, "These studies indicated that VOTT was significantly lower if individuals did not drive the vehicle because they could multitask, which could involve working or doing leisure activities such as reading and listening to music."

MacKenzie and his colleagues conducted a new study that is differentiated from past work by asking respondents to determine their VOTTs when driving themselves as compared to being driven by other means. He says, "Our approach was to ask individuals about their preference in using a RHS versus driving themselves. We randomly assigned respondents with using a human-driven RHS or a driverless RHS. Our initial hypothesis before the study was that people do not trust the technology used in driverless vehicles."

Discrete choice model

The researchers provided respondents with the challenge of taking a 15-mile commute. Individuals were asked to select between driving themselves or one of four options that included a regular human-driven RHS, driverless RHS, regular human-drive RHS with explicit mention of multitasking and driverless RHS with explicit mention of multitasking.

Attributes provided to the respondents included travel time, travel cost and wait time.

MacKenzie says, "We prepared a full factorial experimental design that contained a total of 81 stated preference scenarios. Our respondents were arbitrarily

assigned to one of four choice set groups and given six choice scenarios randomly selected from the 80 scenarios. Attributes provided to the respondents included travel time, travel cost and wait time."

A U.S. national online crowd sourcing platform known as Mechanical Turk was used to recruit respondents. MacKenzie says, "Mechanical Turk is a widely used platform that enabled us to easily recruit more than 500 respondents to participate in the study. We obtained over 90% valid responses. One concern, though, is that Mechanical Turk tends to overrepresent younger and highly educated people."

A discrete choice model was used to evaluate the results. MacKenzie says, "We

used this variation of a linear regression model to determine the relationship between two variables. In our case, we used it when the outcome variable is not continuous but gives the respondent the choice of Option A or Option B."

The study results indicated that RHS enabled respondents to achieve a 13% reduction in VOTT. This figure grew to 45% when the respondents were reminded that using a RHS will enable them to multitask. In contrast, respondents were not as comfortable using a driverless RHS. The VOTT for this situation was 15% higher than if an individual drove a personal car.

MacKenzie says, "We are not sure about the reasons for why a driverless RHS would

increase VOTT. It is possible that respondents are not comfortable using driverless vehicles because this technology is relatively new and most individuals are not familiar with it. With the future growth of driverless technology, it may be worth revisiting this study in the future to assess if there is a change in VOTT."

MacKenzie envisions expanding work in the future to a wider range of variables. He says, "We are considering the possibility of using a different commute length and also having respondents consider traveling for a different purpose other than commuting."

Additional information can be found in a recent article² or by contacting MacKenzie at dwhm@uw.edu.

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New thermoelectric approach

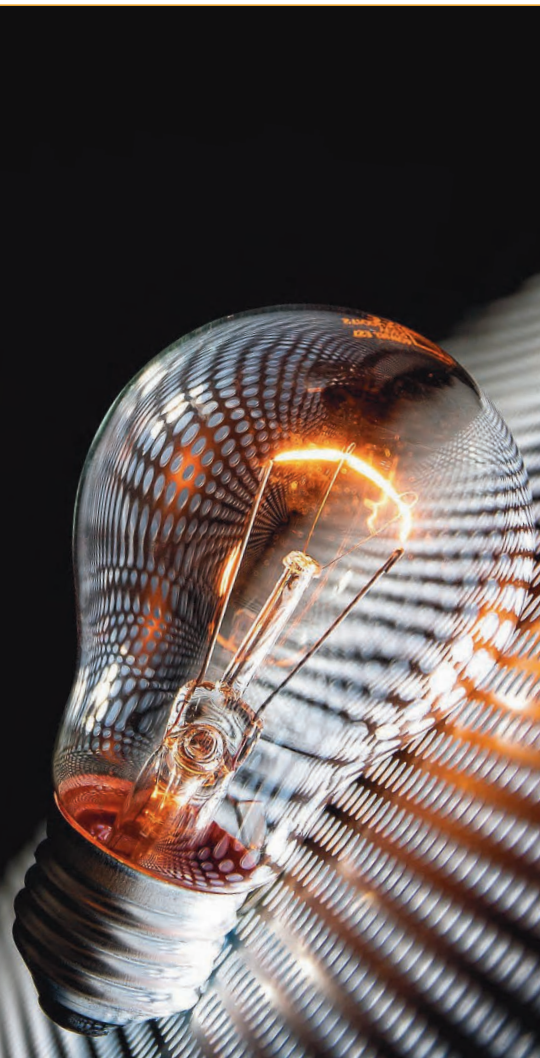


Figure 2. Paramagnetic materials now can be used to harness wasteful heat generated from components such as a light bulb.

Figure courtesy of The Ohio State University.

KEY CONCEPTS

New research shows a paramagnetic material can act in a thermoelectric manner.

Evaluation of lithium-doped manganese telluride showed that thermoelectric properties were found at temperatures above 300 K.

Paramagnon drag occurs in a more localized manner covering only two to three atoms in length over a short period of time.

Paramagnons have been found to exist in paramagnetic materials.

Research is continuing to develop more effective ways for utilizing heat that is the by-product of inefficient electrical and mechanical processes. One prime example is the wasteful heat generated from a light bulb (see Figure 2).

Thermoelectric materials have shown promise in converting heat into electricity by taking advantage of significant temperature differences between the heat produced by a specific device and ambient temperature. One parameter that researchers are working to improve is the figure of merit (ZT), which is a unitless figure directly related to the efficiency of a thermoelectric material.

In a previous TLT material, researchers used spin caloritronics to include the spin of electrons in polarized materials by adding this phenomenon to materials that have strong electrical conductivity but weak thermal conductivity.¹ A theoretical study indicated that a transition metal oxide based on cobalt, nickel and zinc appears to exhibit superior thermoelectric properties. A potential transition metal oxide was found by substituting 25% zinc and 75% nickel for one of the three cobalt atoms.

The origin of thermoelectric materials is due to their ferromagnetic properties. Joseph Heremans, professor of mechanical and aerospace engineering and Ohio Eminent Scholar in Nanotechnology at The Ohio State University in Columbus, Ohio, says, "Magnetic moments created by unfilled energy levels in atomic orbitals are aligned to produce permanent magnetism. As the material is heated, magnetism declines and the electron spins fall out of alignment creating waves known as magnons."

Magnons are able to interact with the electrons present in ferromagnetic materials when a temperature gradient is present in a material. Heremans says, "This interaction leads to the movement of electrons to the cold side of the material. As one

side of a ferromagnetic material is heated, the cold side becomes more magnetic producing spin that leads to the electron flow generating electricity. Magnons are involved by carrying electrons to the cold side of the material in a process known as magnon drag. An analogy for this is the example of a mudslide. Particles of sand by themselves do not cause much of a problem when flowing down the side of a mountain. But when water is used to drag the sand, this creates a more significant effect leading to the movement of a greater flow of sand."

Lithium doping is an essential aspect of this work.

Magnon drag makes a considerable contribution to the effectiveness of thermoelectric materials. Magnetic materials lose their effectiveness at high temperature becoming converted into paramagnets. Heat leads to the speeding up of atoms but enables them to spin in all different direction reducing their alignment and magnetism. This creates the phenomenon of paramagnetism.

Heremans says, "An analogy for the conversion of magnetism to paramagnetism is the melting of water where the order present in the solid phase is lost as more randomness is present in the liquid phase."

To date, there has been no indication that paramagnetic materials can act in a thermoelectric manner. New research has just determined that paramagnetic materials can help to improve the conversion of heat into electricity.

Paramagnon drag

Heremans and his colleagues determined that a paramagnetic material can be designed to produce a thermoelectric figure of merit greater than one at temperatures higher than 900 K. He says, "We worked

with lithium-doped manganese telluride, which is a well-known semiconductor that acts as a thermoelectric material that is known to generate a strong magnon drag effect. Our approach was to dope manganese telluride with specific concentrations of lithium and evaluate the thermopower produced as the temperature is increased."

Heremans pointed out that no work had previously been done to evaluate paramagnetic materials. He says, "In the past, it was not believed that magnon drag could extend to paramagnets. When we worked with lithium-doped manganese telluride we initially found magnon drag at low temperatures. As the temperature increased to above 300 K and the lattice for this material melted, we found that magnons can survive in the paramagnetic regime. These particles we designated as paramagnons, and we found

they produce a similar drag effect to what is seen in the ferromagnetic regime."

Heremans believes that paramagnon drag occurs in a more localized manner that covers only two to three atoms in length for a short period of time. He uses the analogy of liquid water molecules that retain the memory of the solid before they melt. He says, "These liquid molecules are not completely random but tend to arrange themselves in smaller clusters than are found with ice."

The researchers used neutron scattering experiments demonstrated the existence of paramagnons. Heremans says, "In the paramagnetic regime, we found that paramagnons contribute 80%-90% of the thermoelectric effect at high temperatures."

Lithium doping is an essential aspect of this work. The researchers evaluated the

performance of non-intentionally doped manganese telluride and found that the figure of merit is much lower than when lithium doping is carried out.

This is the first study to determine that paramagnetic materials can contribute to the thermoelectric effect. Heremans indicated that the researchers will not be revisiting other semiconductors to determine their effectiveness in the paramagnetic regime. He says, "We will be evaluating the thermoelectric materials, lead and germanium manganese telluride, which should be effective in the paramagnetic regime at elevated temperatures."

Additional information on this study can be found in a recent article² or by contacting Heremans at heremans.1@osu.edu.

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A catalyst for hydrogen generation

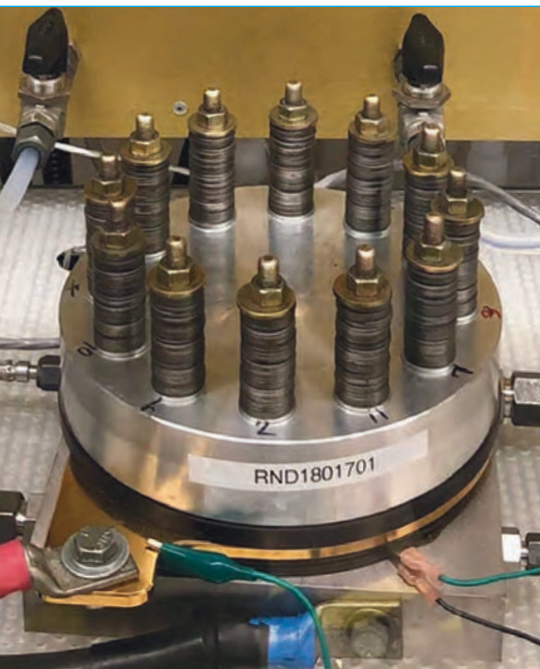


Figure 3. Researchers scaled up production of the non-precious metal catalyst, cobalt phosphide to prepare sufficient material that can be used in the 86 cm² PEM electrolyzer shown.

Figure courtesy of Stanford University and the SLAC National Accelerator Laboratory.

KEY CONCEPTS

A non-precious metal catalyst, cobalt phosphide, has been found to effectively split water in acidic pH without the need for platinum.

The catalyst can be readily scaled up through a new process and demonstrated good, consistent performance.

A power failure encountered during long-term stability testing showed that the catalyst has strong robustness and may be suitable for applications involving renewable sources of power.

The non-precious metal catalyst was stable in the corrosive acidic environment of a PEM electrolyzer.

Hydrogen has significant uses in industrial applications such as in the refining of fuels and the manufacture of basic chemicals such as ammonia and methanol. Interest in using hydrogen stems from the opportunity to manufacture it using renewable energy, along with the potential growth in its market as an energy source in fuel cells or as an alternative to the internal combustion engine.

A number of approaches have been tried to manufacture water electrolyzers with the favored strategy being that of using polymer electrolyte membranes (PEMs) in an acidic environment. In a previous TLT article,¹ researchers reported the development of a multifunctional catalyst based on oxides of copper, chromium and nickel that is effective in splitting water at neutral pH. The objective of operating at neutral pH is to develop a more environmentally favorable process that may be more cost effective in being able to use readily available salt water without further processing. The catalyst demonstrated the lowest potential seen to date for splitting water at neutral pH.

Dr. Thomas Jaramillo, director of the SUNCAT Center for Interfacial Science and Catalysis, a joint partnership between Stanford University in Palo Alto, Calif., and SLAC National Accelerator Laboratory in Menlo Park, Calif., says, "There are two commercial approaches for splitting (or electrolysis) of water with the early one emerging nearly a century ago involving operating under alkaline conditions. In more recent years, the PEM technology has been commercialized and has proven to be very effective with great promise in the long-run."

The problem with the PEM technology is that it employs platinum catalysts, which are very effective but also very expensive. The result is that researchers have been looking for more cost-effective options that involve the use of non-precious metals.

Jaramillo says, "Many non-precious metal catalyst options exist for electrolysis of water under alkaline conditions. Unfortunately, acidic media is not compatible with non-precious metals because most options do not survive under the severe conditions.

One approach for identifying a non-precious metal catalyst was found in the discovery that natural enzymes (hydrogenases and nitrogenases) were found to produce hydrogen under neutral pH conditions. Jaramillo says, "One non-precious metal catalyst inspired by these enzymes was molybdenum disulfide."

This is, of course, the same material that is widely used as a solid lubricant. Jaramillo continues, "The performance benefits seen with molybdenum disulfide led us and others to evaluate a series of other ionic compounds to determine their efficacy as catalysts."

Jaramillo and coworkers, including doctorate student McKenzie Hubert and research associate Dr. Laurie King, scaled up a phosphide-based catalyst for use in commercial water electrolyzers. Together with collaborators at Nel Proton Onsite in Wallingford, Conn., the team found that the non-precious metal catalyst can split water effectively in acidic pH without the need for platinum.

Cobalt phosphide

Jaramillo and his colleagues scaled up the synthesis of cobalt phosphide as a non-precious metal catalyst and found that it is stable in the corrosive acidic environment of a PEM electrolyzer operating under true commercial conditions. Jaramillo says, "This catalyst is not as effective as platinum but represents a step in the direction of seeking a non-precious metal catalyst with comparable performance."

The researchers developed a synthesis of cobalt phosphide that can readily be scaled up. Cobalt phosphide was prepared by impregnating cobalt nitrate onto Vulcan

carbon followed by vapor-phase phosphidation. The process used enabled the catalyst to be mechanically adhered to the substrate used in the electrolysis process.

Jaramillo says, "The process for synthesizing cobalt phosphide enabled us to produce sufficient material for use in a commercial scale 86 cm² PEM electrolyzer." The image of the electrolyzer used to produce hydrogen from water is shown in Figure 3.

The morphology of the catalyst showed that cobalt phosphide nanoparticles with an average diameter of five nanometers were well dispersed on the carbon support. Jaramillo says, "The catalyst we prepared scaled up well and demonstrated good, consistent performance during our evaluation."

The cobalt phosphide catalyst was studied versus a commercial platinum catalyst in both lab-scale cyclic voltammetry testing and in a commercial scale electrolyzer using

gas diffusion electrodes. Operating conditions were 400 psi and 50 C. Jaramillo says, "The gas diffusion electrodes are contained on the membrane electrode assembly. This is a three-phase set up with liquid water passing through the solid catalyst leading to the generation of gaseous hydrogen and oxygen."

The reaction occurring at the anode produces oxygen and hydrogen ions that move across the membrane to meet up with electrons flowing through an external circuit at the cathode, allowing for the production of hydrogen.

The researchers found that the cobalt phosphide catalyst produced hydrogen at a turnover frequency of approximately 0.87 molecules per second to achieve the operating current density of 1.8 ampere per square centimeter. Negligible changes to catalyst efficiency were observed over 14,700+ hours of continuous hydrogen production.

Jaramillo noted that a power failure did occur during the long-term stability test, but the catalyst displayed strong robustness in resuming splitting of water once power was restored. He says, "While we did not plan to interrupt the hydrogen generation process, the resiliency demonstrated by the catalyst after the power failure suggests that this type of catalyst might be suitable for applications involving renewable sources of power (such as wind or solar) that can suddenly stop producing electricity."

The researchers will be continuing to evaluate other types of non-precious metal catalysts to find one that comes closer in performance to platinum.

Additional information on this research can be found in a recent article² or by contacting Jaramillo at jaramillo@stanford.edu.

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Douglas Adams

This RSC Bio Solutions chemist develops lubricants for marine and other environmentally sensitive applications.

By Rachel Fowler
Managing Editor

Douglas Adams The Quick File

Douglas J. Adams is a graduate of the University of Pittsburgh with a bachelor's of science degree in chemistry. His professional career after graduation began with evaluating the water quality of the Ohio River and its tributaries.

His 25-year career in the lubrication industry began at the Southwest Division of the Witco Corp., initially as a chemist until he progressed to be the laboratory manager at this grease manufacturer.

His next challenge was in the lubricant additives industry when he joined Albright and Wilson and developed performance additives based on phosphorus and polymethacrylates.

Adams then held the position of laboratory manager at Battenfeld Grease and Oil. His path led him back to the additives industry at The Elco Corp. in Cleveland, Ohio, where he developed grease and metalworking additives and additive packages.

Now with RSC Bio Solutions in Indian Trail, N.C., Adams develops high-performance environmentally acceptable lubricants used in marine and environmentally sensitive land-based applications.



TLT: When did you first get involved with environmentally friendly lubricants?

Adams: My first significant experience with environmentally friendly lubricants (EALs) occurred when I joined RSC Bio Solutions five years ago. Prior to working for RSC Bio Solutions, I made some lithium greases with canola base oils that were oxidatively unstable.

TLT: How has the landscape for EALs changed since then?

Adams: We were limited to using only vegetable base oils 25 years ago, and since then there have been a number of base fluids developed that meet the EPA's definition of an EAL. Vegetable oils or triglycerides are still used; certain synthetic esters and PAGs also are used. The base fluid that we are using to develop high-performance, commercially viable lubricants are primarily based on PAO and hydrocarbon-related base fluids.

The marine industry is our largest end-use market.

TLT: What are the largest end-use markets demanding EALs?

Adams: The marine industry is our largest end-use market. The use of EALs in the marine market is primarily due to legislation in place for the marine industry for ships operating in U.S. territorial waters that are larger than 79 feet. This legislation was initially adopted in 2013 as the Vessel General Permit or VGP 2013.

Another growth area for this industry is in risk mitigation associated with spills. Lubricant spills that occur on heavy equipment and waste management equipment, for example, are typically caused by pump or seal failures. These spills are subject to clean-up costs and fines. The use of EALs

significantly reduces the costs associated with spills and could lead to a different direction in the press coverage when the spill is reported to the public. Construction over waterways and environmentally sensitive areas utilize EALs for the same reasons.

TLT: Are there new regulations coming online that will make significant changes in the future?

Adams: New legislation is being considered by the EPA that could strengthen or weaken the current guidelines. The current VGP guidelines target oil/water interfaces where the lubricant could be released into the environment. In early 2020 the EPA could reduce the demands initially set forth in VGP 2013 guidelines.

After the EPA issues those guidelines, there will be a comment period, and after the comments are reviewed, the U.S. Coast Guard will decide how best to enforce the guidelines set forth by the EPA, and the VGP will be replaced by the Vessel Incidental Discharge Act. We believe it is possible that the demands of guidelines could be reduced by the EPA since commercial entities are actively pursuing a less stringent set of environmental requirements.

TLT: What is the most difficult performance parameter for an environmentally friendly lubricant?

Adams: Finished hydraulic fluids and gear oils made with synthetic esters, polyalkylene glycol and triglyceride-based lubricants have hydrolytic stability concerns that need to be overcome. The base fluids that we utilize do not have significant water stability issues, and we focus our developmental efforts toward improving the oxidation stability and extreme-pressure performance of the lubricant.

Greases used in either marine applications or outdoor environments are exposed



The EPA has started plans to replace 2013's Vessel General Permit with the Vessel Incidental Discharge Act, which could be less stringent.

to water, and we formulate our products to have exceptional water spray off and water washout performance. Once again, the oxidation stability and extreme-pressure profiles of the grease need to be targeted.

TLT: Are there applications where an EAL would be preferred but it is not yet possible to meet the performance demands?

Adams: Until recently, some of the high-load grease applications that require four-ball weld performance to be above 800 kgf were not attainable. However, recently there have been products developed to address those applications.

TLT: Comparing the U.S., Europe and Asia, which region has the most interest in EALs? Due to current VGP guidelines, the majority of EALs are used on ships in U.S. territorial waters. Do you think this will change in the future?

Adams: The EU currently has a significant amount of interest; however, Ecolabel is not enforced in the same manner throughout Europe. The Asian market recently has been looking into developing guidelines relating to the use of EALs.

We believe there will continue to be environmental regulations for oil/water interfaces on ships. Regulations will continue to evolve that we believe will improve the quality of our seas.

TLT: Is there a universal definition of EAL, or does each region and market define them differently?

Adams: While there is not a universal definition of an EAL, the VGP 2013 definitions are generally accepted to describe an EAL. The VGP 2013 defines an EAL to possess the following characteristics:

- Must biodegrade by 60% or more after 28 days
- Must be minimally toxic to certain marine species
- Must not bioaccumulate in the fatty tissue of fish.

In addition, if a product can be approved under Ecolabel as an EAL then the lubricant also can be classified as VGP compliant.

TLT: What are the most important characteristics of an EAL?

Adams: EALs need to perform as well or better than mineral oil-based lubricants in terms of hydrolytic stability, seal compatibility, oxidation stability and extreme-pressure protection.

Perhaps at one time the performance characteristics described immediately above were not readily attainable; however, new base fluids and additives have led to dramatic improvements in the previously stated performance characteristics of EALs.

TLT: When developing a new formulation, do you start with environmentally friendly ingredients and work to meet the performance requirements or start with a standard formula then work to make it environmentally friendly?

Adams: My suggestion is to start with an environmentally friendly base fluid such as a triglyceride, a synthetic ester, a polyalkylene glycol or a PAO and hydrocarbon-related base fluid to begin the formulation and move forward. Base fluids that are defined as EALs vary significantly in terms of performance. After the base fluid is selected, a review of the lubricant substance classification (LuSC) list is required to determine the additives that can be used to meet the desired performance. The LuSC list was developed by the EU and can also be used to determine acceptable treat rates for each component.

Metals that are typically used in mineral oil-based lubricants, like zinc and antimony, cannot be used in EALs. Consequently, most low-cost EP/AW additives are out of the question. There are new additives and base fluids being developed to improve the performance and cost of EALs. We are optimistic there will continue to be significant growth in the use of EALs for land and sea applications. 🌍

You can reach Douglas Adams at dadams@rscbio.com.

Engine efficiency through surface engineering

New research reveals how a more holistic approach reduces friction loss.

By **Andrea R. Aikin**
Contributing Editor



U.S. Corporate Average Fuel Economy standards require 3%-5% improvement in new vehicle fuel economy each year through 2025. Increasing engine efficiency continues to be a driving force behind engine design, with manufacturers looking at all options to reduce friction and increase fuel economy.

The different types of engines and their different uses, combined with the different types of fuels available, complicate the process of increasing engine efficiency. Although some technologies are well known, they still can be improved upon, and novel solutions to reduce friction and wear are being studied.

Combining coatings and additives can have antagonistic effects.

Modern engines use a wide range of coatings, surface finishes and texturing on engine parts to reduce wear and friction on moving parts. In addition to coatings, finishes and texturing, lubricant additives in engine oil are used to reduce wear and increase fuel economy. However, in some cases, the combination of coatings and additives can have antagonistic effects, increasing wear and friction inside the engine instead of reducing them. In response to this issue, research is being performed to

produce engine coating/lubricant combinations that work synergistically to reduce wear and friction.

Coatings

STLE-member Arup Gangopadhyay, the Ford Motor Co. technical leader for Powertrain Tribology in Novi, Mich., states, "The interface between cylinder bore and piston (and rings) contribute about 45% of the total frictional losses in an engine." Coatings and surface finishes offer opportunities to reduce this engine-friction loss.

STLE-member Hamed Ghaednia, director of research and advanced manufacturing at Gehring L.P. in Farmington Hills,

Mich., notes that tribology improvements in cylinder bore coatings usually occur through the introduction of surface porosity, where the surface pores act as pockets that hold lubricant and deliver the lubricant to the piston group contacts. These surface pores also offer a texturing effect on the surface that can improve film thickness and reduce friction. This use of pores offers new ways to design final surface finishes for various applications to reduce friction and mitigate wear.

Spray bore coating has been used in engines for nearly three decades. These coatings are a substitute for cast-in liners and offer benefits that include weight reduction, improved heat transfer, reduced crevice volume and improved bore spacing. Ghaednia notes that new studies are being done to improve spray bore coatings in conjunction with surface finish to improve the overall tribology.

Gangopadhyay found that the Mo-NiCr coating is widely used in gasoline engines on piston rings. The coating is typically deposited using a plasma spray process that results in the coating being a little porous and rough. In addition, CrN, a physical vapor-deposited hard coating, and solid lubricant diamond-like carbon (DLC) coating have been used recently for friction and wear reduction. Both the CrN and DLC coatings tend to be smoother than the Mo-NiCr coating.

The CrN and DLC coatings are used on the engine's top compression ring and occasionally also on oil control rings. Both CrN and DLC coatings are hard, wear-resistant coatings that could be beneficial when a low-viscosity engine oil is used.

In newer engines, thermal spray coatings are being used on cylinder bores with the coating directly deposited on the aluminum bores, eliminating cast iron liners, which can save between 4-8 pounds of engine weight, depending on the engine architecture. The deposition process introduces porosity that is mostly less than 2%. However, Gangopadhyay noted that this friction reduction is attributed to oil retention, combined with the pores acting as randomly distributed texture that results in

improved oil film thickness, which reduces asperity contacts. Asperity is the unevenness of a surface; even when polished to a mirror finish, some microscopic unevenness remains.

Gangopadhyay stated that "polymer coatings in crank bearings are increasingly used to protect against wear and seizure for turbocharged direct injection engines and engines with start/stop features in micro, mild and full hybrid applications." These crank bearings contain solid lubricant par-



The interface between cylinder bore and piston contribute 45% of an engine's total frictional losses.

ticles that are mixed with hard particles in a polymer matrix. When low-viscosity engine oil is used, further improvements may be needed in wear protection.

Jianliang Lin, principal research scientist at Southwest Research Institute® (SwRI®) in San Antonio, Texas, and his team have two patents for the development of a special piston ring coating that has been shown to reduce friction and wear in both gasoline and diesel engines. The work was originally funded by the SwRI Internal Research Project with the goal of developing advanced low-friction nanocomposite coatings for piston rings for improving engine fuel economy.

The SwRI TiSiCN nanocomposite coating consists of 5-10 nanometer TiCN-nanocrystals embedded in a $\text{Si}_x\text{C}_y\text{N}$ -based amorphous phase. For the piston ring application, the coating can be 15-40 microns, although more than 500-micron thick coatings have been developed for other applications. The plasma-enhanced magnetron sputtering (PEMS) technique was used for depositing the piston ring coatings with the coatings' structure and composition tailored to achieve multifunctionality (i.e., good adhesion, low friction, low wear rate and sufficient thickness).

Lin says, "The piston ring coating was iteratively optimized for its tribological performance in a series of tests including sequentially, pin-on-disc test and Plint TE77 test to narrow down the selection of the coating, single cylinder gasoline engine test to determine the piston ring friction contribution to the entire engine friction loss and heavy-duty diesel engine test to determine the coating wear."

Then the best-performing coating was selected and deposited on the actual piston rings of a four-cylinder gasoline engine, which was then tested using the EPA standard method to determine fuel efficiency in city and highway driving. The SwRI research team found that the coated piston rings exhibited "approximately 1% of improvement in fuel economy," compared to the vehicle engine without the coating.

Surface finishes

The surface finish that exists on cylinder bores is another area of study. Gangopadhyay notes that the typical surface roughness of bores is "about 0.3-0.4 μm (Ra)." Some recent engines have shown improved surface finishes; however, to realize the full benefit from surface finishes, the surface finish of the bore must be appropriately matched with rings and appropriate coatings.

Gangopadhyay noted that in the early 2000s many engines with sliding valve trains were produced with surface finishes and coatings on the cam followers to reduce friction. The recent trend is to use the roller finger follower valve train design, which offers less opportunity for coatings and surface finishes to be used.

According to Gangopadhyay, an optimal solution that considers coatings and surface finishes on cylinder bores, piston skirts and piston rings, “can show up to 2% fuel economy improvement in U.S. metro/highway drive cycles.” The full potential of these coatings can be realized by minimizing cylinder bore distortion.

Ghaednia noted that the laser texturing of surfaces (i.e., laser honing when applied to cylinder bores) introduces depressions in the surface in the form of pockets, lines or complex geometries. The goal of the texturing is to increase surface oil retention as well as introducing a texturing effect to control the oil film thickness and reduce wear. Ghaednia stated that one of the reasons laser honing is being evaluated again is that state-of-the-art computer-aided engineering tribological models are more effective at predicting the effect of textures on the surface.

Results

When looking at the different operating conditions of engines (i.e., gasoline vs. diesel, standard internal combustion engines vs. electric vehicle engines, etc.), the friction reduction benefits of these technologies varies depending on engine speeds and operating temperatures. For example, some piston ring coatings show significant benefits at low speed and high temperature, while others show a friction increase at low speeds but a friction decrease at higher speed. ▶

Gangopadhyay notes that this behavior “could be very easily altered when combined with a spray bore coating,” which indicates that benefits vary depending on the application and the different operating conditions. For example, diesel engines tend to run at lower speeds and at lower engine oil temperatures than gasoline engines. In contrast, in hybrid engines, the oil temperature tends to be cooler than in standard engines as a result of the intermittent engine usage. These variables mean

that friction benefits need to be evaluated depending on specific usage to identify the different operating conditions and the best technologies for those conditions.

Even when considering the finances of vehicle manufacturing and the competition between engine manufacturers, Ghaednia does not see barriers to introducing new manufacturing techniques and coatings because engine manufacturers “are open to bringing new manufacturing solutions and are investing in developing flexible



Lower-viscosity engine oils means new coating technologies are needed for wear protection on critical engine components.

Want more on coatings? Check out these TLT Archives stories.

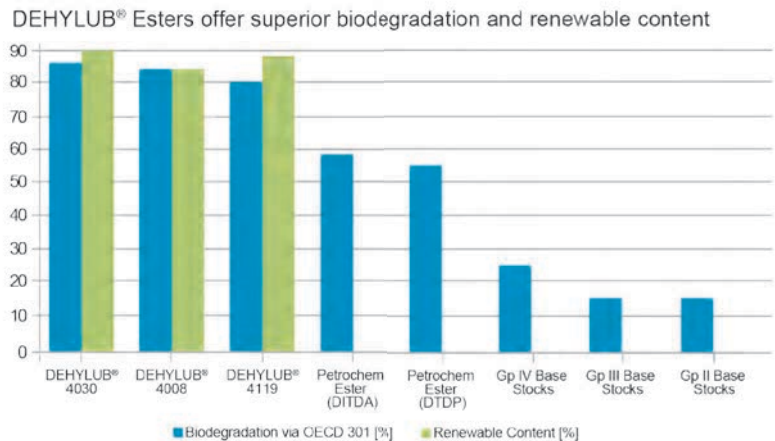
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► and new techniques constantly.” This means that the number of new additives and coatings used in vehicles and engines is on the rise.

Spray bore coating has been used in engines for nearly three decades.

Future focus

There is a trend toward using lower-viscosity engine oils from 5W-20 to 0W-20 and lower (e.g., 0W-16, 0W-12 and even 0W-8). This trend means there will be a need for new coating technologies for wear protection on critical engine components

(i.e., valve and valve guide interface, piston skirt, bearings, etc.). If these coatings also can reduce friction, that will be a plus. However, these coatings need to ensure that other performance attributes like oil consumption and NVH (noise, vibration and harshness) are not compromised. Lower-viscosity oils also might need an improved surface finish on components like crankshaft journals, camshaft journals, etc., to best operate.

Lin notes that current SwRI research is focusing on using the previously described special piston ring coating on other moving components in an engine (e.g., camshafts, fuel intake valves, exhaust valves, etc.) to

further improve fuel efficiency and reduce friction. The coating has already been used in other applications where low friction and high wear resistance are needed, including in the oil and gas field and in cutting tools. Lin has found industry manufacturers to be interested in this new coating and noted that SwRI is “working with several international automotive business-related companies on research projects for further optimizing the coating microstructure and architecture for reducing friction and wear for engine components.”

Andrea R. Aikin is a freelance science writer and editor based in the Denver area. You can contact her at pivoaiki@sprynet.com.

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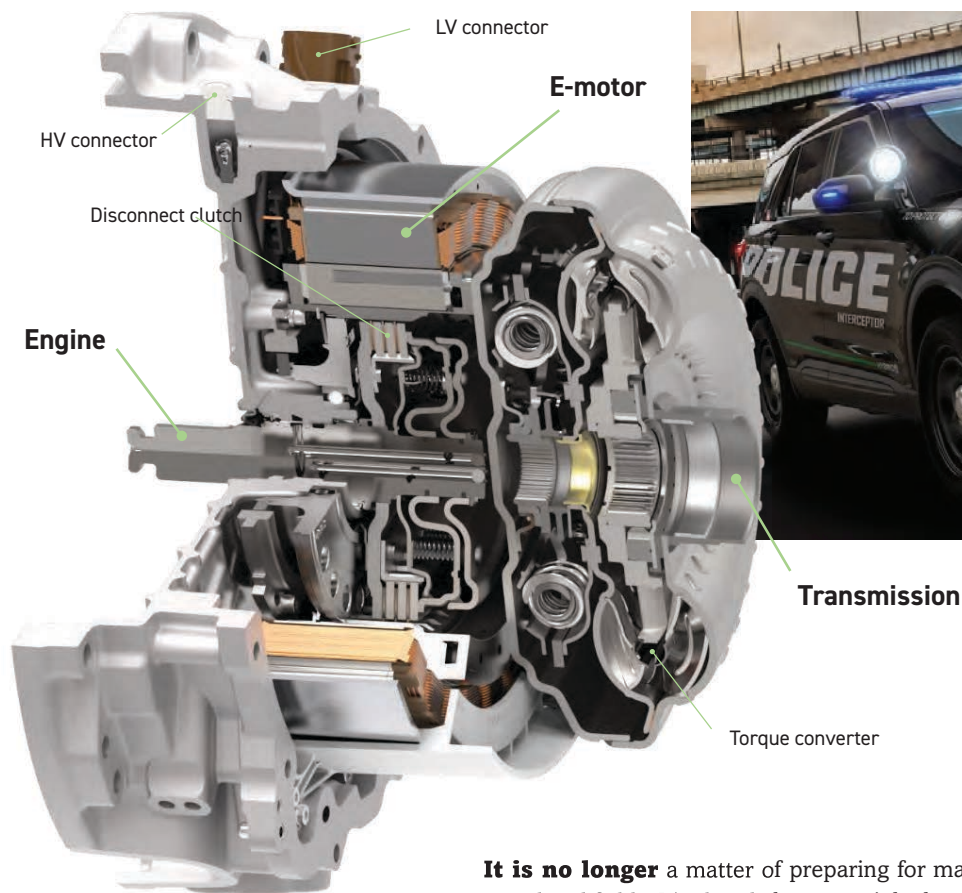
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New vehicle technology and market innovation

Some fluids are going, some staying and some have new roles.

By Jeanna Van Rensselar
Senior Feature Writer



(Images courtesy of Schaeffler Group USA Inc.)

KEY CONCEPTS

Market innovation has arrived for those involved in auto lubrication and tribology.

The need for some fluids will change but might not diminish overall as electric vehicles continue gaining market share.

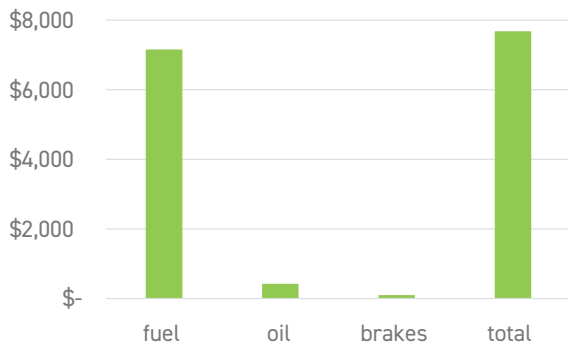
Organizations with an innovation mindset are most likely to thrive.

It is no longer a matter of preparing for market innovation in lubricant and tribology-related fields. It's already here—mainly due to the accelerated transition from internal combustion engines to electric.

Jeff Hemphill, CTO, Schaeffler Group USA Inc., says, “The main thing for people in any field is to watch the trends and spend time thinking about how they could impact your product. For example, electric vehicles are gaining momentum. On an absolute basis, they need a lower quantity of lubricants and additives. But where does the energy get used in an electric vehicle versus a conventional one? Is lubrication more or less important overall? What points of friction exist, and could unconventional approaches work better than simply adopting the equivalent from the conventional vehicle?”

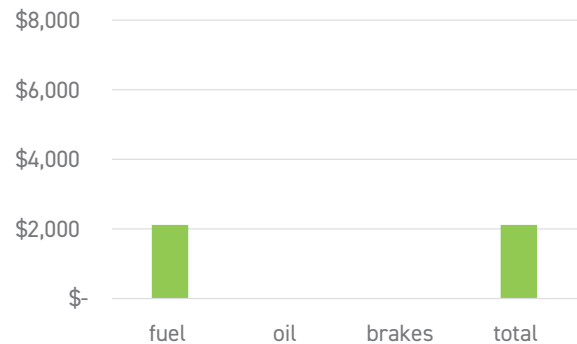
Hemphill, the keynote speaker at STLE’s 2019 Annual Meeting & Exhibition in Nashville, urges colleagues to think about their work as more than just providing a product. Instead of saying “we provide lubricants,” tribologists should re-cast their role as “motion facilitators” who think about where motion is happening in the changing landscape and where they could offer value.

Combustion Engine



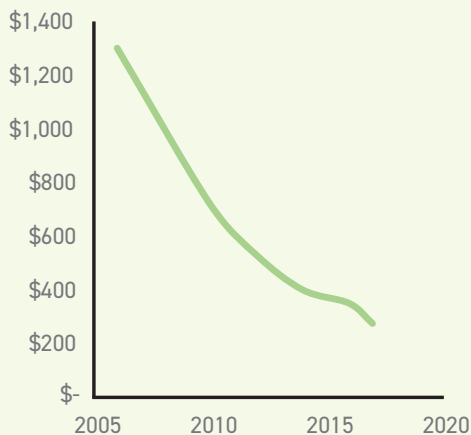
- ▶ A miracle of complexity
- ▶ "Fill-for-life" still has maintenance

Battery Electric



- ▶ Very simple
- ▶ "Fill-for-life" is a reality

Battery Cost [\$/kWh]



The EV market

The market for electric vehicles is approaching a tipping point for reasons that center mostly on the battery: longer time between charges, faster charging technology and lower cost of original and replacement batteries (*see charts*).

STLE Fellow John Burke, CMFS, and global director of engineering services, Quaker Houghton, says there are five basic market drivers:

1. The increased distance a battery electric vehicle (BEV) can travel between recharging—allowing for a practical ride option for daily commuters.
2. Energy cost per mile is now less for the electric car.
3. The perception of less maintenance.
4. Near zero onboard emissions.
5. The cost for electric vehicles has come down, making it affordable for a larger market.

“Investments in information campaigns and general education of the consumers are driving adoption,” Burke says. “The more people learn about electric cars, the more comfortable they become. Also, variety is increasing. There are more options/brands, etc., participating and providing more choices. You can now get an electric SUV and soon will be able to get a pickup truck, whereas before options were limited to small cars.”

EVs, fluids and tribology

“The fluids also have some new jobs to do,” Hemphill says. “For example, automatic transmission fluid today has to facilitate controlled friction in the wet clutch packs, remove the heat from the clutches and do both for more than 100,000 miles. In an electric axle gearbox, the heat might need to be removed from the electric motor, and there are likely no clutch packs. This might make viscosity and specific heat more important than friction modification.”

So which fluids will have diminished needs in an electric vehicle?

Burke says four fluids come to mind: antifreeze, motor oil, automatic transmission fluid and rear differential gear oil. He explains, “These affected fluids will not be needed except for a possible small amount of heat transfer fluid for the battery pack and electric motor. Also, with electric vehicle regenerative braking, the strain on the brake fluid will be less (admittedly, this is a small volume for each vehicle). Overall the

fluid volume in the electric car for lubricants will decline.”

Regarding metalworking fluids for production, Burke says the need for those, too, will decrease. Electric cars do not need radiators, exhaust pipes, catalytic converters, engine blocks, pistons, camshafts, connecting rods, crankshafts, drive shafts, transmissions and associated gear sets, clutches and associated components and rear differentials (assuming an electric motor is used at each drive wheel).

“Therefore, there will be a reduction in stamping/forming fluids, straight cutting oils, water-dilutable cutting fluids, heat treat quenchants, in-process and interim corrosion preventive fluids and cleaning fluids to make these components,” he says. “The burden to dispose of such fluids also will decline.”

STLE Past President Dr. Ali Erdemir, Argonne Distinguished Fellow, Argonne National Laboratory Applied Materials Division, agrees, “There are fewer moving components in an electric vehicle, and, hence, the diversity or type of lubricants also is fewer: gear oils, greases, etc. These might differ from those used in internal combustion engines mainly because of the differences in contact load, speed and heat, which may require better antiwear, anti-scurf capabilities.”

Electric vehicles use conventional transmission fluids.

STLE Past President Dr. Edward P. Becker, P.E., president and founder of Friction & Wear Solutions, LLC, adds, “An electric vehicle has no combustion process to deal with, so there is no engine oil in the conventional sense; this is the biggest change. However, electric vehicles are still using many of the same lubricants. For example, greases for wheel bearings, suspension components and body closures

are essentially unchanged. To date, all electric vehicles are using conventional transmission fluids to lubricate the motor and gears. A new lubricant optimized for the high loads at low speeds will be required for future electric vehicles.”

One major difference, according to Hemphill, is that with electric vehicles, friction losses are a bigger percentage of the on-board energy of the vehicle than in a conventional car—making drag reduction even more important.

“The electric car can accelerate faster than a conventional internal combustion engine, therefore there may be more stress on the lubricant within these components,” Burke says. “Although not a lubricant issue, tire wear is expected to increase due to increased acceleration ability of the electric car” (see Figure 1).

EV issues

The permanent magnet motor currently offers the highest output for a given size and is the preferred design for automotive motors, Becker says. “The best permanent magnets are currently made from some combination of rare earth elements (neodymium, dysprosium and terbium) with iron and boron. These rare earth elements are primarily supplied by China, and the price is subject to great uncertainty. The induction motor, while heavier, is mainly made of iron and copper and is therefore less expensive.

Both types of motors are currently in use in electric automobiles.”

Hemphill points to new issues arising due to the high speed in electric axle gearboxes—for example, bearing creep where the outer race rotates in the housing. This may need surface coatings or tribological solutions. Another new challenge is the presence of high voltages in the gearbox. Due to power switching, which is used to control electric motors, static charges build up and sometimes discharge through the bearings or gears. “In this case, the lubricant becomes the dielectric in a capacitor. A variety of solutions are being explored which may involve insulation, lubricant modification or shunts.”

Becker advises that electric motors themselves are extremely reliable and seldom experience wear-related failures. However, the reduction gears used in electric vehicles to date are subject to very high loads at low speed, much higher than gears in conventional transmissions; thus, these gear loads are the most likely cause of failure in an electric vehicle.

Hemphill points out that the trend toward ride-sharing creates another issue. “Durability is even more important,” he says. “As shared mobility concepts enter the market, vehicles will be used up to 50% or 60% of the time, as opposed to today’s 4% or 5%. Durability is a key part of making the shared mobility ecosystem work.” ▶



Figure 1. Tires wear out faster on electric vehicles due to their increased acceleration ability.



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► **Autonomous vehicles and tribology**

Now that electric vehicles are becoming more mainstream, the next challenge is the design of autonomous vehicles. Schaeffler Group’s Schaeffler Mover robo-taxi has four 90-degree steerable wheels, each with a planetary gearbox. The vehicle goes from one gearbox to eight—creating a significant demand for lubrication.

In addition, the company has recently formed a joint venture with Paravan, which makes drive-by-wire systems (originally to

allow handicapped people to drive). “This solution was quickly adopted by several automotive and industrial OEMs as they created autonomous vehicles because it offers ‘fail functional’ reliability in both electro-mechanical and electrical components,” Hemphill explains. “We are now developing a high-volume version of this that we call SpaceDrive III. This will include actuators and also our own custom eMotors. Since these motors are built into the gearbox, they have the same tribologi-

cal challenges as electric axles.”

Although Erdemir doesn’t have much involvement with autonomous vehicles, he postulates that quick responses to stop/start commands, noise/vibration control (use of good/better lubricants) and temperature extremes might present challenges (see *The Forecast for Autonomous Vehicles*). ►



The forecast for autonomous vehicles



Levels of automation are classified in the following way:

- L0:** Driver (all responsibility to the individual)
- L1:** Feet off (transfer of responsibility)
- L2:** Hands off (transfer of responsibility)
- L3:** Eyes off (transfer of responsibility)
- L4:** Attention off (transfer of responsibility)
- L5:** Passenger (all responsibility to the machine).

According to Frost & Sullivan’s 2018 Global Autonomous Driving Outlook¹, the five top trends to watch are:

1. Rise of virtual voice assistants. The widespread introduction of voice-assisted technology in vehicles, most of which would not require a consistent internet connection.
2. Centralized domain architectures. The introduction of centralized architectures that enable true L3 and L4 autonomous driving.
3. Improved vision and depth-sensing solutions. The advent of vision sensors including 4D cameras, far IR sensors, 360-degree radars and trifocal cameras for better object detection and classification.
4. Shared mobility platforms. OEMs realize the introduction of Level 4 tech is most certainly going to be a ride-hailing service, prompting them to collaborate with or acquire start-ups with fleet management software and cybersecurity capabilities.
5. Artificial intelligence powering development, testing and validation. With increasing amounts of data being captured and processed and with better learning capabilities, AI in cars should grow exponentially.

Following is the rate of adoption major OEMs plan for autonomous vehicles.

Volkswagen: L2 autonomous vehicles by 2019

Hyundai: L4 autonomous vehicles by 2021-2022

Renault: L4 autonomous vehicles by 2022

Mazda: Autonomous driving technology on Mazda vehicles by 2025

Nissan: L2 autonomous vehicles by 2019

Porsche: Optional autonomous drive mode operational on driver’s demand.

The report explained that mass-market-vehicle OEMs lean toward improving and increasing active safety and driver assistance features more than introducing any form of autonomous driving features in their existing models.



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Experts predict a permanent shift toward renewable energy sources to compensate for the increased strain on the electric grid.

► **Sustainability and reliability**

There's no doubt there is going to be a permanent shift toward renewable sources of energy to support the electricity needs of these new vehicles, but that comes with its own issues.

"There will be a strain on electrical generating capacity and the electric grid," Burke predicts. "The grid will be strained on both a macro and micro scale. The energy source to make electricity in power plants will have to increase. That will be from sources such as nuclear, coal, natural gas, wind, solar or even oil. Is there enough electric-generating capacity to make a conversion from oil (as used to make gasoline and diesel fuel) to these other electric energy sources?"

The variety of energy sources is likely to increase.

He continues, "Right now, in certain cities, the macro grid is strained on very hot summer days. It will only get worse as the number of electric cars on the road increases. The micro grid (your neighborhood and home) also will be strained. Imagine if in a neighborhood of 50 homes all having electric cars and all are charging at 6 p.m. Local electrical transformers might not have the capacity to handle that surge. For rapid charging, some homes may need an upgrade from traditional 60-100 AMP panels

to 200-AMP panels, plus larger wires from the utility source into the house."

Hemphill envisions a protracted transition. "We face a long change process toward pure renewables, and the variety of energy sources is likely to increase," he says. "For example, natural gas emits less CO₂ than coal but is not CO₂ neutral. Therefore, the falling costs of wind and solar energy will allow them to play a larger role in the future. As more of the grid becomes renewable, grid energy storage will be needed for reliability. This is a great area for engineers to focus on. Our own company has invested in CMBlu, a start-up using natural lignin in large-scale batteries. Eventually we will establish a mix that works for the different conditions in the different regions of the world."

One of the most environmentally friendly and sustainable source of electricity is solar. However, no one source will be able to meet all future requirements, and a balance of all these and more will be necessary to manage the ever-increasing demand, Becker predicts. "Fuel oil and natural gas are probably the best sources for peak load management, as they can be brought online and offline fairly quickly. Coal has likely peaked and will see a decreasing share of electricity production over a period of decades. Hydropower also is a mature form and will contribute a major share, but sites for new dams are relatively few. Wind turbines will

increase for the foreseeable future. Nuclear power will probably remain near current levels, as high-profile incidents have effectively dampened public support for new projects."

Erdemir also thinks solar will grow but likes wind as a long-range option. "Wind turbines can be considered nearly mature segments of the energy sector," he says. But he cautions, "Classic or traditional problems with micropitting, white-etching cracks in bearings and gear teeth remain as major challenges, and these are still mostly materials related."

Becker thinks longer lubricant life requiring fewer changes will improve the adoption of wind turbine energy. "Longer maintenance intervals will be the primary enabler of wind turbines. In particular, offshore turbines are extremely expensive to service, so long lubricant life, probably seven to 10 years between changes, will be required."

In addition to alternative energy markets, other industries will benefit from electric vehicles as well. "As BEV and other electric car volumes increase, there will be an increase in the demand for electric conducting wire," Burke says. "That increase will be for the macro and micro grid distribution wiring and the wires in the vehicle itself. The electric wire industry will benefit, however there could be a strain on their ability to produce, as demand for conducting wire increases." ►



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► **Innovation imperative**

The experts who contributed to this article agree that companies today need to innovate to thrive.

“History shows many examples of companies that fail to take changes in their market seriously,” Hemphill says. “This is not usually caused by a lack of awareness of the coming change but an underestimation of how well the new technology could work.”

Watch not only new technology but the rate of change of that technology.

He cites Kodak and its failure to take the rate of change into account as an example. “They were far ahead of their competitors in digital photography but eventually abandoned the effort because it was always too slow and expensive. They failed to account for Moore’s Law, which showed that in a few years digital would be orders of magnitude cheaper. Therefore, one has to watch not only new technology but the rate of change of that technology.”

Hemphill continues, “Most companies concentrate on ideation and brainstorming, but a lack of ideas is rarely the problem. Quickly reducing them to practice and keeping them aligned with customer needs is the bigger challenge. In this respect, at Schaeffler we are finding some practices from Agile Software Development to be useful; basically, they work in manageable chunks, get feedback from your customers at each step and then adjust from the feedback and take the next step (see *The Agile Software Strategy*). Our company exists because of innovation, so it is deep in our DNA. However, with such a broad product portfolio, we are always moving our innovation focus to follow our customer and market needs.”

The Agile software strategy

Agile software development is a broad term for a set of frameworks and practices based on the values and principles expressed in the Manifesto for Agile Software Development² and the following 12 principles behind it.³

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable product.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer’s competitive advantage.
3. Deliver working products frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working product is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity—the art of maximizing the amount of work not done—is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Becker believes that both first-to-market and wait-and-see attitudes can be successful. “There is room for both approaches,” he says. “First to market gets headlines; fast followers often get the most profit. My organization’s attitude toward innovation is mainly wait and see.”

Erdemir concludes, “An innovative mindset is extremely important. It is what drives progress, productivity and reliability.

Tribology will remain relevant/important regardless of an increase in electric vehicles on the road; since these too rely on many moving parts (bearings, gears, etc.) for reliable and efficient functioning.” 🌍

Jeanna Van Rensselaar heads her own communications/public relations firm, Smart PR Communications in Naperville, Ill. You can reach her at jeanna@smartprcommunications.com.

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3. Note: the word “product” is substituted for “software” in the original where it occurs.

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Dear Industry Professional,

I'd like to extend a personal invitation to join me for STLE's 75th Annual Meeting & Exhibition, May 3-7, 2020, at the Hyatt Regency hotel in Chicago, the organization's birthplace (where the Society was formed in March 1944).

The May conference will have marked the culmination of a year of events and activities celebrating STLE's 75th Anniversary. I encourage you to start making plans now to engage with nearly 1,600 of your peers in the lubricants industry from around the world who will be participating in an extraordinary combination of technical presentations, education courses, exhibits and related business networking opportunities.

The Annual Meeting is always at the top of the list of benefits derived from STLE membership, and this year's program promises to be stronger than ever. There will be a wealth of information and business contacts waiting in Chicago for those who attend. STLE's Annual Meeting Program and Education Committees, working together with our headquarters staff and paper solicitation chairs (PSCs) representing STLE's 20 technical committees, have developed



an excellent program of more than 500 technical-presentations devoted to all areas of tribology research and lubrication best practices, with presenters from academia, government and industry.

In addition to being recognized as one of the industry's premier technical meetings, the STLE Annual Meeting is also valued as an opportunity for enhancing your professional development through education and certification.

STLE has a well-known tradition of providing continuing education to industry professionals ready to take their careers to the next level and create value to their employers, customers and peers. In a survey taken after the 2019 Annual Meeting, participants rated education courses as the most valuable portion of the event in terms of meeting their business needs. 11 industry-specific courses will be presented in Chicago taught by the top experts in their respected fields.

For more experienced professionals, the STLE Annual Meeting is often the place where individuals sit for one of STLE's four technical certification exams: Certified Lubrication Specialist™, Certified Metalworking Fluids Specialist™ and Oil Monitoring Analyst I & II™.

To learn about the industry's newest technologies, products and services, make sure to visit the exhibition, which is included in the meeting registration. More than 120 companies will have booths, demonstrations and information—looking to do business with you in providing solutions and strategies to help you understand your lubrication systems that will help improve your company's bottom line.

Program details, housing and other information about the meeting are all included in this brochure for your convenience. If you require further information or assistance, please contact STLE headquarters at (847) 825-5536 (USA), or visit the conference website at www.stle.org/annualmeeting for program updates.

I look forward to seeing you in Chicago this May!

Sincerely,

Min

Dr. Min Zou
University of Arkansas
2020 Annual Meeting Program
Committee Chair



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Phone: (847) 825-5536 • Fax: (847) 825-1456

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Hotel Information

Most events for STLE's 2020 Annual Meeting & Exhibition are being held in the:

Hyatt Regency Chicago
151 East Wacker Dr.
Chicago, Illinois (USA) 60601
Phone: (312) 565-1234

Hotel registrations will not be accepted by phone, but you can make your sleeping room reservation by registering online at www.stle.org (see page 6 for housing information).

About STLE

The Society of Tribologists and Lubrication Engineers (STLE) is a not-for-profit professional society founded in 1944 to advance the science of tribology and the practice of lubrication engineering in order to foster innovation, improve the performance of equipment and products, conserve resources and protect the environment. Headquartered in Park Ridge, Illinois (a Chicago suburb), STLE is the leading technical organization serving more than 13,000 industry professionals and 250 companies and organizations that comprise the tribology and lubrication engineering business sector.

STLE offers its members industry-specific education and training, professional resources, technical information, certification programs and career development.

Attendee Roster

The official attendee roster will be made available on the STLE website (www.stle.org) in April 2020 prior to the annual meeting.

About Our Annual Meeting & Exhibition

STLE's conference is where some 1,600 members of the tribology research and lubrication engineering communities gather for five days of industry-specific technical education and professional development. Highlights include some 500 paper presentations, a 120-exhibitor trade show, the popular Commercial Marketing Forum and an opportunity to establish business contacts and friendships with your peers from around the world.

Annual Meeting & Education Course Policies

- All attendees must register.
- All attendees receive a badge with their registration materials. The badge must be worn at all times and is required for admittance to any technical session, education course and the trade show.
- Badges may not be exchanged. Attendees who loan their badges to others will have their badges confiscated and their annual meeting privileges rescinded.
- Annual Meeting registration includes admittance to the trade show, technical sessions, Commercial Marketing Forum and all social events, including the Monday evening Networking Reception and Tuesday afternoon President's Luncheon.
- Distributing handouts at technical sessions is not permitted. Handouts will be given to education course attendees.
- Disseminating material or conducting business in the exhibit hall is not permitted if you are not an official exhibitor.

Recording & Photography Policies

Audio or video recording is not permitted in any of the annual meeting technical sessions or Commercial Marketing Forum presentations. Audio recording is permitted in the education courses with advance permission of the instructor. No video of any kind is permitted. STLE's official photographer will take photos of select technical sessions, Commercial Marketing Forum presentations, social events and the trade show on Tuesday, May 5.

These photos will be used to promote the 2021 STLE Annual Meeting & Exhibition in New Orleans, Louisiana (USA). If you do not wish to have your photograph taken and published, please step out of the photo frame or notify the photographer afterward if your photo has been taken so the image can be deleted.

Dress Code

Business casual dress is appropriate for STLE events at the annual meeting. Technical session and education course speakers often choose attire that is more formal on the day of their presentations.

STLE 365 App

Find all the conference details and program updates in the Annual Meeting section of the STLE 365 App (under the Events Apps Section). Download free from the iOS App Store or the Google Play Store (just search for STLE) or visit: www.tripbuilder.com/apps/stle.

Registration Information

Meeting registration entitles you to all the technical sessions, trade show admission (Monday through Wednesday), Commercial Marketing Forum and all social events, including the Monday evening Networking Reception and Tuesday afternoon President's Luncheon (ticket required). STLE Education courses are \$400 per course with full registration. **Please see the registration form on page 7.**

2020 STLE Annual Meeting Registration Rates				
Individual			Ala Carte	
	Early Bird by April 3 (Save \$100!)	After April 3	General Single Day Registration	Single Education Course*
STLE Members	\$735	\$835	\$335	\$575
Speakers	\$735	\$835		
Presenters	\$735	\$835		
Non-members	\$1,065	\$1,165	\$500	\$775
Life Members	\$165	\$165		
Student Members	\$100	\$100		

**Annual Meeting registration not required or included.*

Cancellations

Requests must be received in writing at STLE's headquarters no later than April 3, 2020, to receive refund less \$100 handling charge. **No refunds will be issued after April 3.**

Payment Method

STLE accepts U.S. currency, check drawn on a U.S. bank and major credit cards: Mastercard, Visa (preferred), American Express and Discover.

Onsite Registration

You may register onsite at the Hyatt Regency Chicago, beginning at Noon on Saturday, May 2, 2020.

The STLE registration desk is open daily thereafter through Thursday, May 7.

Onsite registrants incur a \$100 surcharge. Advance registrants may pick up badges

and registration materials at the registration desk during the following hours:

- **Sunday, May 3** – 7 am – 6 pm
- **Monday, May 4** – 7 am – 6 pm
- **Tuesday, May 5** – 7 am – 6 pm
- **Wednesday, May 6** – 7 am – 6 pm
- **Thursday, May 7** – 7 am – Noon

Non-Members Welcome

Two Options for Attending: STLE's core annual meeting audience is our membership of tribology researchers and lubrication professionals from around the globe. However, non-members are welcome at the conference and encouraged to attend. Participating in our conference is the best way to gain an overview of STLE's many products and services and meet your peers in the

tribology and lubrication engineering communities.

STLE offers full and one-day annual meeting registration options. Because non-members pay a higher meeting registration rate, the best way to attend is by joining the society. Cost of membership is less than the difference between the member and non-member annual meeting registration rates. So you actually save money by joining STLE and coming to the meeting as a member than you would if you came as a non-member plus you get all the other benefits of STLE membership!

However, if your company does not permit you to join a professional society, another option is to pay the non-member registration rate for the annual meeting. If you do, **you'll also receive a complimentary one-year STLE membership—a \$160 value.**

How To Register:



Online

Visit www.stle.org/annualmeeting to register at your convenience, 24/7.



Phone

Call STLE headquarters at (847) 825-5536 and register using a major credit card.



Mail

Use the registration form on page 7 and send your completed form and payment to STLE headquarters.



Fax

Complete the enclosed registration form and submit via fax to (847) 825-1456.

By the Numbers:

Did you know about the STLE Annual Meeting

95% of surveyed attendees indicated that STLE's Annual Meeting met or exceeded their overall expectations.

40+ COUNTRIES REPRESENTED

500 EDUCATION COURSE PARTICIPANTS

40 STUDENT POSTERS

500+ TECHNICAL PRESENTATIONS

1,600 INDUSTRY PROFESSIONALS

120 EXHIBITORS

40 COMMERCIAL MARKETING FORUM SESSIONS



Top 5 Lubricant-Related Markets Attending

- Oil Analysis
- Metalworking Fluids
- Automotive
- Manufacturing
- Bearings

Attendee Profile

5% Academia	6% Government
5% Students	18% Other
66% Industry	

Conference Takeaways:

- Industry networking
- Professional training & certification opportunities
- Explore latest new technologies

“*It (the STLE Annual Meeting) is the best industry conference that I attend, and the business networking is very valuable.*”

Follow us on Social!

Stay connected and keep up with the chatter using hashtag **#STLE2020** when joining the conversation and stay up-to-date with latest annual meeting programming information and much more!



Future Industry Meeting Dates

2020 STLE Tribology Frontiers Conference

Cleveland Marriott Downtown at Key Tower • **Nov. 8-11, 2020**, Cleveland, Ohio (USA)

76th STLE Annual Meeting & Exhibition

Hyatt New Orleans • **May 16-20, 2021**, New Orleans, Louisiana (USA)

7th World Tribology Congress

Lyon Convention Centre • **Sept. 5-10, 2021**, Lyon, France

77th STLE Annual Meeting & Exhibition

Walt Disney World Swan & Dolphin • **May 15-19, 2022**, Orlando, Florida (USA)

78th STLE Annual Meeting & Exhibition

Long Beach Convention Center • **May 21-25, 2023**, Long Beach, California (USA)



To learn more about the benefits of STLE and to access a membership application, log on to www.stle.org or call STLE headquarters at 847-825-5536.



Twitter | [@STLE_Tribology](https://twitter.com/STLE_Tribology)



Facebook | [Facebook.com/STLE](https://www.facebook.com/STLE)



Instagram | [@STLE_Tribology](https://www.instagram.com/STLE_Tribology)

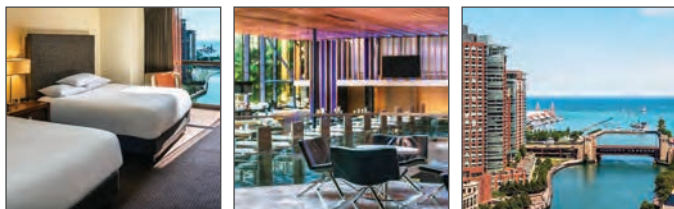


LinkedIn | www.linkedin.com

Need a Visa? International attendees can request an invitation letter for the 2020 STLE Annual Meeting & Exhibition. For more information, contact Merle Hedland at (630) 428-2133, mhedland@stle.org.

Housing & Room Reservations

Housing for the 2020 STLE Annual Meeting & Exhibition is at:



Hyatt Regency Chicago
151 East Wacker Drive • Chicago, Illinois 60601
(312) 565-1234

Situated near the famous Magnificent Mile, Hyatt Regency Chicago is the largest hotel in Chicago and is surrounded by downtown's premier landmarks and attractions. The Hyatt Regency Chicago offers 2,032 rooms, including 123 suites. Marvel at views of the city, Chicago River, or Lake Michigan. In an easy walk or short cab ride from the hotel, guests are linked to Chicago's best shopping, cuisine, museums and theater. The Hyatt Regency Chicago is about 45-minute drive (18 miles) from O'Hare International Airport, and 35-minute drive (12 miles) from Midway International Airport.

Hyatt Regency Chicago Amenities

- Four restaurants and three bars/lounges
- Complimentary wireless Internet in lobby and guest rooms
- Spacious guest rooms with refrigerator, laptop safe and flat-screen TVs
- Complimentary 24-hour fitness center
- Multilingual staff

*STLE Annual Meeting Rates

- \$264 single/double occupancy (1 or 2 people)
- \$284 triple occupancy (3 people)
- \$314 quadruple occupancy (4 people)
- \$339 Regency Club

Attendees are encouraged to stay at the Hyatt Regency Chicago, as doing so helps STLE reduce the costs of future annual meetings. The cutoff date to receive discounted pricing is **April 3, 2020**. However, STLE cannot guarantee housing at the Hyatt Regency Chicago will be available through April 3. Reservations are made on a first-come, first-served basis. If you plan on attending the 2020 STLE Annual Meeting, you are urged to make your room reservations as soon as possible.

Reserve Your Room By April 3, 2020

- Call to make hotel reservations at (312) 565-1234
- Be sure to provide the group code: **G-ESTL**
- Make all hotel reservation changes or cancellations directly with the Hyatt Regency Chicago
- Visit www.stle.org/annualmeeting for a shortcut to the hotel registration site



**Room rates are quoted exclusive of applicable state and local taxes (which are currently 16.4%) or applicable service, or hotel specific fees in effect at the Hyatt Regency Chicago at the time of the meeting. U.S. Government rate rooms are limited; proof of federal government employment must be shown at check-in or higher rate will be charged. U.S. Government rate is the prevailing government rate.*

2020 STLE Annual Meeting Registration Form

Hyatt Regency Chicago • Chicago, IL (USA) • May 3-7, 2020



IN A HURRY? Register online at www.stle.org/annualmeeting

MAIL OR FAX THIS FORM TO: STLE, 840 Busse Highway, Park Ridge, IL (USA) 60068. Fax: 847-825-1456.

Registration Information (Please complete separate forms for each individual from your organization). • **My STLE Member # is:** _____

Title: ___ Mr. ___ Mrs. ___ Ms. ___ Dr. ___ Professor First name for badge: _____

First Name: _____ Last Name: _____

Company/Institution Name: _____

Address: _____

City: _____ State/Province: _____

Zip/Mail Code: _____ Country: _____

E-mail: _____ Fax: _____

Phone: _____ Onsite Cell Phone #* _____

Emergency Contact Name* _____ Emergency Contact Phone #* _____

***STLE does not sell conference attendee cell phone numbers. This information is requested for use only by STLE for conference updates and in case of onsite emergencies.**

Speaker or Presenter? Session Number or Paper Title: _____

NOTE: Registration includes technical sessions, trade show admission, Networking Reception, Commercial Marketing Forum, plus one complimentary ticket to the President's Luncheon. STLE Education Courses are \$400 with full meeting registration except for NLGI Grease Course (\$800).

Cancellation requests must be received in writing no later than April 3, 2020, to receive refund less \$100 handling fee. No refunds issued after that date. Mail or fax this form to: STLE, 840 Busse Highway, Park Ridge, IL (USA) 60068 Fax: (847) 825-1456. Questions? Call (847) 825-5536.

Annual Meeting Registration Rates

Members/Speakers/Presenters: \$735 – Non-members: \$1,065

Life Members: \$165 – Student Members: \$100

After April 3 add \$100

STLE Education Courses: Discounted rate with full meeting registration (\$400 per course) except for NLGI Grease Course (\$800). Lunch included.

Sunday Education Courses, May 3, 2020 (8 am – 5 pm)

Please ✓ one course only!

- Advanced Lubrication 301: Advanced Additives
- Advanced Tribology 310: Nanotribology
- Basic Lubrication 101
- Gears 101
- NLGI – Grease 101
- Metalworking 240: Metalworking Fluid Formulation Concepts
- Synthetic Lubricants 204: Base stock Selection and Applications

Wednesday Education Courses, May 6, 2020 (8 am – 5 pm)

Please ✓ one course only!

- Advanced Lubrication 302: Advanced Lubrication Regimes
- Automotive Lubrication 202: Gasoline
- Basic Lubrication 102
- Metalworking 105: Metal Forming Fluids

Social Functions (Please ✓ all that apply)

- Monday, May 4 – Networking Reception (free). Qty: _____
- Tuesday, May 5 – President's Luncheon (*one complimentary ticket included*).
- Tuesday, May 5 – Additional President's Luncheon guest ticket (\$50)

Ala Carte Offerings

- STLE education course and lunch only. Annual Meeting registration not required or included. **Members:** \$575 per course. **Non-members:** \$775 per course.
- NLGI Grease Course (\$800) with or without separate meeting registration. Lunch included.

Single-Day Registration Admission

Members: \$335. **Non-members:** \$500

- Monday, May 4 (Technical Sessions & Trade Show Only)
- Tuesday, May 5 (Technical Sessions & Trade Show Only)
- Wednesday, May 6 (Technical Sessions & Trade Show Only)
- Thursday, May 7 (Technical Sessions Only)

Payment Information

Payment Enclosed Payment Type: _____

Credit Card #: _____

Exp. Date: _____

Name on Card: _____

Payment Amount: \$ _____ . _____

Signature: _____



Sweet Home Chicago

Chicago is located along the Great Lakes shoreline. It is the third largest city in the United States, with a population of nearly 3 million and metro population approaching 10 million. Chicago is a huge vibrant city and metropolitan area that sprawls over 10,874 km².

It is well known for house music and electronical dance music, blues, jazz, comedy, shopping, dining, sports, architecture, highly-regarded colleges and universities, and premier cultural attractions.

As the hub of the Midwest, Chicago is easy to find with its picturesque skyline, calling across the waters of the huge freshwater Lake Michigan, an impressive sight that soon reveals world-class museums, miles of sandy beaches, huge parks, public art, and perhaps the finest looking downtown in the world.

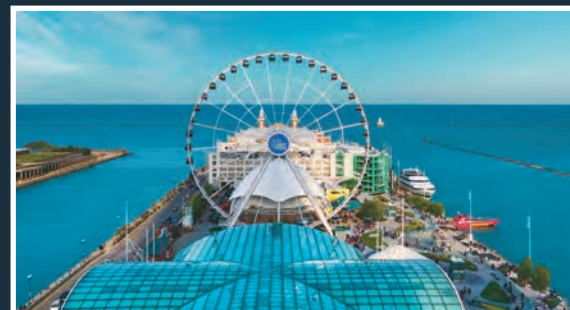
With a wealth of iconic sights and neighborhoods to explore, there's enough to fill a visit of months without ever seeing the end. Prepare to cover a lot of ground; the meaning of Chicago is only found in movement, through its subways and historic elevated rail, and eyes raised to the sky.

NOTABLE ATTRACTIONS

Magnificent Mile (13-block shopping and entertainment district) ✦ Grant Park and Millennium Park ✦ Navy Pier
Buckingham Fountain ✦ Museum of Science and Industry ✦ Field Museum ✦ Shedd Aquarium
Art Institute of Chicago ✦ Adler Planetarium

EXPERIENCE CHICAGO

Explore the sights, and experience the food and nightlife of this world-class city on the shores of Lake Michigan.
Find out what to eat, drink, see and do at www.choosechicago.com.





2020 Chicago Program-at-a-Glance

*As of Dec. 3, 2019

Please visit www.stle.org/annualmeeting for the latest program information and detailed schedule.

Saturday, May 2

Noon – 6 pm
Onsite Registration

Sunday, May 3

7 am – 6 pm
Onsite Registration

7 – 8 am
Education Course Speakers Breakfast

8 am – 5 pm
Education Courses
(*registration required)

Monday, May 4

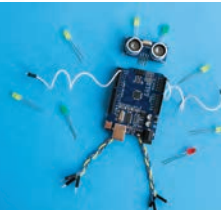
7 am – 6 pm
Onsite Registration

7 – 8 am
Speakers Breakfast

8 – 10 am
Technical Sessions and Commercial Marketing Forum

9 am – 1 pm
Tribology **STEM** Camp

Science
Technology
Engineering
Math



10 – 10:30 am
Refreshment Break

10:30 am – Noon
Opening General Session
Keynote Address:
21st Century Challenges for the Tribology & Lubricants Community

Noon – 1:30 pm
Lunch (on your own)

Noon – 5 pm
Commercial Exhibits and Student Posters

1:30 – 6 pm
Technical Sessions and Commercial Marketing Forum

3 – 4 pm
Exhibitor Appreciation Break

6:30 – 8 pm
Networking Reception (Hyatt Regency Grand Ballroom)

Tuesday, May 5

7 am – 6 pm
Onsite Registration

7 – 8 am
Speakers Breakfast

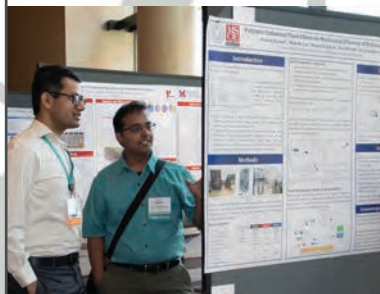
8 – 10 am
Technical Sessions and Commercial Marketing Forum

9:30 am – Noon
Commercial Exhibits and Student Posters

10 – 10:30 am
Refreshment Break

Noon – 2 pm
President's Luncheon/
Business Meeting (Hyatt Regency Grand Ballroom)

2 – 6 pm
Technical Sessions and Commercial Marketing Forum



2 – 5:30 pm
Commercial Exhibits and Student Posters

3 – 4 pm
Exhibitor Appreciation Break

Wednesday, May 6

7 am – 6 pm
Onsite Registration

7 – 8 am
Speakers Breakfast

8 am – 5 pm
Education Courses
(*registration required)

8 am – Noon
Technical Sessions and Commercial Marketing Forum

9:30 am – Noon
Commercial Exhibits and Student Posters

10 – 10:30 am
Refreshment Break

Noon – 1:30 pm
Lunch (on your own)

1:30 – 6 pm
Technical Sessions and Commercial Marketing Forum

3 – 3:30 pm
Refreshment Break

Thursday, May 7

7 am – Noon
Onsite Registration

7 – 8 am
Speakers Breakfast

8 – 10 am
Technical Sessions

8:30 am – 12:30 pm
STLE Certification Exams
(*registration required)

10 – 10:30 am
Refreshment Break

3 – 3:30 pm
Refreshment Break



6:30 – 8 pm
Student Networking Reception (Hyatt Regency Plaza Ballroom)

***Registration required**
All annual meeting events are held at the Hyatt Regency Chicago.



Technical Sessions

Choose from more than 500 papers and presentations!

The following is the preliminary 2020 STLE Annual Meeting technical program that will be updated right up until the meeting in Chicago. Please visit www.stle.org/annualmeeting for the latest program information. Registrants also will receive a Program Guide at the meeting with updated information.

***As of Dec. 3, 2019 – Subject to Change.**

Monday, May 4, 2020

★ Session 1A

COMMERCIAL MARKETING FORUM I

8 – 8:30 am | Open Slot

8:30 – 9 am | Chevron Phillips Chemical Co.

9 – 9:30 am | Zschimmer & Schwarz

9:30 – 10 am | ANGUS Chemical Co.

10 – 10:00 am – Break

★ Session 1B

METALWORKING FLUIDS I

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3273531 ★ Oil Soluble Polyglycol on Semi-Synthetic Metalworking as Multifunctional Enhancer Synthetic Polymeric Additive Proposal

Eduardo Lima, Dow Brazil, Jundiai, São Paulo, Brazil

8:30 – 9 am

3279542 ★ Systematic Investigation of Phosphorous Compounds in Metalworking Fluids by Mixture Screening DoE

Yixing Philip Zhao, Alexandra Goode, Shilpa Beesabathuni, Houghton International, Norristown, PA, Yan Zhou, Houghton International, Oak Ridge, TN

9 – 9:30 am

3279198 ★ Adenylate Energy Charge – New Tool for Determining Metalworking Fluid Microbial Population's Sublethal Response to Microbicide Treatment

Frederick Passman, Biodeterioration Control Associates, Inc., Princeton, NJ, Peter Küenzi, Blaser Swisslube, Hasle-Ruegsau, Switzerland, Jordan Schmidt, Luminultra Technologies, Ltd., Fredericton, New Brunswick, Canada

9:30 – 10 am

3279916 ★ Low Foam Emulsifiers for Semi-Synthetic Metalworking Fluids

Jocelyn Zhao, Dow Chemical Investment Co., Ltd., Shanghai, China

10 – 10:30 am – Break

★ Session 1C

ROLLING ELEMENT BEARINGS I

Session Chair: Nikhil Londhe, The Timken Co., Canton, OH

Session Vice Chair: Daniel Merk, Schaeffler Technologies, Schweinfurt, Bavaria, Germany

8 – 8:30 am

3278343 ★ Replenishment of the EHL Contacts in a Grease Lubricated Ball Bearing

Piet Lugt, SKF Research and Technology Development, Houten, Netherlands, Hui Cen, Xuchang University, Henan, China

8:30 – 9 am

3285585 ★ Characterization of the Channeling Behavior of Lubricating Greases in Rolling Bearings

Sathwik Chatra Kalsanka Ramakrishna, SKF B.V., Nieuwegein, Utrecht, Netherlands, Piet Lugt, SKF Research and Technology Development, Houten, Netherlands

9 – 9:30 am

3322067 ★ Starvation in Rolling Bearings: From Single Contact Devices to Rolling Bearing Simulators

David Kostal, Josef Fryza, Petr Sperka, Ivan Krupka, Martin Hartl, Brno University of Technology, Brno, Czechia

9:30 – 10 am

3316427 ★ Effect of Lubricant Properties and Contact Conditions on False Brinelling Damage

Rachel Januszewski, Amir Kadiric, Imperial College London, London, United Kingdom, Victor Brizmer, SKF Research and Technology Development, Houten, Netherlands

10 – 10:30 am – Break

★ Session 1D

BIOTRIBOLOGY I

Session Chair: Angela Pitenis, University of California, Santa Barbara, Santa Barbara, CA

Session Vice Chair: Alison Dunn, University of Illinois at Urbana-Champaign, Urbana, IL

8 – 8:30 am

3283332 ★ Remarkable Wear and Fracture Properties and Unique 3D-Microstructure of Enamel in the Dentition of the Hadrosaurid Dinosaur

Tomas Grejtak, Tomas Babuska, Brandon Krick, Lehigh University, Bethlehem, PA, Stephen Hendricks, Gregory Erickson, Florida State University, Tallahassee, FL, Soumya Varma, Manish Jain, Yi Lee, Siddhartha Pathak, University of Nevada-Reno, Reno, NV, Mark Norell, American Museum of Natural History, New York, NY

8:30 – 9 am

3325025 ★ Tribology of Tactile Perception – FE Modeling of Skin Aging

Marc Masen, Rikeen Jobanputra, Imperial College London, South Kensington, London, United Kingdom

9 – 9:30 am

3292469 ★ Effects of Contact and Shear on Corneal Epithelial Cell Mucus Layer

Jack Famiglietti, Eric McGhee, Juan Uruena, Padraic Levings, W. Gregory Sawyer, University of Florida, Gainesville, FL

9:30 – 10 am

3284256 ★ Mechanical Regulation of Blood Flow Shear in Hemostasis Process

Xiangyu Hu, Tsinghua University, Beijing, China

10 – 10:30 am – Break

★ Session 1E

SEALS I

Session Chair: Khalid Malik, Ontario Power Generation, Pickering, Ontario, Canada

Session Vice Chair: Noel Brunetiere, Institut Pprime, Futuroscope Chasseneuil Cedex, France

8 – 8:30 am

3322475 ★ **Simulation of Transient Processes of a Hydraulic Seal with Elastohydrodynamic Lubrication**

Arne Leenders, Leibniz University Hannover, Hannover, Germany

8:30 – 9 am

3269407 ★ **Shaft and Seal Wear Determination Using a TEHD-Simulation Model**

Christoph Burkhart, Stefan Thielen, Bernd Sauer, TU Kaiserslautern, Kaiserslautern, Rhineland-Palatinate, Germany

9 – 9:30 am

3293189 ★ **Leakage Characteristics of Static Seal under Pressure Cycling Condition**

De Huang, Andreas Almqvist, Lulea Technology University, Lulea, Sweden, Chien Nguyen, Saint-Gobain, Bristol, RI

9:30 – 10 am

3286645 ★ **In Situ Observation of Three-Body Contact in Rubber Sealing Interface**

Kun Qin, Qin Zhou, Kai Zhang, China University of Geosciences – Beijing, Key Laboratory of Deep Geodrilling Technology, Ministry of Land and Resources, Beijing, China

10 – 10:30 am – Break

★ Session 1F

LUBRICATION FUNDAMENTALS I

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 pm

3325112: ★ **The Effect of Chemical Structure on Tribological Behavior of Base Oils**

Kun Qian, Zhijiang Ye, Cameron Timothy, Mark Sidebottom, Miami University, Oxford, OH

8:30 – 9 am

3284374 ★ **Adsorption on Metal Oxides: An in Silico Design of Lubricants**

Sarah Blanck, Sophie Loehle, Centre de Recherche Total de Solaize, Solaize, France, Carine Michel, Stephan Steinmann, University of Lyone, Laboratoire de Chimie, Lyon, France

9 – 9:30 am

3284304 ★ **Molecular Dynamics Simulation of Lubricating Oil Flow in Porous Polyimide Retainers of Bearing**

Wenbin Chen, Wenzhong Wang, Pengzhe Zhu, Beijing Institute of Technology, Beijing, China

9:30 – 10 am

3337146 ★ **Using Rheology, Colloid Force Microscopy and Mathematical Modeling for Understanding the Role of Associative Polymers in Lubrication**

Eugene Pashkovski, Reid Patterson, The Lubrizol Corp., Wickliffe, OH, Timothy Murdoch, Robert Carpick, Daeyeon Lee, University of Pennsylvania, Philadelphia, PA, Ilya Kudish, ILRIMA Consulting, Inc., Sarasota, FL

10 – 10:30 am – Break

★ Session 1H

GREASE I

Session Chair: William Tuszynski, The Unami Group, LLC, Quakertown, PA

Session Vice Chair: Cindy Liu, Klüber Lubrication NA LP, Nashua, NH

8 – 8:30 am

3303461 ★ **Lubrication Condition Monitoring of Practical Ball Bearings under Grease Lubrication by Electrical Impedance Method**

Taisuke Maruyama, Masayuki Maeda, NSK Ltd., Fujisawa, Kanagawa, Japan, Ken Nakano, Yokohama National University, Yokohama, Japan

8:30 – 9 am

3319594 ★ **Tribology Bench Tests for the Development of Next-Generation Greases with Optimized Lubrication Properties**

Rory McAllister, Marc Masen, Philippa Cann, Imperial College London, London, United Kingdom

9 – 9:30 am

3279951 ★ **Contact Protection by Grease in Aeronautical Heavily**

Charged Oscillating Bearings

Lucas Frache, LaMCoS Laboratory, Villeurbanne, Rhône Alpes, France

9:30 – 10 am

3284996 ★ **Complementary Approach in Stick-Slip Analysis of a Lubricated Contact: From the Local Contact Behavior to the Dynamical Response of the System**

Ilaria Ghezzi, Yves Berthier, INSA Lyon, Lyon, France, Davide Tonazzi, Francesco Massi, University of Rome La Sapienza, Rome, Italy, Michael Rovere, Cedric Le Coeur, SOMFY, Cluses, France

10 – 10:30 am – Break

★ Session 1I

TRIBOCHEMISTRY I

Superlubricity & Mechanochemistry of Carbon-Based Solid Lubricants

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3285407 ★ **The Effect of Sliding Counterbodies on Tribological Properties of Nanocrystalline Diamond Film**

Wei Qi, Tsinghua University, Beijing, China

8:30 – 9 am

3285508 ★ **Temperature Induced Structural Evolution and Superlubricity Mechanisms in Amorphous Carbon-Based Films**

Muhammad Irfan Fareed, Tsinghua University, Beijing, China

9 – 9:30 am

3281530 ★ **Atomistic Simulation Revealing the Temperature Dependence of Frictional Property of Diamond-Like Carbon in Vacuum**

Yang Wang, Koshi Adachi, Momoji Kubo, Tohoku University, Sendai, Miyagi, Japan

9:30 – 10 am

3305924 ★ **Towards, Robust Superlubricity on Industrially Relevant Surfaces and Sliding Conditions**

Anirudha Sumant, Kalyan Mutyala, Srilok Srinivasan, Jianguo Wen, Subramanian K.R. S. Sankaranarayanan, Argonne National Laboratory, Lemont, IL

10 – 10:30 am – Break



★ Session 1K

ENGINE AND DRIVETRAIN

Special Session on Electric Vehicles I

Session Chair: Babak Lotfi, ExxonMobil, Baytown, TX

Session Vice Chair: Dairene Uy, Shell Technology Center, Houston, TX

8 – 8:30 am

3274913 ★ **Study of Vibration Wear in Plug-In Hybrid Vehicle Engine**

Weizi Li, Shell (Shanghai) Technology Limited, Shanghai, China, Yunfei Wang, Qin hao Fan, Zhi Wang, Tsinghua University, Beijing, China, Robert Taylor, Shell Global Solutions UK, London, United Kingdom

8:30 – 9 am

3284028 ★ **Thermal Management in Battery Electric Vehicle (BEV)**

Dean Tomazic, FEV North America Inc., Auburn Hills, MI

9 – 9:30 am

3340704 ★ **A Model for Prediction of Power Losses in Electric Vehicle Transmissions**

Amir Kadiric, Joseph Shore, Imperial College London, London, United Kingdom

9:30 – 10 am

3316891 ★ **Test Facility to Investigate Function and Efficiency of the Speed4E Hyper-High-Speed Electromechanical Powertrain**

Lukas Pointner-Gabriel, Hermann Pflaum, Karsten Stahl, Technical University of Munich, Garching, Bavaria, Germany

10 – 10:30 am – Break

★ Session 1L

CONTACT MECHANICS I

Session Chair: Morgan Jones, Sandia National Laboratory, Albuquerque, NM

Session Vice Chair: Kylie Van Meter, University of Florida, Gainesville, FL

8 – 8:30 am

3278148 ★ **3D Elastodynamic Frictional Contact Model**

Xin Zhang, Qian (Jane) Wang, Northwestern University, Evanston, IL

8:30 – 9 am

3279700 ★ **Investigating the Effect of Radius of Curvature Evolution on Elastic-Perfectly Plastic Contact**

Eoghan O'Neill, Matthew Brake, Rice University, Houston, TX, Hamid Ghaednia, Massachusetts General Hospital-Harvard Medical School, Boston, MA

9 – 9:30 am

3302964 ★ **Digital Image Correlation Based Subsurface Stress Measurements in Hydrogels**

Alexander McGhee, Jack Famiglietti, Eric McGhee, University of Florida, Gainesville, FL

9:30 – 10 am

3324921 ★ **Adhesion Hysteresis in Soft Contacts**

Kyle Schulze, Auburn University, Auburn, AL, Alexander Bennett, University of Pennsylvania, Philadelphia, PA

10 – 10:30 am – Break

★ Session 1M

NANOTRIBOLOGY I

Session Chair: Rosa Espinosa-Marzal, University of Illinois at Urbana-Champaign, Urbana, IL

Session Vice Chair: Zhijiang Ye, Miami University, Oxford, OH

8 – 8:30 am

3287020 ★ **Friction and Wear Behavior of Confined Surrogate Fuels**

Judith Harrison, Sabina Maskey, Brian Morrow, U.S. Naval Academy, Annapolis, MD, J.D. Schall, North Carolina A&T State University, Greensboro, NC

8:30 – 9 am

3282147 ★ **In Situ Study of the Lubrication Mechanism of Phosphonium Phosphate Ionic Liquid in Nanoscale Single-Asperity Sliding Contacts**

Filippo Mangolini, Zixuan Li, Oscar Morales-Collazo, Hugo Celio, Andrei Dolocan, Joan Brennecke, The University of Texas at Austin, Austin, TX, Jerzy Sadowski, Brookhaven National Laboratory, Upton, NY

9 – 9:30 am

3325316 ★ **Nanorheology of Ionic Liquids Probed by an Extended Surface Forces Apparatus**

Mengwei Han, Rosa Espinosa-Marzal, University of Illinois at Urbana-Champaign, Urbana, IL

9:30 – 10 am

3304839 ★ **Polarized Light Microscopy for Visualizing Liquid Crystal Lubricants in EHD Contacts**

Robert Elkington, Monica Ratoi, University of Southampton, Hampshire, United Kingdom

10 – 10:30 am – Break

★ Session 2A

COMMERCIAL MARKETING FORUM II

1:30 – 2 pm | Clark Reliance Corp.

2 – 2:30 pm | Lockhart Chemical Co.

2:30 – 3 pm | The Lubrizol Corp.

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm | Kao Chemicals GmbH

4:30 – 5 pm | BASF Corp.

5 – 5:30 pm | Evonik Oil Additives, USA

★ Session 2B

METALWORKING FLUIDS II

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3283179 ★ **Machining of Aluminum Alloys – Effects of Composition & Microstructure on Machinability**

Robert Evans, Quaker Houghton, Conshohocken, PA

2 – 2:30 pm

3283602 ★ **Lubrication and Machining of Hard Wear-Resistant Materials**

Bailey Decker, Quaker Houghton, King of Prussia, PA

2:30 – 3 pm

3286000 ★ **Comparing Forming Fluids Using a Cup Drawing Hydraulic Press**

Joseph Schultz, Daniel Banks, Britt Minch, The Lubrizol Corp., Wickliffe, OH

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3287711 ★ **Investigation of Metalworking Fluids on Titanium Alloys**

Yan Zhou, Jeff Larsh, Yixing Philip Zhao, Quaker Houghton, Conshohocken, PA, Junhui Ma, Javad Mohammadi, Olufisayo Gali, Reza Riahi, University of Windsor, Windsor, Ontario, Canada

4:30 – 5 pm

3286129 * **A New Ferrous Corrosion Inhibitor (CI) Reinforcing Oil-Based Industrial Lubricants in the Battle against Corrosion**

Ryan Weber, Brett Wessler, Samantha Lauro, Christina Brancel, Britt Minch, The Lubrizol Corp., Wickliffe, OH

5 – 5:30 pm

3286352 * **Polyglykol as Performance Wear Lubricant and Synergism with Extreme Pressure Additives on Net Oil Metalworking Fluid**

Eduardo Lima, Dow Brazil, Jundiai, São Paulo, Brazil

5:30 – 6 pm

3286526 * **Theoretical and Practical Deficiencies of Non-Si Defoamer Technology for Aqueous Metalworking Fluids**

Ernest Galgocí, Justin Mykietyń, Münzing, Bloomfield, NJ

* Session 2C

ROLLING ELEMENT BEARINGS II

Session Chair: Hannes Grillenberger, Schaeffler Technologies AG & Co. KG, Herzogenaurach, Bayern, Germany

Session Vice Chair: Nikhil Londhe, The Timken Co., Canton, OH

1:30 – 2 pm

3287171 * **Innovative Bearing Solutions for E-Mobility Applications**

Jitesh Modi, Schaeffler Group USA, Troy, MI

2 – 2:30 pm

3287182 * **Electric Current Effects on Wind Turbine Rolling Element Steel**

Robert Erck, Benjamin Gould, Nicholas Demas, Aaron Greco, Argonne National Laboratory, Argonne, IL

2:30 – 3 pm

3285517 * **Voltage Induced Roller Bearing Fatigue**

André Harder, Tobias Schirra, Eckhard Kirchner, Technical University of Darmstadt, Darmstadt, Hessen, Germany

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3279905 * **Load Sensing Bearing – Influence of Damage Progression on the Electric Bearing Impedance**

Tobias Schirra, Georg Martin, Eckhard Kirchner, Technical University of Darmstadt, Darmstadt, Hessen, Germany

4:30 – 5 pm

3324286 * **Novel and Traditional Techniques for Detection of Sub-surface Damage in Bearing Steel**

Monica Ratoi, Brian Mellor, University of Southampton, Southampton, United Kingdom, Hiroyoshi Tanaka, Joichi Sugimura, Kyushu University, Fukuoka, Japan

5 – 5:30 pm

3318097 * **Progress of Rolling Machine Elements**

Hirotohi Aramaki, NSK Ltd., Fujisawa, Japan

* Session 2D

BIOTRIBOLOGY II

Session Chair: Dipankar Choudhury, University of Arkansas, Fayetteville, AR

Session Vice Chair: Kurt Beschorner, University of Pittsburgh, Pittsburgh, PA

1:30 – 2 pm

Invited Talk

2 – 2:30 pm

3322474 * **Cartilage and Joint Mechanics: New Insights into the Conditions of the Buried Interface**

David Burris, University of Delaware, Newark, DE

2:30 – 3 pm

3340959 * **The (Cartilage/Cartilage) Friction: A Model Explaining the Relation Between Charged (+/+), (-/-) and Neutral (\pm/\pm) Surfaces**

Zenon Pawlak, Tribochemistry Consulting, Salt Lake City, UT, Tomasz Kaldonski, Krzysztof Gocman, Tadeusz Kaldonski, Military University of Technology, Warsaw, Poland, Marek Macko, Kazimierz Wielki University, Bydgoszcz, Poland

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3279450 * **Investigation on the Superlubricity and Nanomechanics of Liposome Adsorption on Titanium Alloys**

Yuhong Liu, Tsinghua University, Beijing, China

4:30 – 5 pm

3281562 * **Insight into the Lubrication Behavior of Phospholipids Pre-Adsorbed on Silica Surfaces at Different Adsorption Temperatures**

Shaofei Feng, Yuhong Liu, Tsinghua University, Beijing, China

5 – 5:30 pm

3278081 * **Increased Utilized Friction During Walking Predicts Shoe Wear Rates: Insights into the Wear Mechanism**

Sarah Hemler, Kurt Beschorner, University of Pittsburgh, Pittsburgh, PA

5:30 – 6 pm

3309331 * **Shoe Tread Wear Rate May Not Necessarily Be Associated with Material Hardness**

Sarah Hemler, Claire Tushak, Paul Walter, Kurt Beschorner, University of Pittsburgh, Pittsburgh, PA

* Session 2E

SEALS II

Session Chair: Bo Tan, University of Kentucky, Lexington, KY

Session Vice Chair: Jorge Pacheco, John Crane Inc., Morton Grove, IL

1:30 – 2 pm

3302009 * **Gas Seal Face Optimization Using a Scalable Parallel Simulation Environment**

Michael LaPresti, FPoliSolutions, Pittsburgh, PA

2 – 2:30 pm

3323410 * **New Dry Gas Seal Material for Enhanced Wear Resistance during Contact**

Christina Twist, Jiao Yang, Marwan Jahchan, Kanza Amanullah, Ian Goldswain, John Crane Inc., Chicago, IL

2:30 – 3 pm

3285338 * **A Method of Direct Measurement of Mechanical Seal Wear in Pumps and Compressors**

Mark Slivinski, Carbide Derivative Technologies, Tucson, AZ

3 – 4 pm – Exhibitor Appreciation Break



Technical Sessions

4 – 4:30 pm

3304823 * **Effects of Radial Force on the Sealing Performance and Tribology Behavior of Rotary Lip Seals**

Bingqi Jiang, Fei Guo, Tsinghua University, Beijing, China

4:30 – 5 pm – Seals Business Meeting

* Session 2F

LUBRICATION FUNDAMENTALS II

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3309106 * **Tribological and Tribochemical Evaluation of Various Lubricants on Steel as well as WC-DLC Coating Under Extreme-Pressure Boundary Lubrication Conditions: Bench Test: Part 1**

Kuldeep Mistry, Carl Hager, Thierry Ruzicka, Praveen Pauskar, The Timken Co., North Canton, OH

2 – 2:30 pm

3309230 * **Tribological and Tribochemical Evaluation of Various Lubricants on Steel as well as WC-DLC Coating Under Extreme-Pressure Boundary Lubrication Conditions: Rig Test: Part 2**

Kuldeep Mistry, Carl Hager, Doug Lucas, Praveen Pauskar, The Timken Co., North Canton, OH

2:30 – 3 pm

3285602 * **Designing a Simple Test to Measure Lubricant Efficiency**

Marc Ingram, Ingram Tribology Ltd., Carmarthen, United Kingdom, Izzy Roots, Clive Hamer, PCS Instruments, London, United Kingdom

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3287631 * **Running-In of Rough Surface EHL Contacts**

Jonny Hansen, Marcus Björling, Roland Larsson, Luleå University of Technology, Luleå, Sweden

4:30 – 5 pm

3318394 * **Friction Increase in Starved EHL Contact**

Petr Sperka, Ivan Krupka, Martin Hartl, Brno University of Technology, Brno, Czechia

5 – 5:30 pm

3309028 * **A Novel Iteration Method for Mixed Lubrication**

Chen Shi, Zhinan Zhang, Shanghai Jiaotong University, Shanghai, China, Xiaojiang Cai, Shanghai Key Laboratory of Aerospace Intelligent Control Technology, Shanghai, China

5:30 – 6 pm

3282852 * **Correlation of EHD Friction with Molecular Structure of Highly Refined Hydrocarbon Base Oils**

Hak Mook Kim, SK innovation, Daejeon, Republic of Korea, Hugh Spikes, Imperial College London, London, United Kingdom

* Session 2H

GREASE II

Session Chair: Wenyang Zhang, Tesla, Palo Alto, CA

Session Vice Chair: TBD

1:30 – 2 pm

3285676 * **Do Polymers Affect the Mechanical Stability of Grease?**

Erik Willett, Functional Products Inc., Macedonia, OH

2 – 2:30 pm

3284674 * **Back to the Basics, Part II: Fundamental Building Blocks of Grease Formulation – The Next Story**

Joseph Kaperick, Afton Chemical Corp., Richmond, VA

2:30 – 3 pm

3284232 * **Effect of Tribofilm Component on Preventing White Etching Crack in Grease Lubricated Ball Bearings**

Takeshi Tsuda, Yurie Yamashita, Kouji Yoshizaki, Takanori Kurokawa, Hirokazu Arai, JTEKT Corp., Kashiwara, Osaka, Japan

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3278125 * **Enhanced Performance Characteristics in Greases with Alkylated Naphthalenes**

Ross Dworet, Amanda Harris, Maureen Hunter, King Industries Inc., Norwalk, CT

4:30 – 5 pm

3308601 * **Polymer Grease Flow Behavior Under Low- and High-Pressure**

Josep Farré, UPC – Technical University of Catalonia, Terrassa, Spain, Lars Westberg, Luleå University of

Technology, Luleå, Sweden, Gemma Camp, UPC, Riells del Fai, Spain, Jasmina Casals-Terré, Universitat Politècnica de Catalunya, Terrassa, Spain

5 – 5:30 pm – Grease Business Meeting

* Session 2I

TRIBOCHEMISTRY II

Tribocatalysis of Additives

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3316033 * **Nature of ZDDP Tribofilm, Part A: Effect of Relative Humidity**

Pourya Parsaeian, Abdel Dorgham, Ardian Morina, Anne Neville, University of Leeds, Leeds, United Kingdom

2 – 2:30 pm

3329999 * **Friction and Wear Performance of Novel Hybrid Base Fluids with Phosphorous Containing Additives**

Sergei Glavatskih, Yiyuan Tian, KTH Royal Institute of Technology, Stockholm, Sweden, Thomas Norrby, Nynas AB, Nynashamn, Sweden

2:30 – 3 pm

3282109 * **Anti-Wear Performance and Lubrication Mechanism of New TiO₂ Particle-Based Lubricant Additives**

Fabrice Dassenoy, Sophie Pavan, Jules Galipaud, LTDS – Ecole Centrale of Lyon, Ecully, France, Istvan Jenei, Stockholm University, Stockholm, Sweden, Stephan Wieber, Michael Hagemann, EVONIK, Darmstadt, Germany

3 – 4 pm – Exhibitor Appreciation Break

4 – 5 pm

3339340 * **Invited Talk: Tribocatalytic Formation of Carbon Films & Tribochemistry of Graphene/Graphite and MoDTC**

M. Clelia Righi, University of Modena and Reggio Emilia, Modena, Italy

5 – 5:30 pm

3283545 * **MoDTC Tribofilm Growth from Low Viscosity Fully Formulated Engine Oils**

Gerda Vaitkunaite, Cayetano Espejo, Chun Wang, Anne Neville, Ardian Morina, University of Leeds, Leeds, Yorkshire, United Kingdom, Benoit Thiebaut, Catherine Charrin, TOTAL, Solaize, France

★ Session 2K

ENGINE AND DRIVETRAIN

Special Session on Electric Vehicles II

Session Chair: Hamed Ghaednia, Gehring Group, Farmington Hills, MI

Session Vice Chair: Babak Lotfi, ExxonMobil, Baytown, TX

1:30 – 2 pm

3343494 ★ Hybrid/Electric Powertrain Components & Tribology

Raj Chandramohanam, Tyler Garrard, BorgWarner Inc., Arden, NC

2 – 2:30 pm

3322965 ★ Dielectric Fluids for Use in Hybrid and Electric Vehicles

Gareth Moody, Croda, New Castle, DE

2:30 – 3 pm

3328322 ★ Ultra-Low Viscosity Synthetic Fluids for Electric Vehicles (EVs)

Babak Lotfi, ExxonMobil Chemical Co., Houston, TX

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3297982 ★ Lubricant & Greases Solutions for the Whole Electrical Vehicle Drivetrain Including the Thermal Management of Batteries

Torsten Murr, Shell Global Solutions Germany, Hamburg, Germany

4:30 – 5 pm

3284626 ★ Effects of Lubricant Additives on Copper in Soaking Test

Xinggao Fang, Don Pheneger, Afton Chemical Co., Richmond, VA

★ Session 2L

CONTACT MECHANICS II

Session Chair: Alexander McGhee, University of Florida, Gainesville, FL

Session Vice Chair: Noel Brunetiere, Institut Pprime, Futuroscope Chasseneuil Cedex, France

1:30 – 2 pm

3325660 ★ Effects of Surface Roughness and Viscoelastic Properties on the Friction from the

Sliding Contact between Elastomer and a Dissimilar Hard Surface: A Numerical Investigation

Huan Zhang, Daniel Mosher, United Technologies Research Center, East Hartford, CT

2 – 2:30 pm

3325986 ★ Elastic Rough Surface Contact & Root Mean Square Slope

Robert Jackson, Yang Xu, Swarna Saha, Kyle Schulze, Auburn University, Auburn, AL

2:30 – 3 pm

3325269 ★ The Contact Mechanics Challenge for Predicting Indentation Hardness

Matthew Brake, Rice University, Houston, TX, George Pharr IV, Texas A&M University, College Station, TX, Rosa Maria Espinosa Marzal, University of Illinois Urbana-Champaign, Urbana, IL, Philip Egberts, University of Calgary, Calgary, Alberta, Canada

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3325628 ★ Effects of Lubrication on Normal Elastic-Plastic Contact

Senyo Ahadzie, Rice University, Houston, TX

4:30 – 5 pm

3313360 ★ Influences of Adsorbed Water on the Interfacial Adhesion in the Early Stage of Sliding

Zaid Subhi, Malaysia-Japan International Institute of Technology, Kuala Lumpur, Kuala Lumpur, Malaysia

5 – 5:30 pm

3288287 ★ An Investigation on Oblique Gravitational Wave Trapping Using Poroflexible Geometry in Stratified Sea with Varying Base Topography

Nagmani Prasad, Indian Institute of Technology, Dhanbad, Jharkhand, India

5:30 – 6 pm

3309555 ★ Contact Deformation and Stress Field of Materials Containing Debonded Inhomogeneities Under Cyclic Loading

Donglong Li, Northwestern University, Evanston, IL

6 – 6:30 pm – Contact Mechanics Business Meeting

★ Session 2M

NANOTRIBOLOGY II

Session Chair: Filippo Mangolini, The University of Texas at Austin, Austin, TX

Session Vice Chair: Prathima Nalam, University at Buffalo, Buffalo, NY

1:30 – 2:30 pm

3289517 ★ Invited Talk: Functionalizing Hydrogels with Polymer Brushes to Produce Lubricious Surfaces

Nicholas Spencer, ETH Zurich, Zurich, Switzerland

2:30 – 3 pm

3333229 ★ Mechanochemical Decomposition of Phosphate Esters Confined and Sheared Between Iron Oxide Surfaces

James Ewen, Carlos Ayestaran Latorre, Daniele Dini, Imperial College London, London, United Kingdom

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3320006 ★ Effect of Macromolecular Architecture on Dynamic Cross-linked Self-Healing Polymers

Zhijiang Ye, Qinghua Fang, Ballal Ahammed, Borui Zhang, Mehdi Zanjani, Dominik Konkolewicz, Miami University, Oxford, OH

4:30 – 5 pm

3337880 ★ Ab-Initio and Molecular Dynamics Simulations to Study Surfactants Interactions with Engineering Surfaces

Carlos Ayestaran Latorre, James Ewen, Daniele Dini, Imperial College London, London, United Kingdom, Chiara Gattinoni, ETH Zurich, Zurich, Switzerland

5 – 5:30 pm

3318070 ★ High Temperature Nanomechanical & Nanotribological Behavior of Nitrogen-Doped Carbon Overcoats Films

Ahmad Shakil, Andreas Polycarpou, Texas A&M University, College Station, TX

5:30 – 6 pm

3285152 ★ Effect of Chain Weight on Transfer-Film Formation Due to Friction Between PTFE and Si₃N₄

Huijie Tang, Le Gu, Harbin Institute of Technology, Harbin, Heilongjiang, China



Tuesday, May 5, 2020

★ Session 3A

COMMERCIAL MARKETING FORUM III

8 – 8:30 am | Open Slot

8:30 – 9 am | Biosynthetic Technologies

9 – 9:30 am | The Lubrizol Corp.

9:30 – 10 am | Münzing

10 – 10:30 am – Break

10:30 – 11 am | Croda, Inc.

11 – 11:30 am | Evonik Oil Additives, USA

11:30 am – Noon | King Industries Inc.

★ Session 3B

METALWORKING FLUIDS III

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3303669 ★ Foam Control and Formulation Techniques to Minimize Foam in Water Dilutable MWFs

Michael Miller, Univar Solutions, Houston, TX

8:30 – 9 am

3286360 ★ Non-Ionic Performance Surfactants on High Performance Metal Cleaners

Eduardo Lima, Dow Brazil, Jundiai, São Paulo, Brazil

9 – 9:30 am

3313898 ★ Metalworking Fluids and Chloride Corrosion on Aluminum Alloys

Alan Cross, John Burke, Quaker Houghton, Norristown, PA

9:30 – 10 am

3324594 ★ Reserving Metalworking Formulation Space for the Impossibilities

Nicole Clarkson, Clayton Cooper, Soraya Kraszczyk, ANGUS Chemical Co., Buffalo Grove, IL

10 – 10:30 am – Break

10:30 – 11 am

3325105 ★ Beating the Odds – How to Consistently Build Successful Products

Emil Schnellbacher, Chemico Systems, Chesterfield, MI

11 – 11:30 am

3314190 ★ Concentration and Stability Profiles of Copper-Infused Wire Drawing Fluids

Matt Vanden Eynden, Formulaction, Inc., Worthington, OH, Christelle Tisserand, Yoann Iefeuve, Pascal Bru, Gerard Meunier, Formulaction, Toulouse, France

11:30 am – Noon

3283029 ★ Surface Behavior and Lubricative Properties of Hydroxyproline Rich, Natural Proteins in Metal Working Fluids

Eric Yezdimer, Gelita USA, Sergeant Bluff, IA, Matthias Reihmann, Gelita AG, Eberbach, Germany

★ Session 3C

ROLLING ELEMENT BEARINGS III

Session Chair: Daniel Merk, Schaeffler Technologies, Schweinfurt, Bavaria, Germany

Session Vice Chair: Bryan Allison, SKF Aeroengine, Clymer, NY

8 – 8:30 am

3282380 ★ Numerical Modeling of Three-Dimensional Crack Propagation Under Rolling Contact Fatigue

Florian Meray, Daniel Nelias, Anthony Gravouil, Thibaut Chaise, Univ Lyon, INSA-Lyon, Villeurbanne, France, Bruno Descharrieres, Airbus Helicopters, Marignane, France

8:30 – 9 am

3309993 ★ Evolution of Short Surface Cracks under Rolling Contact: 3D Crack Morphology and Influence of Material Composition

Chiara Bertuccioli, Finn Giuliani, Amir Kadiric, Imperial College London, London, United Kingdom

9 – 9:30 am

3278313 ★ Propagation of Rolling Contact Fatigue Cracks in Ball Bearing

Kenji Matsumoto, Honda R&D Co., Ltd., Haga-gun, Japan, Naoaki Yoshida, Kyushu University, Kasuga, Fukuoka, Japan, Akira Sasaki, Maintek, Yokohama, Kanagawa, Japan

9:30 – 10 am

3323724 ★ Investigation into the Propagation of Surface Cracks Under Rolling Contact Using Experimental and Numerical Methods

Bjoern Kunzelmann, Amir Kadiric, Imperial College London, London, United Kingdom, Guillermo Morales-Espejel, SKF Research and Technology Development, Houten, Netherlands

10 – 10:30 am – Break

10:30 – 11 am

3283782 ★ Investigation of Formation Mechanisms of Dark Etching Regions and White Etching Bands in SAE 52100 Steel Bearings

Mostafa El Laithy, Ling Wang, Terry Harvey, University of Southampton, Southampton, United Kingdom, Bernd Vierendeel, Schaeffler Technologies AG & Co. KG, Schweinfurt, Germany

11 – 11:30 am

3284271 ★ Formation of White Etching Areas / Cracks on a Four-Disk Rig – Investigating Microstructural Changes

Adrian Mikitisin, Central Facility for Electron Microscopy, Aachen, Germany, Florian Steinweg, Institute for Materials Applications in Mechanical Engineering, Aachen, Germany

11:30 am – Noon

3285641 ★ Fracture-Mechanical Evaluation of Inclusions – Comparison with Test Results and Other Approaches

Joerg Binderszewsky, Wolfram Kruhoeffer, Toni Blass, Schaeffler Technologies AG & Co. KG, Herzogenaurach, Germany

★ Session 3D

BIOTRIBOLOGY III

Session Chair: Dipankar Choudhury, University of Arkansas, Fayetteville, AR

Session Vice Chair: Jack Famiglietti, University of Florida, Gainesville, FL

8 – 8:30 am

3280258 ★ Tribological Effect of Nanodiamonds as Potential Lubricant for Artificial Joints

Asghar Shirani, Diana Berman, University of North Texas, Little Elm, TX

8:30 – 9 am

3324250 * Novel Bio-Tribometer Exposing Macrophages to Freshly Generated In-Situ CoCrMo-Debris

Simona Radice, Kathrin Ebinger, Lauryn Samelko, Pourzal Robin, Nadim Hallab, Markus Wimmer, Rush University Medical Center, Chicago, IL

9 – 9:30 am

3316419 * Fretting-Corrosion Induced Hydrogen Permetiation in Biomedical Ti-Alloys

Micheal Bryant, University of Leeds, Leeds, United Kingdom

9:30 – 10 am

Invited Talk

10 – 10:30 am – Break

10:30 – 11 am

3284242 * A Biomaterial for Cartilage Replacement – A Tribological Study

Rahul Ribeiro, Arun B.P., Alliance University, Bengaluru, Karnataka, India

11 – 11:30 am

3286662 * Sniffing Wear Patterns: Acoustic Emission Signals as a Diagnostic Tool for Joint Wear

Khadijat Olorunlambe, Hua Zhe, Duncan Shepherd, Karl Dearn, University of Birmingham, Birmingham, United Kingdom

*** Session 3F**

LUBRICATION FUNDAMENTALS III

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3321496 * Macroscale Superlubricity Enabled by Hydrated Multivalent Ions

Tianyi Han, Zhang Chenhui, Jianbin Luo, Tsinghua University, Beijing, China

8:30 – 9 am

3277410 * The Effect of Magnetic Field on the Hydration Revealed by THz Spectroscopy and MDs

Yanqi Gu, Tianbao Ma, Jianbin Luo, State Key Laboratory of Tribology – Tsinghua University, Beijing, China

9 – 9:30 am

3302240 * Three-Way Compatibility Among Ionic Liquids, MoDTC, and

PIBSI Dispersant

Weimin Li, Lanzhou Institute of Chemical Physics, Lanzhou, Gansu, China, Chanaka Kumara, Huimin Luo, Harry Meyer, Xin He, Jun Qu, Oak Ridge National Laboratory, Oak Ridge, TN, Dien Ngo, Seong Kim, Pennsylvania State University, University Park, PA

9:30 – 10 am

3284970 * Tribo-Induced Interfacial Nanostructures Assisting Robust Superlubricity in Amorphous Carbon Films: From Mechanisms to Tailoring Strategies

Xinchun Chen, Tsinghua University, Beijing, China

10 – 10:30 am – Break

10:30 – 11 am

3337896 * Viscosity-Temperature Equations for Petroleum-Based Lubricating Oils

Jack Zakarian, JAZTech Consulting, LLC, Orinda, CA, Shaun Flannigan, Ashlie Martini, University of California, Merced, Merced, CA

11 – 11:30 am

3293046 * The Molecular Origins of Viscosity in the Ester Lubricants

Thomas Theyson, TensTech Inc., Matthews, NC

11:30 am – Noon

3299774 * Shear-Thinning and Rheological Transition in Lubricants Sheared at High Strain Rates

Vikram Jadhao, Indiana University, Bloomington, IN

*** Session 3G**

MATERIALS TRIBOLOGY I

Solid Lubricants for Extreme Applications

Session Chair: John Curry, Sandia National Laboratories, Albuquerque, NM

Session Vice Chair: Tyler Torgerson, University of North Texas, Denton, TX

8 – 9 am

Invited Talk: Lubrication by Carbon – Surface Aromatization a General Route for Achieving Superlubricity

Maria-Isabel De Barros Bouchet, École Centrale de Lyon

9 – 9:30 am

3286873: * Aging Gracefully: Storage Effects on the Run-In of MoS₂-Based Solid Lubricants

Michael Dugger, Brendan Nation, Morgan Jones,

Nicolas Argibay, John Curry, Michael Chandross, Sandia National Laboratories, Albuquerque, NM

9:30 – 10 am

3320312 * Tribological Properties of Duplex PEO/Chameleon Coating on Aluminum Alloys

Asghar Shirani, Samir Aouadi, Andery Voevodin, Diana Berman, University of North Texas, Little Elm, TX, Aleksey Yerokhin, University of Manchester, Manchester, United Kingdom, Jon-Erik Mogonye, U.S. Army Research Laboratory, Adelphi, MD, Andras Korenyi-Both, Tribologix Inc., Golden, CO

10 – 10:30 am – Break

10:30 – 11 am

3286767 * Tribological Performance of PS400 Coating from Cryogenic to Elevated Temperatures for Space Application

Kian Bashandeh, Vasilis Tsigki, Texas A&M University, College Station, TX, Pixiang Lan, Jacob Meyer, ATSP Innovations, Champaign, IL, Andreas Polycarpou, Texas A&M University, College Station, TX

11 – 11:30 am

3309532 * Tribochemistry and Performance of Nanoparticle Additives in Spacecraft Lubricants

Andrew Clough, Edith Leung, Jeffrey Lince, The Aerospace Corp., El Segundo, CA

11:30 am – Noon

3339073 * Effect of Stoichiometry and Oxygen on Crystallization of MoS₂ from Atomic and Molecular Precursors

Rimei Chen, Ashlie Martini, University of California, Merced, Merced, CA, Arben Jusufi, Andrew Konicek, Chris Kliever, Aditya Jaishankar, Alan Schilowitz, ExxonMobil Research and Engineering Co., Annandale, NJ

*** Session 3H**

GREASE III

Session Chair: Gareth Fish, The Lubrizol Corp., Wickliffe, OH

Session Vice Chair: Weixue Tian, ExxonMobil Research & Engineering, Annandale, NJ

8 – 8:30 am

3308619 * A New Methodology to Characterize Constant Velocity Joint Greases

Valentin Ripard, Fabrice Ville, Jérôme Cavoret, LaMCoS – INSA Lyon, Villeurbanne, France, Pierre Charles, Groupe PSA, Velizy-Villacoublay, France



Technical Sessions

8:30 – 9 am

3284263 * **Corelating the Adhesion and Tackiness of Greases to Their Frictional Performance**

Emmanuel Georgiou, Dirk Drees, Falex Tribology NV, Rotselaar, Belgium

9 – 9:30 am

3324539 * **Review of Custom SRV Tribological Test Fixturing to Simulate Bearing Test Rig Conditions**

Rob Mulkern, Nye Lubricants, Fairhaven, MA

9:30 – 10 am

3322529 * **On the Modeling of Lubricating Grease Thickener Deformation**

Lars Westerberg, Naser Hamed, Luleå University of Technology, Luleå, Sweden

10 – 10:30 am – Break

10:30 – 11 am

3340628 * **The Effect of Heavy Viscosity Base Oils on Grease Performance Properties**

Edward Casserly, Ergon, Jackson, MS

11 – 11:30 am

3347641 * **Application of Nano-Structure Urea Grease (INS-UG) to Wave Generation Gear**

Hideki Nakata, Idemitsu Kosan, Co.Ltd, Tokyo, Japan

* Session 3I

TRIBOCHEMISTRY III

Tribofilm Growth – Modeling & Characterization

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3338744 * **First-Principles Insights into the Mechanism of Metal-Polymer Contact Electrification for Triboelectric Nanogenerator**

Alessandra Ciniero, Imperial College London, London, United Kingdom

8:30 – 9 am

3325336 * **Relating Tribofilm Formation and Performance to the Adsorption Strength of Surface-Active Precursors**

Arman Mohammad Khan, Qian (Jane) Wang, Yip-Wah Chung, Northwestern University, Evanston, IL, Hongxing Wu, Xi'an Jiaotong University, Xian, China

9 – 9:30 am

3325221 * **Comparing the Composition and Evolution of Macro- and Nano-Scale Phosphorus Antiwear Tribofilms with ToF-SIMS**

Kerry Cogen, Ryan Rieth, Infineum USA L.P., Linden, NJ, Matthias Lorenz, Alison Pawlicki, Nikolay Borodinov, Olga Ovchinnikova, Oak Ridge National Laboratory, Oak Ridge, TN

9:30 – 10 am

3325301 * **Understanding the In-Situ Formation and Evolution of Phosphorus Antiwear Tribofilms with FFM and NanoIR-AFM**

Kerry Cogen, Ryan Rieth, Hitesh Thaker, Infineum USA L.P., Linden, NJ, Alison Pawlicki, Nikolay Borodinov, Olga Ovchinnikova, Oak Ridge National Laboratory, Oak Ridge, TN

10 – 10:30 am – Break

10:30 – 11 am

3286546 * **Fundamentals of Tribochemistry – Model Study with Tribopolymerization of Adsorbate Molecules**

Seong Kim, Xin He, Pennsylvania State University, State College, PA

11 – 11:30 am

3285552 * **Tribochemical Process on Silicon Surface: Fundamental Understanding and Application to Nanofabrication**

Linmao Qian, Lei Chen, Chen Xiao, Southwest Jiaotong University, Chengdu, Sichuan, China, Seong Kim, Pennsylvania State University, State College, PA

11:30 am – Noon

3313186 * **Molecular Simulation Approach to Attack Friction Fade Out Phenomena**

Hitoshi Washizu, Hirotohi Akiyama, Riio Nakae, University of Hyogo, Kobe, Japan

* Session 3J

CONDITION MONITORING I

Session Chair: Jatin Mehta, Fluitec International, Bayonne, NJ

Session Vice Chair: Kemberlee Snelling, Trico Corp., Davison, MI

8:30 – 9 am

3285675 * **The Increased Acid Number Question – Does it or Doesn't it Cause Corrosion?**

Michael D. Holloway, 5th Order Industry, Highland Village, TX

9 – 9:30 am

3285444 * **Introduction of Online Oil Condition Monitoring System for Hydraulic Excavator**

Hideki Akita, Hitachi Construction Machinery Co., Ltd., Tsuchiura, Ibaraki, Japan

9:30 – 10 am

3284840 * **The Analysis of Wear and Wear Products from Gearboxes Utilization of Statistical Analysis**

Surapol Raadnui, KMUTNB, Bangkok, Bang-Sue, Thailand

10 – 10:30 am – Break

10:30 – 11 am

3317073 * **High Throughput Particle Count and Elemental Analysis of In-Service Oils in One Run**

Autumn Wassmuth, PerkinElmer, New Haven, CT

11 – 11:30 am

3285697 * **Strange Influences on Oil Analysis Results**

Michael D. Holloway, 5th Order Industry, Highland Village, TX

* Session 3K

ENGINE & DRIVE TRAIN I

Session Chair: Behzad Mahmoudi, Chevron Oronite LLC, Richmond, CA

Session Vice Chair: Abhishek Kar, Shell Global Solutions US Inc., Houston, TX

8 – 8:30 am

3274941 * **Emission and Vehicle Performance Evaluation of Aged Gasoline Particle Filter via Accelerated Ash and Soot Loading**

Weizi Li, Xiaojun Wu, Shell (Shanghai) Technology Limited, Shanghai, China, Yansong Lin, Jinchong Pan, Suzhou Automotive Research Institute, Tsinghua University, Suzhou, China, Chen Yang, Haijun Yang, Geely Powertrain Research Institute, Ningbo, China

8:30 – 9 am

3318940 * Facile Mimicking of Internal Engine Oil Viscosity at Real Temperature and Shear by Way of a Microfluidic Rheometer

Matt Vanden Eynden, Formulaction, Inc., Worthington, OH, Patrycja Adamska, Thanina Amiar, Hubert Ranchon, Pascal Bru, Gerard Meunier, Formulaction, Toulouse, France

9 – 9:30 am

3294373 * Effects of Powertrain Formulations in Taxi Cab Severe Field Service

JoRuetta Ellington, Evonik Industries, Horsham, PA

9:30 – 10 am

3284520 * Friction and Wear of Thermal Spray Coatings for Cylinder Bores

Arup Gangopadhyay, Larry Elie, Robert Zdrodowski, Zhiqiang Liu, Urban Morawitz, Joachim Patschull, Cliff Maki, Ford Motor Co., Novi, MI, Hamed Ghaednia, Gehring Group, Farmington Hills, MI

10 – 10:30 am – Break

10:30 – 11 am

3285656 * Development of a Fired-Engine Test Cycle to Evaluate the Effect of Engine Oil Formulation on Emulsion Formation

Dan Engstrom, Southwest Research Institute, San Antonio, TX

11 – 11:30 am

3286684 * Component Wear in Diesel Engine High Pressure Fuel Pumps Operating with Heavy Fuel

Nikhil Murthy, Stephen Berkebile, Blake Johnson, CCDC Army Research Laboratory, Aberdeen Proving Ground, MD, Caleb Matzke, University of North Dakota, Grand Forks, ND

11:30 am – Noon

3283984 * Influence of Fluids on the Operational Efficiency of Transmissions and Drivetrain Components

Dean Tomazic, FEV North America Inc., Auburn Hills, MI

* Session 3L

CONTACT MECHANICS III

Session Chair: Kylie Van Meter, University of Florida, Gainesville, FL

Session Vice Chair: Bo Tan, University of Kentucky, Lexington, KY

8 – 8:30 am

3278124 * Computational Contact Modeling of Lithium Metal and Solid Electrolyte Interfaces

Xin Zhang, Qian (Jane) Wang, Northwestern University, Evanston, IL, Stephen Harris, Lawrence Berkeley National Lab, Berkeley, CA

8:30 – 9 am

3283853 * Comparison of Scale in Indentation Experiments

John Despard, Matthew Brake, Rice University, Houston, TX

9 – 9:30 am

3315526 * A Benchmark Study of Conformal Contact

Jiahui Hou, Pu Li, JiangLin Li, Xiaoqing Jin, Chongqing University, Chongqing, China, Leon M. Keer, Northwestern University, Evanston, IL

9:30 – 10 am

3314982 * The Origin of the Friction Coefficient for Randomly Rough Surfaces in Elastic Contact

Feng-Chun Hsia, Cyrian Leriche, Steve Franklin, Bart Weber, Advanced Research Center for Nanolithography (ARCNL), Amsterdam, Netherlands, Daniel Bonn, University of Amsterdam, Amsterdam, Netherlands

10 – 10:30 am – Break

10:30 – 11 am

3322337 * Transient Thermo-mechanical Analysis of Asperity Sliding Contact Considering the Effect of Temperature and Strain Rate on Material Properties

Bin Zhao, Hanzhang Xu, Xiquan Lu, Zhigang Liu, Tongyang Li, Harbin Engineering University, Harbin, China

11 – 11:30 am

3317854 * High-Temperature Nanomechanical Behavior of Inconel 617 Surface Oxides

Sepehr Salari, Ali Beheshti, George Mason University, Fairfax, VA, Md Saifur Rahman, Andreas Polycarpou, Texas A&M University, College Station, TX

11:30 am – Noon

3323585 * High-Temperature Contact Creep and Friction of Inconel 617 Surface Oxides

Sepehr Salari, Lamar University, Fairfax, VA, Md Saifur Rahman, Andreas Polycarpou, Texas A&M University, Fairfax, VA, Ali Beheshti, George Mason University, Fairfax, VA

* Session 3M

LUBRICATION FUNDAMENTALS: SPECIAL SESSION 1

Four Decades of Patri-Cheng Average Flow Model and Future Challenges in Tribology

Session Chair: TBD

Session Vice Chair: TBD

Invited Talks: As the lubrication science deepens in understanding and widens in its application to novel fields, time has come to review progress made in the past 40 years and discuss current challenges and future needs. This symposium brings together researchers in the field of lubrication to share their accomplishments in research and present their visions for future research and development.

* Session 4A

COMMERCIAL MARKETING FORUM IV

2 – 3 pm | Afton Chemical's Key Driver Seminar

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm | The Lubrizol Corp.

4:30 – 5 pm | BASF Corp.

5 – 5:30 pm | Eastman Chemical Co.



Technical Sessions

★ Session 4B

METALWORKING FLUIDS IV

Session Chair: TBD

Session Vice Chair: TBD

2 – 2:30 pm

3324812 ★ Cross-Functional Benefits of Metalworking Fluid Additives

Nicole Clarkson, ANGUS Chemical Co., Buffalo Grove, IL, Michael Stapels, Kao Chemicals GmbH, Emmerich am Rhein, Germany, Clayton Cooper, Soraya Kraszczyk, ANGUS Chemical Co., Buffalo Grove, IL, Sabine Wohlfahrt, Lea Tekath, Kao Chemicals GmbH, Emmerich am Rhein, Germany

2:30 – 3 pm

3297106 ★ Investigation of O/W Emulsion in Rolling of Strips

Behnam Hajshirmohammadi, Louisiana State University, Baton Rouge, LA

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3303685 ★ Measuring Tapping Performance Parameters – Using Tapping Torque to Evaluate Coolants and Coolant Additives

Michael Miller, Univar Solutions, Houston, TX

4:30 – 5 pm

3319978 ★ Correlation of Cutting Fluid Lubricity to Tool Life in Hard Metal Machining with an Improved Tapping Torque Test Method

Chandra Khadilkar, Brian Mattes, Z. Tahir, Master Fluid Solutions, Perrysburg, OH

5 – 5:30 pm

3310322 ★ The Performance of Environmentally Friendly Metalworking Fluids in Drilling on Titanium Alloy

Junhui Ma, Javad Mohammadi, Olufisayo Gali, Reza Riahi, University of Windsor, Windsor, Ontario, Canada, Yan Zhou, Houghton International, Oak Ridge, TN, Jeff Larsh, Kris Januszkiewicz, Yixing Zhao, Quaker Houghton, Philadelphia, PA

5:30 – 6 pm – Metalworking Fluids Business Meeting

★ Session 4C

ROLLING ELEMENT BEARINGS IV

Session Chair: Bryan Allison, SKF Aeroengine, Clymer, NY

Session Vice Chair: Behrooz Jalalahmadi, Sentient Science Corp., Charlotte, NC

2 – 2:30 pm

3329361 ★ Experimental and Numerical Assessment of Power Loss in Aero-Engine Cylindrical Roller Bearings: M50 versus Hybrid Bearings

Rami Kerrouche, Azzedine Dadouche, Mahmoud Mamou, National Research Council Canada, Ottawa, Ontario, Canada, Salah Boukraa, University of Saad Dahlab, Blida, Algeria

2:30 – 3 pm

3285428 ★ Minimum Energy Hypothesis in Quasi-Static Equilibrium Solutions for Angular Contact Ball Bearings

Pradeep Gupta, PKG Inc., Clifton Park, NY

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3283250 ★ Bearing Performance Analysis Using an Advanced Dynamic Bearing Model

Young Kang, Matthew Wilmer, The Timken Co., North Canton, OH

4:30 – 5 pm

3285157 ★ Investigation of Cage Instability Mechanism with Considering Cage Design

Yuanqing Liu, Wenzhong Wang, Beijing Institute of Technology, Beijing, China

5 – 5:30 pm

3311744 ★ Experimental & Numerical Investigation of Spherical Rolling Element Bearing Performance Under Different Combinations of Radial and Axial Loads, Speed and Lubrication

Nikhil Londhe, John Rhodes, Caleb Chovan, Shawn Froelich, The Timken Co., Canton, OH

5:30 – 6 pm

33282859 ★ Investigation on the Mixed Lubrication Performance of a Coated Angular Contact Ball Bearing

Jiqiang Wu, Liqin Wang, Tingjian Wang, Harbin Institute of Technology, Harbin, China

6 – 6:30 pm – Rolling Element Bearing Business Meeting

★ Session 4D

BIOTRIBOLOGY IV

Session Chair: Angela Pitenis, University of California, Santa Barbara, Santa Barbara, CA

Session Vice Chair: Gagan Srivastava, Dow Chemical Co., Jackson, TX

2 – 2:30 pm

3325108 ★ Biotribological Investigation of Cartilage Inspired Textured Ti-6Al-4V and PEEK Interface

Dipankar Choudhury, Evelyn Smith, Josh Goss, Min Zou, University of Arkansas, Fayetteville, AR

2:30 – 3 pm

3313747 ★ A New Laser Textured Structure to Improve Tribocorrosion Behavior of Ti-6Al-4V ELI for Orthopedic Applications

Yidong Xu, Jiahui Qi, Mingwen Bai, Jiawei Xi, Nutter John, Mark Rainforth, University of Sheffield, Sheffield, United Kingdom

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3276530 ★ Experimental Biotribological Testing of Hydrogels and Articular Cartilage for Medical Engineering Applications

Florian Rummel, Anton Paar Germany GmbH, Ostfildern, Germany, Dominique Felk, Tübingen University, Tübingen, Germany, Kartik Pondicherry, Anton Paar GmbH, Graz, Austria

4:30 – 5 pm

3285465 ★ Comparison of the Biotribological Behaviors of an Artificial Cervical Disc with the Articulation of TC4-XPE and CoCrMo-XPE

Song Wang, Research Institute of Tsinghua University, Shenzhen, Guangdong, China

5 – 5:30 pm

3325261 * **Wear of Antibacterial Coatings on CoCrMo Under Butterfly Motion and Dynamic Loads in a Biotribometer**

Angela Maria Tortora, Deepak Halenahally Veeregowda, Ducom Instruments Europe B.V, Groningen, Netherlands

5:30 – 6 pm – **Biotribology Business Meeting**

*** Session 4E**

SURFACE ENGINEERING I

Additive Manufacturing

Session Chair: TBD

Session Vice Chair: TBD

2 – 2:30 pm

3282152 * **Effect of Test Temperature on Tribological Behavior of Additively Manufactured Stellite 21 Coating on 350 Maraging Steel**

Sougata Roy, Niyanth Sridharan, Jun Qu, Oak Ridge National Laboratory, Oak Ridge, TN, Hamed Ghaednia, Gehring Group, Farmington Hills, MI, Arup Gangopadhyay, Ford Motor Co., Novi, MI

2:30 – 3 pm

3287053 * **Surface Energy & Wetting Behavior of Additive Manufactured Inconel 718 Alloy for Efficient Tribological System**

Arpith Siddaiah, Pankaj Kumar, Manoranjan Misra, Pradeep Menezes, University of Nevada-Reno, Reno, NV

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3316642 * **Tribology of Surfaces with 3D Textures Fabricated via Two Photon Lithography: A Multi-Scale In-Situ Study**

Mahyar Afshar Mohajer, Min Zou, University of Arkansas, Fayetteville, AR

4:30 – 5 pm

3322986 * **Characterization and Performance of a PTFE-Based Ice-Phobic Coating**

Robert Fleming, Arkansas State University, Jonesboro, AR, Giselle Toledo, German Perez Bakovic, Sam Beckford, SurfTec, Fayetteville, AR

5 – 5:30 pm

3285432 * **Post-Additive Manufacturing Surface Modification Technology for Controlling Microstructure and Tribological Properties of Metallic Alloys**

Auezhan Amanov, Young-Sik Pyun, Sun Moon University, Asan, Republic of Korea

*** Session 4F**

LUBRICATION FUNDAMENTALS IV

Session Chair: TBD

Session Vice Chair: TBD

2 – 2:30 pm

3321896 * **Soot Composition and its Impact on Wear**

Nicole Doerr, Serhiy Budnyk, Adam Agocs, Marcella Frauscher, AC2T Research GmbH, Wiener Neustadt, Austria

2:30 – 3 pm

3325719 * **A System Engineering Approach to Reduce Soot Wear**

Deepak Halenahally Veeregowda, Angela Maria Tortora, Ducom Instruments Europe B.V, Groningen, Netherlands

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3291404 * **A New Approach to Optimize the One-Dimensional Lubricated Contact**

Mhammed El Gadari, Ensam Meknes, Meknes, Morocco, Mohamed Hajjam, Institut Pprime, Poitiers, France

4:30 – 5 pm

3284937 * **Investigation of the Lubricant Oil Flow Pattern Around Rolling Point Contacts**

Hongbai Chen, Wenzhong Wang, He Liang, Beijing Institute of Technology, Beijing, China

5 – 5:30 pm

3281895 * **Achieving Liquid Superlubricity Under Boundary Lubrication Conditions**

Qiang Ma, Arman Mohammad Khan, Qian (Jane) Wang, Yip-Wah Chung, Northwestern University, Evanston, IL

5:30 – 6 pm

3273970 * **Influence of Surface Thermal Properties on EHL Friction**

Wassim Habchi, Lebanese American University, Byblos, Lebanon, Scott Bair, Georgia Institute of Technology, Atlanta, GA

*** Session 4G**

MATERIALS TRIBOLOGY II

Protective Thin Films & Coatings

Session Chair: Mary Makowiec, Pratt & Whitney, East Hartford, CT

Session Vice Chair: TBD

2 – 2:30 pm

3286724 * **Polymer Coatings as “Pre-Deposited Transfer Layers” for Extreme Temperature Applications**

Pixiang Lan, Jacob Meyer, ATSP Innovations, Champaign, IL, Vasilis Tsigkis, Kian Bashandeh, Andreas Polycarpou, Texas A&M University, College Station, TX

2:30 – 3 pm

3317704 * **Effect of Cosmic Radiation on the Micro/Nano-mechanical and Morphological Properties of Selected Hard and Soft Coatings**

Andreas Polycarpou, Vasilis Tsigki, Kian Bashandeh, Texas A&M University, College Station, TX, Pixiang Lan, Jacob Meyer, ATSP Innovations, Champaign, IL

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3284210 * **Carbon Nanotube Forest as a Protective Coating for Tribological Application**

Chanaka Kumara, Michael Lance, Jun Qu, Oak Ridge National Laboratory, Oak Ridge, TN

4:30 – 5 pm

3325457 * **Ultralow Wear Plasma Enhanced Atomic Layer Deposited Nitrides: Exploring Processing, Structure, Properties & Mechanisms**

Tomas Babuska, Jewel Haik, Istiaque Chowdhury, Nicholas Strandwitz, Brandon Krick, Lehigh University, Bethlehem, PA, Mark Sowa, Veeco CNT, Waltham, MA, Alexander Kozen, University of Maryland, College Park, MD, Guosong Zeng, Lawrence Berkeley National Laboratory, Berkeley, CA, Kylie Van Meter, University of Florida, Gainesville, FL

5 – 5:30 pm – **Materials Tribology Business Meeting**



Technical Sessions

★ Session 4H

GREASE IV

Session Chair: Scott Crawford, Primrose Oil Co., Dallas, TX

Session Vice Chair: Erik Willett, Functional Products Inc., Macedonia, OH

2 – 2:30 pm

3286489 ★ Fully Customizable Calcium Sulfonate Greases for Optimum Performances

Guillaume Notheaux, SEQENS, Porcheville, France

2:30 – 3 pm

3321671 ★ A New Preformed Polyurea Thickener for Grease

Zhe Jia, John Cuthbert, Kevin Capaldo, Bruce Hook, Andrew Larson, Dow Chemical, Freeport, TX

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3332057 ★ Novel Additive for Water Elimination in Bearing Greases

Germán Prieto, Walter Tuckart, Camila Müller, Consejo Nacional de Investigaciones Científicas y Técnicas, Bahía Blanca, Buenos Aires, Argentina, Bruno Pilotti, Andrés Ciolino, Planta Piloto de Química/UNS-CONICET, Bahía Blanca, Buenos Aires, Argentina

4:30 – 5 pm

3284306 ★ The Impact of Viscosity of Naphthenic Oils on Different Type of Lubricating Greases

Mehdi Fathi-Najafi, Nynas AB, Nynäshamn, Sweden, Ameneh Schneider, Optimal Instruments Prueftechnik GmbH, Munich, Germany

5 – 5:30 pm

3282417 ★ The Effects of Addition of Zinc Stearate in Grease on the Tribological Properties of PA66-GF Composite in Contact with Carbon Steel

Takeshi Kunishima, Vincent Fridrici, Gaëtan Bouvard, Jean-Christophe Abry, Philippe Kapsa, LTDS Laboratoire de Tribologie et Dynamique des Systèmes, Lyon, France

★ Session 4I

TRIBOCHEMISTRY IV

Perspectives & Applications

Session Chair: TBD

Session Vice Chair: TBD

2 – 2:30 pm

3324464 ★ Tribochemistry – Past, Present, and Future

Stephen Hsu, George Washington University, Washington, DC

2:30 – 3 pm

3284999 ★ Mechanochemical Wear of Silicate Glass: Beyond the Conventional Materials Removal

Hongtu He, Southwest University of Science and Technology, Mianyang, Sichuan, China, Seung Ho Hahn, Seong Kim, Pennsylvania State University, State College, PA

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3291335 ★ Durable Lubricating Properties of Mussel-Inspired Polydopamine Nanoparticles as a Water-Based Additive

Guangyan Chen, Yongyong He, Jianbin Luo, State Key Laboratory of Tribology, Beijing, China, Jun Zhao, Beijing University of Chemical Technology, Beijing, China

★ Session 4J

CONDITION MONITORING II

Session Chair: Daniel Walsh, Spectro Scientific, Chelmsford, MA

Session Vice Chair: Michael Plumley, U.S. Coast Guard Academy, New London, CT

2 – 2:30 pm

3271943 ★ Determination of Total Oil Content in Metalworking Fluid Emulsions by a Fourier-Transform Infrared Method

Brittney Lagerman, BP Lubricants USA Inc., Naperville, IL

2:30 – 3 pm

3284704 ★ Analysis of Metal Additives and Wear Metals in Lubricants by High-Resolution ICP-OES

Oliver Buettel, Siqi Sun, Analytik Jena US LLC, Upland, CA

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3293271 ★ Prevention of Electrostatic Charge Generation in Filtration of Low Conductive Oils by Surface Modification of Modern Filter Media

John Duchowski, Johannes Staudt, HYDAC FluidCareCenter®, Sulzbach, Saar, Germany, Stephan Leyer, University of Luxembourg, Luxembourg

4:30 – 5 pm

3295693 ★ Isolation & Identification of Oxidation Products in Thermally Oxidized Group I, III, and IV Base Oils by Flow Modulated Two-Dimensional Gas Chromatography – Time of Flight Mass Spectrometry

Paul Harvath, Added Dimension Consulting, Lake Orion, MI, Christina Kelly, Joe Binkley, Lorne Fell, LECO Corp., St. Joseph, MI, John Buccì, Bill VanBergen, Savant Group, Midland, MI

5 – 5:30 pm

3310476 ★ Fast and Reliable Quality Control of Fresh and In-Service Lubricants by FT-MidIR Spectrometry

Aaron Mendez, Analytical Instruments, Chicago, IL

5:30 – 6 pm – Condition Monitoring Business Meeting

★ Session 4K

ENGINE AND DRIVETRAIN II

Session Chair: Oluwaseyi Ogunsola, Shell Technology Center, Houston, TX

Session Vice Chair: Piotr Grzyska, Afton Chemical Corp., Richmond, VA

2 – 2:30 pm

3316461 ★ A Study of Surface Acoustic Wave Sensors to Evaluate Fuel Dilution in Engine Oils

Seyed Mirmiran, FCA US LLC, Auburn Hills, MI
Lisa Williams, Randi Price, Spectro Scientific, Chelmsford, MA

2:30 – 3 pm

3296296 ★ Real-Time Wear Mapping of a 2.0L Turbocharged Gasoline Direct Injection Engine – Part II

Peter Lee, Gregory Hansen, Carlos Sanchez, Craig Wileman, Cole Hudson, Southwest Research Institute, San Antonio, TX

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3323460 * The Effect of Engine Oil and Lubrication System Design on Engine Friction as Demonstrated in a Motored Engine

William Anderson, Kongsheng Yang, Yun Zhang, Sha Yang, Afton Chemical Corp., Richmond, VA, Yuelei Ding, PATAC, Shanghai, China

4:30 – 5 pm

3286119 * Development and Testing of a Low Viscosity, Fuel-Efficient, Heavy-Duty Diesel Engine Oil for Severe Service

Allen Comfort, US Army Ground Vehicle Systems Center, Warren, MI, Steven Thrush, Oakland University, Rochester, MI

5 – 5:30 pm

3269401 * Efficiency and Friction Investigation on Drive Chains – Comparison between Two Different Tribological Test Rig Concepts

Dominik Meffert, Andre Becker, Bernd Sauer, Technische Universität Kaiserslautern, Kaiserslautern, Germany

5:30 – 6 pm

3313981 * Piston Ring on Liner Lubrication Monitoring in a Marine Diesel Engine using Ultrasound

Jack Rooke, Xiangwei Li, Rob Dwyer-Joyce, University of Sheffield, Sheffield, South Yorkshire, United Kingdom, Henry Brunskill, Peak to Peak Measurement Solutions Ltd., Sheffield, South Yorkshire, United Kingdom, Matthias Stark, WinGD, Winterthur, Switzerland

6 – 6:30 pm

3326611 * Tribological Aspects of Utilizing Wet Friction Materials in Wet Clutch Systems

Vladimir Klotchikhine, Greening Inc., Detroit, MI

* Session 4L

2D MATERIALS

Materials Tribology and Nanotribology Joint Session I

Session Chair: Mohammad Vazirisereshk, University of California, Merced, Merced, CA

Session Vice Chair: Nicholas Chan, University of Calgary, Calgary, New Brunswick, Canada

2 – 2:30 pm

3286531 * Chemical and Physical Origins of Friction on Two-Dimensionally Flat Surface with Atomic Steps

Seong Kim, Zhe Chen, Pennsylvania State University, State College, PA, Ashlie Martini, Arash Khajeh, Mohammad R. Vazirisereshk, University of California, Merced, Merced, CA

2:30 – 3 pm

3288831 * Superlubricity of Black Phosphorus as Lubricant Additive

Hanjun Gong, Guoxin Xie, Shuai Wu, Tsinghua University, Beijing, China, Wei Wang, Xi'an University of Architecture and Technology, Xi'an, China, Ziyi Cui, Zhuzhou Electrical Locomotive Co., Zhuzhou, China

3 – 4 pm – Exhibitor Appreciation Break

4 – 4:30 pm

3323166 * In-Situ Reactive Formation of MoS₂ Tribofilms: Interaction with ZDDP and Dispersants

Manel Rodriguez Ripoll, Bernhard Kohlhauser, Sara Spiller, AC2T Research GmbH, Wiener Neustadt, Austria, Carmen Vladu, CEST GmbH, Wiener Neustadt, Austria

4:30 – 5 pm

3321456 * Effect of Ni Dopant and Environment on Wear Life of MoS₂ Dry Film Lubricant

Azhar Vellore, Sergio Romero Garcia, Ashlie Martini, University of California, Merced, Merced, CA, Duval Johnson, Andrew Kennett, Matthew Heverly, NASA Jet Propulsion Laboratory (JPL), Pasadena, CA, Nicholas Walters, Lawrence Livermore National Laboratory, Livermore, CA

5 – 5:30 pm

3279907 * In-Plane Potential Gradient Induces Low Frictional Energy Dissipation During the Stick-Slip Sliding on the Surfaces of 2D Materials

Feng He, Xiao Yang, Guoxin Xie, Jianbin Luo, State Key Laboratory of Tribology, Tsinghua University, Beijing, China

5:30 – 6 pm

3281733 * Tribo-Induced Interfacial Material Transfer of AFM Probe Assisting Superlubricity in WS₂/Graphene Heterojunction

Jisen Tian, Tsinghua University, Beijing, China

* Session 4M

LUBRICATION FUNDAMENTALS SPECIAL SESSION

Four Decades of Patri-Cheng Average Flow Model and Future Challenges in Tribology (Invited Talks Only)

Session Chair: TBD

Session Vice Chair: TBD

As the lubrication science deepens in understanding and widens in its application to novel fields, time has come to review progress made in the past 40 years and discuss current challenges and future needs. This symposium brings together researchers in the field of lubrication to share their accomplishments in research and present their visions for future research and development.



Wednesday, May 6, 2020

★ Session 5A

COMMERCIAL MARKETING FORUM V

8 – 8:30 am | Open Slot

8:30 – 9 am | Open Slot

9 – 9:30 am | Pilot Chemical Co.

9:30 – 10 am | STLE Emerging Trends Report

10 – 10:30 am – Break

10:30 – 11 am | Savant Labs & Institute of Materials

★ Session 5B

ENVIRONMENTALLY FRIENDLY FLUIDS I

Session Chair: Brajendra Sharma, University of Illinois at Urbana-Champaign, Urbana, IL

Session Vice Chair: Mark Miller, Biosynthetic Technologies, Indianapolis, IN

8:30 – 9 am

3283665 ★ EU Ecolabel for Lubricants – European Approach to Evaluate EALs

Salvatore Rea, Lanxess Corp., Perkasie, PA, Thomas Klein, Lanxess Deutschland GmbH, Mannheim, Germany

9 – 9:30 am

3322919 ★ EALs for Marine Vessel Stern Tubes – Not all Esters are Equal
Kevin Duncan, Croda, Cowick, United Kingdom

9:30 – 10 am

3285535 ★ Experimental Comparison of EALs for Marine Vessel Stern Tubes

Sam Davison, University of Sheffield, Sheffield, South Yorkshire, United Kingdom

10 – 10:30 am – Break

10:30 – 11 am

3308645 ★ Triblock Polyalkylene Glycols as Hydrolytic Stability Improvers for Esters

Martin Greaves, Dow Chemical, Horgen, Switzerland

11 – 11:30 am

3285392 ★ Group V Basestocks on the Rise – Unconventional Basestocks as One Lever for More Sustainable Lubrication

Frank Rittig, René Koschabek, Henrik Heinemann, Uwe Förster, Edith Tuznya, BASF SE, Ludwigshafen, Germany, Gene Zehler, BASF Corp., Cincinnati, OH

11:30 am – Noon

3324278 ★ Optimization of Bio-Derived Basefluid Properties to Improve Efficiency in Hydraulic Systems

M. Cinta Lorenzo Martin, Oyelayo Ajayi, George R. Fenske, Argonne National Laboratory, Lemont, IL, Girma Biresaw, Grigor Bantchev, USDA-ARS-NCAUR-BOR, Peoria, IL

★ Session 5C

ROLLING ELEMENT BEARINGS V

Session Chair: Vasilios Bakolas, Schaeffler Technologies AG & Co. KG, Schweinfurt, Germany

Session Vice Chair: Trevor Slack, American Roller Bearing Co., Morgantown, NC

8 – 8:30 am

3279481 ★ Dynamics in Kinematics – Running Noise Calculation of Bearings in the Kinematic Regime

Hannes Grillenberger, Schaeffler Technologies AG & Co. KG, Herzogenaurach, Bayern, Germany

8:30 – 9 am

3286527 ★ A Strongly Coupled FDM – FEM Model for 2D Elastohydrodynamically Lubricated Contact

Wyatt Peterson, Thomas Russell, Farshid Sadeghi, Purdue University, West Lafayette, IN, Michael Tekletsion Berhan, Ford Motor Co., Dearborn, MI

9 – 9:30 am

3323754 ★ Fatigue Spall Propagation of AISI 52100 and VIM-VAR M50 Angular-Contact Bearings

Jeremy Nickell, Lewis Rosado, Mathew Kirsch, AFRL/RQTM, Wright Patterson Air Force Base, OH

9:30 – 10 am

3288261 ★ Influence on Rolling Bearing Performance of Contact Temperature and Wear

Jonas Stahl, Lars-Erik Stacke, AB SKF, Goteborg, Sweden, Guillermo Morales-Espejel, SKF BV, Houten, Netherlands

10 – 10:30 am – Break

10:30 – 11 am

3286447 ★ The Rating Life of Needle Roller Bearings in Universal Joints

Georg Breslau, Institute of Machine Elements and Machine Design (Technische Universitaet Dresden), Dresden, Germany

11 – 11:30 am

3316320 ★ Service Life in Rolling Element Bearings

Bruno Mevel, NTN-SNR, Anancy, France

★ Session 5D

FLUID FILM BEARINGS I

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3286293 ★ Drag Power Loss Correlations for Flooded Tilting Pad Journal Bearings – A Predictive Model and its Experimental Verification

Manish Thorat, Wei Li, Elliott Group, Jeannette, PA, Luis San Andres, Texas A&M University, College Station, TX, Hardik Jani, Honeywell, Mt. Laurel, NJ, Hussain Kaizar, Kelm Engineering, Friendswood, TX

8:30 – 9 am

3322397 ★ Performance Evaluation of Different Configurations of Hydrostatic Grinding Spindles

Hua-Chih Huang, Wei-Yang Chen, National Kaohsiung University of Science and Technology, Kaohsiung City, Taiwan

9 – 9:30 am

3319883 ★ Numerical & Experimental Analysis of Starvation for a Tilting Pad Journal Bearing

Scan DeCamillo, Kingsbury, Inc., Philadelphia, PA, Cori Watson-Kassa, University of Virginia, Charlottesville, VA

9:30 – 10 am

3286458 ★ Computer Experimental Design for Tribological Optimization

Nenzi Wang, Yu-Wen Chen, Chang Gung University, Tao-Yuan, Taiwan

10 – 10:30 am – Break

10:30 – 11 am

3285921 ★ Experimental Response of a Rotor Supported on Simple Rigid Surface Gas Bearings

Keun Ryu, Youngseok Song, Hanyang University, Seoul, Republic of Korea

11 – 11:30 am

3323521 * On the Significance of Bearing Configurations and Imbalances on the Dynamics of Small Automotive Turbochargers: A Lesson from Comprehensive Experiments and Predictions

Keun Ryu, Kyuman Kim, Hanyang University, Seoul, Republic of Korea

11:30 am – Noon

3326426 * Experimental and Numerical Analysis of a Connecting Rod Bearing

Aurelian Fatu, Mihail Radoi, Yann Henry, Institut Pprime, Angoulême, France

*** Session 5E**

TRIBOLOGY OF BIOMATERIALS

Biotribology and Materials Tribology Joint Session I

Session Chair: George Degen, University of California, Santa Barbara, Santa Barbara, CA

Session Vice Chair: Kylie Van Meter, University of Florida, Gainesville, FL

8 – 8:30 am

3324450 * Mechanisms of Aqueous Gel Adhesion

George Degen, Allison Chau, Angela Pitenis, University of California, Santa Barbara, Santa Barbara, CA

8:30 – 9 am

3325549 * Microstructural Contribution to Hydrogel Frictional Dissipation

Tooba Shoaib, Paige C. Prendergast, Justin Silberman, Rosa Espinosa-Marzal, University of Illinois at Urbana-Champaign, Urbana, IL

9 – 9:30 am

3324847 * Speed-Independent Friction with Yield Stress Gradients

Eric McGhee, W. Gregory Sawyer, University of Florida, Gainesville, FL

9:30 – 10 am

3325050 * Fragile Objects and Interfaces

Angela Pitenis, George Degen, Allison Chau, University of California, Santa Barbara, Santa Barbara, CA

10 – 10:30 am – Break

10:30 – 11 am

3315962 * A Numerical Modeling Framework for Lubrication in Compliant Contacts

Abdullah Azam, Abdel Dorgham, Micheal Bryant, Mark Wilson, Nikil Kapur, Anne Neville, University of Leeds, Leeds, United Kingdom

11 – 11:30 am

3324615 * Impact of Metal Release on Chondrocytes Due to Biotribocorrosion in CoCrMo Sliding Against Articular Cartilage

Manel Rodriguez Ripoll, Bojana Simlinger, Friedrich Franek, AC2T Research GmbH, Wiener Neustadt, Austria, Christoph Bauer, Christoph Stotter, Thomas Klestil, Stefan Nehrer, Danube University Krems, Faculty of Health and Medicine, Krems, Austria

11:30 am – Noon

3324098 * Mechanical and Biological Responses of Cartilage to Tribological Challenge- a 3-Factor Central Composite Design Analysis

Catherine Yuh, Benjamin Witt, Spencer Fullam, Susanna Chubinskaya, Markus Wimmer, Rush University, Chicago, IL, Suzanne Maher, Hospital for Special Surgery, New York City, NY

*** Session 5F**

LUBRICATION FUNDAMENTALS V

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3283757 * Sliding Tribological Performance of the Proppant in Shale Rock Fractures Under Water-Based Fracturing Fluid

Huijie Zhang, Shuhai Liu, Huaping Xiao, China University of Petroleum-Beijing, Beijing, China

8:30 – 9 am

3323479 * Rheology and Wear Reduction Characteristics of Base Oils in Pure Sliding Point Contacts

Sipho Masilela, Philip de Vaal, University of Pretoria, Pretoria, Gauteng, South Africa

9 – 9:30 am

3323514 * The Effect of Temperature on the Friction and Wear Behavior of Fuel Oils Under Oxygen and Nitrogen (Inert) Atmosphere

Trinity Thobejane, Philip de Vaal, University of Pretoria, Pretoria, Gauteng, South Africa

9:30 – 10 am

3324555 * Steady State Friction of Metals: Progress in Prediction

Stephen Hsu, George Washington University, Washington, DC

10 – 10:30 am – Break

10:30 – 11 am

3323522 * Thermo-Kinetic Behavior and Lubricity of Molecularly Thin Lubricant in Head-Disk Interface

Changdong Yeo, Shahriar Rahman, Jingan Song, Texas Tech University, Lubbock, TX

11 – 11:30 am

3325184 * Development of Lubricity Test Methods to Investigate Aging of Lubricants

Deepak Halenahally Veeregowda, Fabio Alemanno, Giulia Chiarioni, Ducom Instruments Europe B.V, Groningen, Netherlands

11:30 am – Noon

3323616 * Using Bespoke Friction Rigs to Develop the Next Generation of Slideway Technologies

Ralph Lumby, Afton Chemical Ltd., Bracknell, United Kingdom

*** Session 5G**

MATERIALS TRIBOLOGY III

Hard to Soft: Fluoropolymer Composites & Hydrogels

Session Chair: Istiaque Alam, University of Delaware, Newark, DE

Session Vice Chair: Morgan Jones, Sandia National Laboratories, Albuquerque, NM

8 – 8:30 am

3319935 * A Comparative Study on the Structure – Process Relationship of PTFE-PEEK Composites

Kasey Campbell, Cooper Atkinson, Tomas Babuska, Brantley Balsamo, Christopher Junk, Brandon Krick, Lehigh University, Bethlehem, PA, Mark Sidebottom, Miami University, Oxford, OH

8:30 – 9 am

3289374 * Maximizing the Impact of Nanofillers on PTFE Wear Resistance

Istiaque Alam, Aman Garodia, David Burris, University of Delaware, Newark, DE



Technical Sessions

9 – 9:30 am

3323503 * Effect of Filler and Countersurface Mechanical Properties on Wear of Fluoropolymer Composites

Mark Sidebottom, Sifat Ullah, Miami University, Oxford, OH, Nathan Heckman, Brad Boyce, Sandia National Laboratory, Albuquerque, NM, Tomas Babuska, Brandon Krick, Lehigh University, Bethlehem, PA

9:30 – 10 am

3324515 * Fluoropolymer Composites: Effect of Counterface and Filler Material Properties on Wear Performance

Sifat Ullah, Mark Sidebottom, Alex Rhodes, Jan Gabski, Miami University, Oxford, OH

10 – 10:30 am – Break

10:30 – 11 am

3323565 * Hysteretic Lubrication of Polyacrylamide Hydrogels Caused by Transient Water Film Formation

Jiho Kim, Alison Dunn, University of Illinois at Urbana-Champaign, Urbana, IL

11 – 11:30 am

3322046 * Compositional Dependence of Hydrogel Wear Mechanisms Under Mild Abrasion

Shabnam Bonyadi, Alison Dunn, University of Illinois at Urbana-Champaign, Urbana, IL

11:30 am – Noon

3285834 * Linking Energy Loss in Soft Adhesion to Surface Roughness

Tevis Jacobs, Abhijeet Gujrati, Subarna Khanal, University of Pittsburgh, Pittsburgh, PA, Siddhesh Dalvi, Ali Dhinojwala, University of Akron, Akron, OH, Lars Pastewka, University of Freiburg, Freiburg, Germany

*** Session 5H**

2D MATERIALS

Materials Tribology and Nanotribology Joint Session II

Session Chair: Philip Egberts, University of Calgary, Calgary, Alberta, Canada

Session Vice Chair: Arnab Bhattacharjee, University of Delaware, Newark, DE

8 – 8:30 am

3286667 * Hydrodynamic Slip and Frictional Characteristics of the

Graphene-Liquid Interface

Rosa Espinosa-Marzal, Gus Greenwood, Jin Myung Kim, SungWoo Nam, University of Illinois at Urbana-Champaign, Urbana, IL

8:30 – 9 am

3320097 * Novel Solid Lubricants for Use in Multifarious Environments at High Load and Sliding Speeds

Aditya Ayyagari, Kalyan Mutyala, Anirudha Sumant, Argonne National Laboratory, Lemont, IL

9 – 9:30 am

3272845 * Liquid Superlubricity Enabled with Two-Dimensional Nano-Additives

Hongdong Wang, Yuhong Liu, Tsinghua University, Beijing, China, Ali Erdemir, Argonne National Laboratory, Argonne, IL, Jianbin Luo, Tsinghua University, Beijing, China

9:30 – 10 am

3285813 * Shear Response of Graphene in N-Hexadecane

Behnoosh Sattari Baboukani, Prathima Nalam, University at Buffalo, Buffalo, NY, Zhijiang Ye, Miami University, Oxford, OH

10 – 10:30 am – Break

10:30 – 11:30 am

Invited Talk

Jonathan Felts, Texas A&M University

11:30 am – Noon

3282823 * Direct Visualization of Exciton Transport in Defective Few-Layer WS₂ by Ultrafast Microscopy

Huan Liu, Dameng Liu, Jianbin Luo, State Key Laboratory of Tribology, Tsinghua University, Beijing, China

*** Session 5I**

SURFACE ENGINEERING II

Surface Texture

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3281368 * Tribology and Biomimetic Surface Application in Oil and Gas Field

Yanbao Guo, Zheng Zhang, Xuanli Zhou, Deguo Wang, China University of Petroleum, Beijing, China

8:30 – 9 am

3287110 * The Effect of the Surface Texturing Fabrication Technique on the Coefficient of Friction Under Dry Sliding Contact Condition

Ola Rashwan, Pennsylvania State University – Harrisburg, Middletown, PA, Vesselin Stoilov, University of Windsor, Windsor, Ontario, Canada

9 – 9:30 am

3323364 * Friction Characteristics of Arbitrary Biosurfaces

Shelby Maddox, Mahyar Afshar Mohajer, Min Zou, University of Arkansas, Fayetteville, AR

9:30 – 10 am

3323495 * Design Guide of Laser Surface Texturing for Reduction of Wear and Coefficient of Friction by Using Different Geometries on Tools for Manufacturing Applications

Demófilo Maldonado, Laura Pena-Paras, Natalia Rodriguez, Marcelo Posada, Universidad de Monterrey, San Pedro, Mexico

10 – 10:30 am – Break

10:30 – 11 am

3323715 * Tribological Effects of Triangle-Shaped Surface Textures under Unidirectional Lubricated Sliding

Pawel Pawlus, Slawomir Wos, Waldemar Koszela, Andrzej Dzierwa, Rzeszow University of Technology, Rzeszow, Poland

11 – 11:30 am

3324246 * Surface Texture Design Guideline and Testing

Stephen Hsu, Govindaiah Patakamuri, George Washington University, Washington, DC, Tim Cushing, GMC, Detroit, MI

11:30 am – Noon

3284264 * Effect of Film-Temperature Boundary Conditions on the Lubrication Performance of Micro-Dimpled Parallel Thrust Bearing

Tae-Jo Park, Gyeongsang National University, Jinju, Republic of Korea

★ Session 5J

CONDITION MONITORING III

Session Chair: Kemberlee Snelling, Trico Corp., Davison, MI

Session Vice Chair: Daniel Walsh, Spectro Scientific, Chelmsford, MA

8:30 – 9 am

3284243 ★ **Monitoring of Transmissions With Oil Immersed Discs in Heavy Duty Equipment: Ineffectiveness of Standard Oil Analysis and the Need for Specific Testing**

Joseph Fotue, TOTAL Cameroon, Douala, Cameroon

9 – 9:30 am

3287103 ★ **Product Quality Maintenance & Reliability in the Lubricant Supply Chain**

Michael Roe, MJR Lubricant Distribution Consulting & Auditing, Cypress, TX

9:30 – 10 am

3323493 ★ **Bearing Condition Monitoring with High-Frequency Impedance Analysis**

Georg Martin, TU Darmstadt, Darmstadt, Germany

10 – 10:30 am – Break

10:30 – 11 am

3324910 ★ **Diagnosing the Root Cause of an Overheated Gearbox**

Evan Zabawski, TestOil, Calgary, Alberta, Canada

11 – 11:30 am

3324972 ★ **Diagnosing Improper Bearing Lubrication Using Oil Analysis**

Evan Zabawski, TestOil, Calgary, Alberta, Canada

★ Session 5K

ENGINE AND DRIVETRAIN III

Session Chair: Raj Chandramohanam, BorgWarner Inc., Arden, NC

Session Vice Chair: Behzad Mahmoudi, Chevron Oronite LLC, Richmond, CA

8 – 8:30 am

3322996 ★ **Tribofilm Chemistry for Engine Oils Formulated with Organic Polymeric Friction Modifiers**

John Eastwood, Croda, Goole, East Yorkshire, United Kingdom

8:30 – 9 am

3324584 ★ **Organic Polymeric Friction Modifiers Effects on Tribofilm Formation and Properties in HDDEO Formulations**

Alexei Kurchan, Croda, New Castle, DE

9 – 9:30 am

3286465 ★ **Lubrication Property Analysis of Piston Ring in Low Speed Marine Considering Oil Supply**

Xuan Ma, Tongyang Li, Bowen Jiao, Xiquan Lu, Harbin Engineering University, Harbin, Heilongjiang, China

9:30 – 10 am

3279177 ★ **Road to Ultra-Low Viscosity 0W Oils: Quantifying Frictional Benefits on the Journal Bearing Machine and Start/Stop Durability via Sapphire Rig Tests**

Priyanka Desai, Shell Global Solutions (US) Inc., Houston, TX, Konstantinos Kalogiannis, Omar Mian, MAHLE Engine Systems (UK) Ltd., Rugby, United Kingdom, Francesco Manieri, Tom Reddyhoff, Imperial College London, London, United Kingdom, Robert Mainwaring, Shell Global Solutions (UK) Inc., London, United Kingdom

10 – 10:30 am – Break

10:30 – 11 am

3310366 ★ **Lubricating Behavior at a Fluid-Solid Interface**

Yan Chen, Hong Liang, Texas A&M University, College Station, TX, Johnny Yue, Lawrence Berkeley National Laboratory, Berkeley, CA, Mojdeh Rasoulzadeh, The University of Alabama, Tuscaloosa, AL

11 – 11:30 am

3320910 ★ **Optimizing Lubricant Formulation with Group II Base Oils for Automotive Applications**

Yue-Rong Li, Chevron, Richmond, CA

11:30 am – Noon

3305842 ★ **Low Viscosity Engine Oils, a Comparative Evaluation of Advanced Base Stock Technology**

Paula Vettel, Steve Haffner, David Matucha, Novvi LLC, Emeryville, CA

★ Session 5L

TRIBOTESTING I

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3277865 ★ **On Measuring the Friction Component of Oils**

Kenneth Budinski, Bud Labs, Rochester, NY

8:30 – 9 am

3285253 ★ **Impact-Slide Wear Testing for Evaluation of Hard Coatings for Tooling Applications**

Suvrat Bhargava, Ranjan Deshmukh, Rodney Martens, Bradley Schultz, TE Connectivity, Middletown, PA

9 – 9:30 am

3287117 ★ **Development of a Novel Test Method for Friction Assessments of Shock Absorber Fluids**

Jason Papacek, Calumet Specialty Products Partners, Indianapolis, IN

9:30 – 10 am

3289046 ★ **Statistical Considerations in Wear Scar Measurement in Antifriction Coatings**

Melissa Mushrush, DuPont de Nemours, Inc., Midland, MI, Kevin Wier, The Dow Chemical Co., Midland, MI

10 – 10:30 am – Break

10:30 – 11 am

3296301 ★ **Investigation of the Sensitivity of the Wire-On-Capstan**

Peter Lee, Southwest Research Institute, San Antonio, TX

11 – 11:30 am

3321771 ★ **Investigation of Lubrication Regime Transitions for High-Speed Reciprocating Applications**

Oluwaseyi Ogunsola, Shell Global Solutions, Houston, TX

11:30 am – Noon

3294506 ★ **Depletion of MoDTC and Synergism with OFM in Boundary Lubricated Tribological Contacts**

Simon Barnes, Shahriar Kosarieh, Ardian Morina, Anne Neville, University of Leeds, Witney, Oxon, United Kingdom, David Gillespie, Gareth Moody, Croda, Goole, United Kingdom



★ Session 5M

**LUBRICATION
FUNDAMENTALS
SPECIAL SESSION**

Four Decades of Patri-Cheng Average Flow Model and Future Challenges in Tribology (Invited Talks Only)

Session Chair: TBD

Session Vice Chair: TBD

As the lubrication science deepens in understanding and widens in its application to novel fields, time has come to review progress made in the past 40 years and discuss current challenges and future needs. This symposium brings together researchers in the field of lubrication to share their accomplishments in research and present their visions for future research and development.

★ Session 6A

**COMMERCIAL MARKETING
FORUM VI**

1:30 – 2 pm | Open Slot

2 – 2:30 pm | Open Slot

2:30 – 3 pm | Open Slot

3 – 3:30 pm – Break

3:30 – 4 pm | Open Slot

4 – 4:30 pm | Open Slot

4:30 – 5 pm | Open Slot

★ Session 6B

NONFERROUS METALS I

Biobased and Synthetic Lubricants

Session Chair: Girma Biresaw, BOR, USDA-ARS-NCAUR-BOR, Peoria, IL

Session Vice Chair: Rick Pruhs, Quaker Houghton, Waverly, IA

1:30 – 2 pm

3286625 ★ **Cold, Clean and Green: Biomimetic Industrial Lubricants to Support the Cold Chain**

Iestyn Stead, David Eckold, Karl Dearn, University of Birmingham, Birmingham, United Kingdom

2 – 2:30 pm

3305233 ★ **A Non-Ferrous Study Investigating the Lubricity and Film Thickness Behavior of Rolling Oils Containing Mixed Ester Packages on Varying Grades of Aluminium**

Emma Pates, Stephen Chestnutt, Total UK, London, United Kingdom, Annie King, Total Specialties USA, Inc., Linden, NJ

2:30 – 3 pm

3308433 ★ **Non-Edible Vegetable Oils: Options and Choices for Meeting Different Types Lubricant Requirements**

Joseph Pattathilchira Varghese, (formerly with Indian Oil R&D Center), Faridabad, Haryana, India

3 – 3:30 pm – Break

3:30 – 4 pm

3319543 ★ **Vaporization and Flow Properties of Biobased Oils**

Tom Karis, TEK Data Systems, Aromas, CA, Girma Biresaw, USDA-ARS-NCAUR-BOR, Peoria, IL, P. Iaccarino, Raj Shah, Koehler Instruments Co., Inc., Holtsville, NY

4 – 4:30 pm

3320243 ★ **Biobased Disulfide Additive Based on Soybean Oil**

Girma Biresaw, Grigor Bantchev, James Lansing, Rogers Harry-O'Kuru, USDA-ARS-NCAUR-BOR, Peoria, IL, Yunzhi Chen, South China University of Technology, Guangzhou, Guangzhou, China

4:30 – 5 pm

3327894 ★ **Gas-to-Liquids (GTL) Technology Advances in Metalworking and Aluminum Rolling Fluids Are Enhancing Safety, Operations and Performance**

Gregory Wehr, ChemGroup, Inc., Louisville, LA

5 – 5:30 pm

3303091 ★ **Synthesis, Characterization and Physical Properties of Dimer Acid 2-Ethylhexyl Ester (DA2EH)**

Shehu Isah, Delaware State University, Norristown, PA, Victor Wyatt, Helen Ngo, Jianwei Zhang, USDA-ARS, Wyndmoore, PA

5:30 – 6 pm – **Nonferrous Business Meeting**

★ Session 6C

**SYNTHETIC LUBRICANTS
AND HYDRAULICS I**

Session Chair: Lauren Huffman, Dow Chemical Co., Midland, MI

Session Vice Chair: Robert Davidson, Afton Chemical Corp., Richmond, VA

1:30 – 2 pm

3301723 ★ **Novel Base Oil Technologies for Industrial Gear Oils**

Justin Langston, Gabriela Fedor, Thomas Schimmel, Evonik Oil Additives, Horsham, PA

2 – 2:30 pm

3281345 ★ **Oil Miscible Polyalkylene Glycol (OMP) – An Excellent Novel Base Fluid for High Performance Lubricant Formulations**

Govind Khemchandani, Sasol, Westlake, LA

2:30 – 3 pm

3285879 ★ **New Hydrolytic Stability Testing on Biobased Lubricants and Base Fluids**

Marlon Lutz, Biosynthetic Technologies, Indianapolis, IN

3 – 3:30 pm – Break

3:30 – 4 pm

3295567 ★ **Fluid Effects on Mechanical Efficiency of Hydraulic Pumps**

Pawan Panwar, Ashlie Martini, University of California, Merced, Merced, CA, Paul Michael, Milwaukee School of Engineering, Milwaukee, WI

4 – 4:30 pm

3296238 ★ **Fluid Effects on Stick-Slip Friction in Hydraulic Cylinder Rod Seals**

Paul Michael, Muhammad Khan, Milwaukee School of Engineering, Milwaukee, WI, Fred Ondarza, Shell Global Solutions, Houston, TX

4:30 – 5 pm

3325464 ★ **Could the Latest Oil Technology Give You Cleaner, Longer-Lasting and More Productive Hydraulic Systems?**

Sravani Gullapalli, Sameer Sathaye, Shell Global Solutions US Inc., Houston, TX

5 – 5:30 pm

3321722 * Tribological Performance of Used and Artificially Altered Hydraulic Oils

Nicole Doerr, Serhiy Budnyk, AC2T Research GmbH, Wiener Neustadt, Austria, Daria Kolbas, Gubkin Russian State University of Oil and Gas, Moscow, Russian Federation, Ameneh Schneider, Optimol Instruments Prueftechnik GmbH, Munich, Germany, Franz Novotny-Farkas, Engineer Consultant, Schwechat, Austria

5:30 – 6 pm – Synthetic Lubricants & Hydraulics Business Meeting

*** Session 6D**

FLUID FILM BEARINGS II

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3281808 * A New Fully Coupled Aeroelastic Model for Air Foil Journal Bearings

Yang Hu, Yonggang Meng, Tsinghua University, Beijing, China

2 – 2:30 pm

3323393 * Numerical & Experimental Investigation of Aerostatic Bearing with Applications to High-Frequency Rotation (More Than 100 kHz)

Rajdeep Deb, Beat Meier, Solid State Nuclear Magnetic Resonance, ETH Zurich, Zurich, Switzerland, Patrick Jenny, Institute of Fluid Dynamics, Zurich, Switzerland, Dirk Wilhelm, ZHAW School of Engineering, Winterthur, Switzerland

2:30 – 3 pm

3325188 * Externally Pressurized Porous Gas Bearings: Measurements of Static Load Characteristics and Rotordynamic Performance

Keun Ryu, Hanyang University, Ansan, Gyeonggi-do, Republic of Korea

3 – 3:30 pm – Break

3:30 – 4 pm

3283576 * Measuring Oil Films in Dynamically Loaded Journal Bearings

Scott Beamish, Rob Dwyer-Joyce, University of Sheffield, Sheffield, United Kingdom, Henry Dodson, Ricardo, Leamington Spa, United Kingdom

4 – 4:30 pm

3290036 * Non-Newtonian Couple-Stress Squeeze Film Behavior between Oscillating Anisotropic Porous Circular Discs with Sealed Boundary

Benyebka Bou-Saïd, INSA Lyon, Villeurbanne, France, Mustapha Lahmar, Guelma University, Guelma, Algeria

4:30 – 5 pm

3308592 * Rotating Gear Supported by a Plain Journal Bearing: A Numerical Analysis of the Dynamic Characteristics

Balint Pap, Florent Lejeune, Ludwig Biadalla, Safran Transmission Systems, Colombes, France

5 – 5:30 pm

3323571 * Rotating Gear Supported by a Plain Journal Bearing: An Experimental Case Study

Balint Pap, Antoine Pennacino, Safran Transmission Systems, Colombes, France

5:30 – 6 pm – Fluid Film Bearings Business Meeting

*** Session 6E**

WEAR I

Session Chair: Mathieu Renouf, CNRS University of Montpellier, Montpellier, France

Session Vice Chair: John Bomidi, Baker Hughes, The Woodlands, TX

1:30 – 2 pm

3281805 * Suppressed Triboluminescence Attributed to Electron Structure Changes in the Doped Surface

Changhui Song, Liran Ma, Jianbin Luo, State Key Laboratory of Tribology, Beijing, China

2 – 2:30 pm

3300187 * An Analytical Model of Erosive Wear of BioMass Comminution Components

George Fenske, Oyelayo Ajayi, Argonne National Laboratory, Argonne, IL, Jun Qu, Kyungjun Lee, Oak Ridge National Laboratory, Oak Ridge, TN, Jeffrey Lacey, Idaho National Laboratory, Idaho Falls, ID

2:30 – 3 pm

3279796 * Tribo-Corrosion Behavior of AISI 4715 Pipeline Steel Used in Hydraulic Fracturing

Jitendra Panda, Brandon Wong, Philip Egberts, University of Calgary, Calgary, Alberta, Canada, Tom McLoughlin, Keri Yule, Calfrac Well Services Ltd., Calgary, Alberta, Canada

3 – 3:30 pm – Break

3:30 – 4 pm

3301686 * Adhesive Wear of the Workpiece Material to Abrasive Grits during the Grinding Process

Matthew Marshall, University of Leeds, Leeds, West Yorkshire, United Kingdom

4 – 4:30 pm

3323520 * In Situ Observation of Friction and Wear Characteristics of Aluminum Alloys

Kazuyuki Yagi, Yuya Abe, Joichi Sugimura, Kyuhu University, Fukuoka, Japan

4:30 – 5 pm

3319067 * Anti-Wear and Anti-Corrosion of Polymer-Alloy Composites

Peter Renner, M. Ozaydin, Hong Liang, Texas A&M University, College Station, TX

5 – 5:30 pm

3285167 * Analysis on Surface Damage of M50 Steel at High-Speed Impact-Sliding Contacts

Che Wang, Harbin Institute of Technology, Harbin, Heilongjiang, China

5:30 – 6 pm

3304314 * Investigating & Mitigating Wear of Hammer Mill for Size Reduction of Biomass Feedstock

Kyungjun Lee, James Keiser, Jun Qu, Oak Ridge National Laboratory, Oak Ridge, TN, Jeffrey Lacey, Vicki S. Thompson, Idaho National Laboratory, Idaho Falls, ID, Oyelayo Ajayi, George R. Fenske, Argonne National Laboratory, Argonne, IL

6 – 6:30 pm – Wear Business Meeting



★ Session 6F

**LUBRICATION
FUNDAMENTALS VI**

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3285726 ★ **Selecting Suppliers for Your Lubricant Additives and Base Oils**

Michael D. Holloway, 5th Order Industry, Highland Village, TX

2 – 2:30 pm

3276873 ★ **Analytical Approaches to Chemical Structure and Physical Property Measurements of Lubricant Oils**

Eleanor Riches, Caitlyn Da Costa, Jeff Goshawk, Gordon Jones, Michael Jones, Waters Corp., Wilmslow, United Kingdom, James Browne, TA Instruments – Waters Corp., New Castle, DE

2:30 – 3 pm

3285561 ★ **Influence of Base Oils on Heat Transfer Characteristics of Lubricants for E-Motors in HEVs and EVs**

Masato Yokomizo, Narita Keiichi, Idemitsu Kosan Co., Ltd., Ichihara-shi, Chiba, Japan

3 – 3:30 pm – Break

3:30 – 4 pm

3286550 ★ **Base Oil, Ionic Liquid, Anti-Wear Additive, and Friction Modifier – Which One is at the Solid/Lubricant Interface?**

Seong Kim, Dien Ngo, Pennsylvania State University, State College, PA, Jun Qu, Xin He, Huimin Luo, Oak Ridge National Laboratory, Oak Ridge, TN

4 – 4:30 pm

3277617 ★ **Research on Durable Organic Friction Modifiers for PCMO and HDDEO Applications**

Brian Casey, Vincent Gatto, Vanderbilt Chemicals, LLC, Norwalk, CT

4:30 – 5 pm

3285405 ★ **In Situ Studies on the Adsorption of Lubricant Additives**

Alex Mannion, BASF Corp., Florham Park, NJ, Jennifer Honselmann, Fraunhofer IWM, Karlsruhe, Germany, Martin Dienwiebel, Karlsruhe Institute for Technology KIT, Karlsruhe, Germany, Thomas Ruehle, Patrick Wilke, BASF SE, Ludwigshafen, Germany

5 – 5:30 pm

3288324 ★ **Fuel Economy Motor Oils: Formulation, Testing and Approval Challenges**

Boris Zhmud, BIZOL Germany GmbH, Berlin, Germany

5:30 – 6 pm – Lubrication Fundamentals Business Meeting

★ Session 6G

MATERIALS TRIBOLOGY IV

Advanced Engineering Polymers

Session Chair: Mark Sidebottom, Miami University, Oxford, OH

Session Vice Chair: Sifat Ullah, Miami University, Oxford, OH

1:30 – 2 pm

3281574 ★ **Effect of Temperature and Filler on the Tribological Responses of Sintered Polyimides**

Kian Kun Yap, Marc Masen, Imperial College London, South Kensington, London, United Kingdom

2 – 2:30 pm

3305030 ★ **Understanding Friction and Wear Performance of High-Temperature Thermoplastics Across Different Lubrication Regimes**

Isaac Ballinas, Allegheny Performance Plastics, Leetsdale, PA

2:30 – 3 pm

3285141 ★ **Effect of Thermal Aging Treatment on Blend Phase Morphology and Tribological Performance of PI/UHMWPE Blend Composites**

Bingxue Cheng, Hongfei Shang, Tianmin Shao, State Key Laboratory of Tribology, Tsinghua University, Beijing, China, Haitao Duan, Jian Li, Wuhan Research Institute of Materials Protection, Wuhan, Hubei, China, Song Chen, Hunan Institute of Science and Technology, Yuyang, Hunan, China

3 – 3:30 pm – Break

3:30 – 4 pm

3277831 ★ **Tribological Performance of Polyimides and Other Engineering Polymers Against Various Metallic Surfaces**

Jennifer Vail, DuPont, Wilmington, DE

4 – 4:30 pm

3286058 ★ **Tribological Behavior of Textured Polymer Surfaces**

Mohammad Hossain, Emeka Chukwuonu, Bhavinkumar Patel, Texas A&M University-Kingsville, Kingsville, TX, Hung-Jue Sue, Texas A&M University, College Station, TX

4:30 – 5 pm

3323158 ★ **Lubrication-Induced Softening of Polymeric Materials in Tribological Contacts**

Go Tatsumi, Monica Ratoi, Brian Mellor, University of Southampton, Southampton, United Kingdom, Yuji Shitara, Shinji Hasegawa, Kiyomi Sakamoto, JXTG Nippon Oil & Energy Corp., Yokohama, Japan

5 – 5:30 pm

3309851 ★ **Nanoscale Structures Determined Tribological Behaviors of Styrene-Ethylene-Butylene-Styrene Block Copolymer**

Qinghua Fang, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun, Jilin, China

★ Session 6H

2D MATERIALS

Materials Tribology and Nanotribology Joint Session III

Session Chair: Shilpa Beesabathuni, Quaker Houghton, Eagleville, PA

Session Vice Chair: Mengwei Han, University of Illinois at Urbana-Champaign, Urbana, IL

1:30 – 2 pm

3325478 ★ **Probing the Influence of Water and Oxygen on the Friction and Wear of MoS₂ Using In Situ LEIS**

Tomas Babuska, Brandon Krick, Lehigh University, Bethlehem, PA, John Curry, Sandia National Laboratory, Albuquerque, NM

2 – 2:30 pm

3285663 ★ **Nanomechanical Properties of Ti₃C₂ and Nb₂C MXene**

Xuanli Zhou, Yanbao Guo, Quan Xu, Deguo Wang, China University of Petroleum, Beijing, China

2:30 – 3 pm

3282352 * Understanding Interlayer Contact Conductance in Twisted Bilayer Graphene

Zhiwei Yu, Tianbao Ma, Jianbin Luo, State Key Laboratory of Tribology, Tsinghua University, Beijing, China

3 – 3:30 pm – Break

3:30 – 4 pm

3286917 * Friction and Mechanical Stiffness Measurements on Graphene-covered Substrates: The Influence of Water Intercalation

Philip Egberts, Zahra Aboolizadeh, Peng Gong, Leszek Sudak, University of Calgary, Calgary, Alberta, Canada

4 – 4:30 pm

3297772 * Nanotribology of 2D Transition Metal Dichalcogenides: Friction Contrast between MoS₂, MoSe₂, and MoTe₂

Mohammad R. Vazirisereshk, Ashlie Martini, University of California, Merced, Merced, CA, Kathryn Hasz, Meng-Qiang Zhao, A.T. Charlie Johnson, Robert Carpick, University of Pennsylvania, Philadelphia, PA

4:30 – 5 pm

3285069 * Environmental Effects on Friction of Graphene Step Edges

Zhe Chen, Seong Kim, Pennsylvania State University, University Park, PA

5 – 5:30 pm

3283657 * The Evolution Mechanism of Ultra-Low Friction Interface Based on Onion-Like Carbon Structure

Jianxun Xu, Tsinghua University, Beijing, China

5:30 – 6 pm

3276812 * Interfacial Nanostructured Tribofilm of Long-Durability and Ultralow-Wear 2D-Materials/QDs Coating

Xuan Yin, State Key Laboratory of Tribology, Tsinghua University, Beijing, China

6 – 6:30 pm

3278877 * Nanoscale Tribological Behavior of Few Layer Graphene with Considering Material Microstructure and Potential

Shengguang Zhu, Guangdong Xinhui CIMC Special Transportation Equipment Co., Ltd., Jiangmen, Guangdong, China

* Session 6I

SURFACE ENGINEERING III

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3317907 * Research on the Frictional Performance of Laser Textured and Rough Surface Based on Pin-On-Disk Test

Bo Xu, Bifeng Yin, Xuan Xie, Zhiling Chen, Xuefeng Wang, Jiangsu University, Zhen Jiang, China

2 – 2:30 pm

3281789 * Mechanochemical Surface Finishing: The Rebinder Effect in Action

Boris Zhmud, Applied Nano Surfaces Sweden AB, Uppsala, Sweden

2:30 – 3 pm

3288844 * Surface Functionality Prediction via Curvature Analysis

Mark Malburg, Digital Metrology Solutions, Columbus, IN

3 – 3:30 pm – Break

3:30 – 4 pm

3320195 * The Influence of Disc Surface Texture on Tribological Performance of Disc-Ball Sliding Pair under Dry Sliding Conditions

Andrzej Dzierwa, Pawel Pawlus, Rzeszow University of Technology, Rzeszow, Poland, Rafal Reizer, University of Rzeszow, College of Natural Sciences, Rzeszow, Poland

4 – 4:30 pm

3325618 * Morphology Image-Based Surface Classification by Using Convolutional Neural Network (CNN)

Huan Zhang, Daniel Mosher, United Technologies Research Center, East Hartford, CT

4:30 – 5 pm

3291319 * Capillary Force Lithography and Nanodrawing Techniques for Engineering Nanoscale Polymer Patterns for Tribological Applications

Eui-Sung Yoon, Hong Nam Kim, Korea Institute of Science and Technology, Seoul, Seongbuk-gu, Republic of Korea, Prashant Pendyala, Hanyang University, Seoul, Republic of Korea

5 – 5:30 pm

3325943 * Investigation of the Evolution of Pores During Scuffing Resistance Tests Performed on Sintered Steel Vacuum Impregnated with Graphite

Nicolas Araya, Aloisio Klein, Cristiano Binder, Guilherme Neves, Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil, Jose Biasoli de Mello, Universidade Federal de Uberlandia, Uberlandia, Minas Gerais, Brazil

5:30 – 6 pm – Surface Engineering Business Meeting

* Session 6K

ENGINE AND DRIVETRAIN IV

Session Chair: Raj Chandramohanam, BorgWarner Inc., Arden, NC

Session Vice Chair: Piotr Grzyska, Afton Chemical Corp., Richmond, VA

1:30 – 2 pm

3314847 * A Ceramic Nano-Composite Coating for Potential Engine Applications

Swarn Jha, Yan Chen, Hong Liang, Texas A&M University, College Station, TX

2 – 2:30 pm

3287678 * Formulation Approaches to Meet the Latest SAE J306 Standard for Automotive Gear Oils

Justin Mills, Evonik Oil Additives, Horsham, PA

2:30 – 3 pm

3305554 * Correlating Viscosity to Fuel Efficiency in the Heavy-Duty Diesel Engine Fuel Efficiency Tests and the Influence of Viscosity Index Improvers

Lucas Camposo, Phil Hutchinson, Julien Couet, Boris Eisenberg, Evonik Oil Additives, Horsham, PA

3 – 3:30 pm – Break



Technical Sessions

3:30 – 4 pm

3307947 * **Effect of Friction Modifier and Extreme Pressure Agent on NVH of Chain CVTF**

Toshiaki Iwai, Idemitsu Kosan, Ichihara, Chiba, Japan

4 – 4:30 pm

3318911 * **Three-Dimensional Multiphase Physics-Based Model to Study Engine Cylinder-Kit Assembly Tribology**

Sadiyah Sabah Chowdhury, Harold Schock, Michigan State University, East Lansing, MI

4:30 – 5 pm

3284934 * **Finite Element Analysis of Cylinder Liner Thermal Deformation Based on Fluid-Solid Coupling**

Bowen Jiao, Xuan Ma, Tongyang Li, Xiqun Lu, Zhigang Liu, Harbin Engineering University, Harbin, Heilongjiang, China

5 – 5:30 pm

3294961 * **Wear and Friction Simulations for the Main Journal Bearings under Start-Stop and Transient-Loading Conditions**

Zhiqiang Liu, Arup Gangopadhyay, Ford Motor Co., Dearborn, MI

5:30 – 6 pm – **Engine & Drivetrain Business Meeting**

* Session 6L

TRIBOTESTING II

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3305068 * **Understanding Friction and Wear Performance of High Temperature Thermoplastics Across Different Lubrication Regimes**

Isaac Ballinas, Allegheny Performance Plastics, Leetsdale, PA

2 – 2:30 pm

3309375 * **Localized Scuffing of a Flake Graphite Cast Iron Cylinder Liner by Geometric Contact Pressure Variation**

John Walker, Zach Barnes, Peng Jiang, Timothy Kamps, University of Southampton, Southampton, Hampshire, United Kingdom

2:30 – 3 pm

3310894 * **Shoe Tread Can Reduce Slip Risk on Surface Contaminated with Slurry Contaminants**

Mahiyar Nasarwanji, Kurt Beschoner, University of Pittsburgh, Pittsburgh, PA, Jonisha Pollard, National Institute for Occupational Safety and Health, Pittsburgh, PA

3 – 3:30 pm – **Break**

3:30 – 4 pm

3314683 * **An Updated Method for Fuel Lubricity: Line-On-Cylinder Lubricity Evaluator (LOCLE)**

Greg Hansen, Peter Lee, Southwest Research Institute, San Antonio, TX

4 – 4:30 pm

3316313 * **Improving Repeatability of Friction and Wear Testing Results on the SRV Test Rig**

Howard Benade, University of Pretoria, Pinetown, KwaZulu Natal, South Africa

4:30 – 5 pm

3280430 * **Nano Diamond as Potential Candidate for Sliding Wear Applications Under Lubricated Conditions**

Ankush Raina, Shri Mata Vaishno Devi University, Katra, Jammu and Kashmir, India

* Session 6M

NANOTRIBOLOGY III

Session Chair: Tevis Jacobs, University of Pittsburgh, Pittsburgh, PA

Session Vice Chair: Prathima Nalam, University at Buffalo, Buffalo, NY

1:30 – 2:30 pm

3318323 * **Invited Talk: Mechanical Dissipation of Energy: From Breaking of Bonds to the Release of Adhesive Contacts**

Lars Pastewka, Richard Jana, Antoine Sanner, University of Freiburg, Freiburg, Germany

2:30 – 3 pm

3303722 * **Stress-Dependent Adhesion in Nanoscale Contacts**

Sai Bharadwaj Vishnubhotla, Andrew Baker, Tevis Jacobs, University of Pittsburgh, Pittsburgh, PA, Rimei Chen, Ashlie Martini, University of California, Merced, Merced, CA

3 – 3:30 pm – **Break**

3:30 – 4 pm

3282831 * **Study of Deformation Behaviors of Nanoscale Textured Surfaces in the Contact Using Molecular Dynamics**

Pengzhe Zhu, Beijing Institute of Technology, Beijing, China, Baozhen Li, Beijing Jiaotong University, Beijing, China

4 – 4:30 pm

3284114 * **Influence of Crystal Anisotropy on Deformation Behaviors in Nanoscratching of AlN**

Baozhen Li, Beijing Jiaotong University, Beijing, China, Pengzhe Zhu, Beijing Institute of Technology, Beijing, China

4:30 – 5 pm

3317629 * **Super Lubricity of Solids from Quantum Mechanics**

Bo Zhang, Saga University, Saga-shi, Saga, Japan

5 – 5:30 pm

3294663 * **Resolution of Stability Issues in Fluid Systems Containing Nanostructured Particles**

Stephan Wieber, Michael Hagemann, Roland Wilkens, Aidan Rose, Evonik Resource Efficiency GmbH, Darmstadt, Germany

5:30 – 6 pm

3323530 * **Nanomechanical and Tribological Properties of Hardened 60NiTi**

Charles Miller, Min Zou, University of Arkansas, Fayetteville, AR

6 – 6:30 pm – **Nanotribology Business Meeting**

* Session 6N

ROUNDTABLE DISCUSSION SESSION

A scientific brainstorming and networking event is organized on the basis of discussion roundtables (DRTs) by the STLE Rolling Element Bearing Technical Committee, together with other technical committees. This event aims to encourage open discussions between experts of different disciplines on various topics of interest. The format of the DRTs is very fruitful to facilitate a creative atmosphere on complex topics character and to find technical impulses by brainstorming.

The topics are proposed by the table hosts themselves and are based on current interests. A typical property of DRTs is the writable table cloth to inspire the discussion, as well keep notes for subsequent discussions.

The benefit of DRTs goes beyond the technical impulses. During the DRTs, the hosts will guide the discussion only and not give a lecture. Active participation, including experience sharing of each participant, is one of the main features of this event, providing an unique opportunity to connect and learn.

Thursday, May 7, 2020

★ Session 7B

NONFERROUS METALS II

Lubricant Analysis and Filtration

Session Chair: TBD

Session Vice Chair: Andrea Knopp, Constellium, Ravenswood, WV

8:30 – 9 am

3279624 ★ Analysis of Nonferrous Rolling Emulsions Using Laser Diffraction and Multiple Light Scattering

Tom Oleksiak, Lucinda Knelsen, Novelis, Inc., Kennesaw, GA

9 – 9:30 am

3284266 ★ Improving and Expanding the Applicability of an Existing Pin & Vee Standardized Test Method for Cutting Fluid Evaluation

Emmanuel Georgiou, Dirk Drees, Falex Tribology NV, Rotselaar, Belgium

9:30 – 10 am

3285657 ★ Chemistry Behind Settling Metal Fines in Aqueous Metalworking Fluids

Stefanie Velez, James Sullivan, Münzing, Bloomfield, NJ

10 – 10:30 am – Break

10:30 – 11 am

3286026 ★ Filtration of Rolling Oil Fluids

Craig Thomas, JR Schneider Co., Inc., Benicia, CA

1 – 11:30 am

3286714 ★ Nuclear Magnetic Resonance as a Useful Tool for Routine Analysis of Emulsions

Josef Leimhofer, AMAG Rolling GmbH, Ranshofen, Austria

11:30 am – Noon

3322954 ★ Tramp Oils – What Are They and How Do You Deal with Them?

Andrea Knopp, Constellium, Ravenswood, WV

★ Session 7C

ENVIRONMENTALLY FRIENDLY FLUIDS II

Session Chair: Selim Erhan, Archer Daniels Midland, Decatur, IL

Session Vice Chair: Brajendra K. Sharma, University of Illinois Urbana-Champaign, Champaign, IL

8:30 – 9 am

3288275 ★ A New Generation of Bio-Based Extreme Pressure Additives

Lotje Smolders, Oleon, Oelegem, Belgium

9 – 9:30 am

3281884 ★ Biobased Bright Stock Replacement: Property-Blending Relationships and Formulation Challenges

Boris Zhmud, Applied Nano Surfaces Sweden AB, Uppsala, Sweden, Ian Bancroft, Natalia Slawniak, University of York, York, United Kingdom

9:30 – 10 am

3285681 ★ New Hydrolytic Stability Testing on Biobased Lubricants and Base Fluids

Mark Miller, Alex Kitchel, Biosynthetic Technologies, Indianapolis, IN

10 – 10:30 am – Break

10:30 – 11 am

3316323 ★ Biomimetic Tribology: Exploiting Synovial Fluid Lubrication Mechanisms for Mechanical Devices

Manoj Murali, Marc Masen, Philippa Cann, Imperial College London, London, United Kingdom

11 – 11:30 am

3314861 ★ Nature-Guided Design of Biolubricants Based on the Unique Fatty Acid Structure of Chinese Violet Seed Oil

Diana Berman, Asghar Shirani, Trevor Romsdahl, Kent Chapman, University of North Texas, Denton, TX, Edgar Cahoon, University of Nebraska-Lincoln, Lincoln, NE, Robert Minto, Indiana University-Purdue University, Indianapolis, IN

11:30 am – Noon

3283219 ★ Latest in Biosynthetic Base Oils – Evaluating Estolide Performance Characteristics in Expanding Viscosity Ranges

Jake Bredsguard, Biosynthetic Technologies, Indianapolis, IN

★ Session 7D

FLUID FILM BEARINGS III

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3279210 ★ Effect of Partial Coatings on the TEHD Behavior of Plain Journal Bearings with Considering Wall Slip

Shuhui Cui, Michel Fillon, Institut Pprime, Poitiers, France, Le Gu, Harbin Institute of Technology, Harbin, China

8:30 – 9 am

3280451 ★ Synthesis of the Experimental Analyses of Thermal Unbalance Effects Induced by Cylindrical and Tilting Pad Journal Bearings

Thibaud Plantegenet, Mihai Arghir, Pascal Jolly, Institut Pprime – Université de Poitiers, Poitiers, France, Mohamed-Amine Hassini, EDF Lab Paris Saclay, Palaiseau, France



Technical Sessions

9 – 9:30 am

3284942 * **Effects of Film Temperature Boundary Conditions on the Thermal Wedge Lubrication in Parallel Thrust Bearings**

Tae-Jo Park, Gyeongsang National University, Jinju, Republic of Korea

9:30 – 10 am

3316740 * **Experimental-Theoretical Correlation Study of the Morton Effect**

Alan Palazzolo, Dongil Shin, Jongin Yang, Xiaomeng Tong, Erwin Thomas, Texas A&M University, College Station, TX

10 – 10:30 am – Break

10:30 – 11 am

3284955 * **Lubrication Characteristics Analysis of Slipper-Swash Plate Interface in Swash Plate Type Axial Piston Pump**

Xiangxu Meng, Xuan Ma, Xiqun Lu, Tongyang Li, Bowen Jiao, Wen Sun, Yongqiang Wang, Harbin Engineering University, Harbin, China

11 – 11:30 am

3285598 * **Effect of Groove Textures on the Dynamic Characteristics of a Water-Lubricated Hydrodynamic Bearing**

Huihui Feng, Xiulin Ji, Hohai University, Changzhou, Jiangsu, China

11:30 am – Noon

3284425 * **On Development of 7KW Oil-Free Compressor Driven by 120000 r/min Permanent Magnet Motor with Gas Foil Bearings**

Guanghui Zhang, Zhansheng Liu, Harbin Institute of Technology, Harbin, Heilongjiang Province, China, Xiaowei Wang, Nanjing University of Aeronautics and Astronautics, Nanjing, China, Shiwei Ji, Nanjing Shenwei Huizhogn Me Company, Nanjing, China

* Session 7E

WEAR II

Session Chair: Yan Zhou, Houghton International, Oak Ridge, TN

Session Vice Chair: Chin-Pei, Cummins, Inc., Columbus, IN

8 – 8:30 am

3324718 * **Helium Tribology of Ni-Based Alloys at High Temperature Up to 950°C**

Md Saifur Rahman, Andreas Polycarpou, Texas A&M University, College Station, TX, Ali Beheshti, George Mason University, Fairfax, VA

8:30 – 9 am

3284276 * **Enhancing Wear Resistance of Selective Laser Melted (SLM) Parts**

Yang Yang, Yi Zhu, Zhejiang University, Hangzhou, China

9 – 9:30 am

3300118 * **A Review of Tribological and Surface Behavior of MAX Phase-Based Composites**

Surojit Gupta, Maharshi Dey, Sabah Javaid, Caleb Matzke, Quan Tran, University of North Dakota, Grand Forks, ND, Nikhil Murthy, Stephen Berkebile, Army Research Laboratory, Aberdeen Proving Ground, MD

9:30 – 10 am

3284171 * **Wear Mechanisms of DLC: A Reactive Molecular Dynamics Study**

Yang Wang, Tohoku University, Sendai, Japan

10 – 10:30 am – Break

10:30 – 11 am

3313790 * **Load-Carrying Capacity of Aircraft Turbine Engine Lubricants Using the FZG-Ryder Gear Test Rig**

Alexander Fletcher, Patrick Hellman, Air Force Research Laboratory, Wright-Patterson Air Force Base, OH, Peter John, University of Dayton Research Institute, Dayton, OH

11 – 11:30 am

3293669 * **Introducing a Next Generation of Anti-Wear Technology for Lubricants**

Christelle Chretien, Solvay, Bristol, PA

11:30 am – Noon

3281367 * **Fretting Friction and Wear of Flange Gasket**

Zheng Zhang, China University of Petroleum, Beijing, China, Deguo Wang, Yanbao Guo, China University of Petroleum, Beijing, China

* Session 7F

LUBRICATION FUNDAMENTALS VII

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3288865 * **Mechanochemistry in High Pressure EHD Contacts**

Hugh Spikes, Jie Zhang, Janet Wong, Daniele Dini, Imperial College London, London, United Kingdom

8:30 – 9 am

3293309 * **Adsorption Behaviors of Organic Friction Modifiers on Iron Oxide Surfaces: A Nonequilibrium Molecular Dynamics**

Junqin Shi, Haifeng Wang, Northwestern Polytechnical University, Xi'an, Shaanxi, China, Jie Lu, Qian (Jane) Wang, Jannat Ahmed, Northwestern University, Evanston, IL, Ning Ren, Valvoline Inc., Lexington, KY

9 – 9:30 am

3301806 * **Tuned Polar Methacrylate Viscosity Index Improvers for Enhanced Shear Stability and Wear Prevention**

Lelia Cosimbescu, Kristen Campbell, Marie Swita, Pacific Northwest National Laboratory, Richland, WA, Robert Erck, Argonne National Laboratory, Argonne, IL

9:30 – 10 am

3293985 * **Mechanochemical Reactions between Di-Tert-Butyl Disulfide and Ferrous Surfaces**

Karen Mohammadtabar, Ashlie Martini, University of California, Merced, Merced, CA, Stefan Eder, Nicole Doerr, AC2T Research GmbH, Wiener Neustadt, Austria

10 – 10:30 am – Break

10:30 – 11 am

3310741 * **An Investigation of Anti-Oxidant Expression in Naphthenic Base Oils**

Thomas Norrby, Jinxia Li, Nynas AB, Nynashamn, Sweden

11 – 11:30 am

3308132 * Tribological Properties of Sulfur- and Phosphorus-Free Organic Molybdenum Compounds as Additives in Oil

Wenjun Huai, Zhang Chenhui, Tsinghua University, Beijing, China

11:30 am – Noon

3316347 * Influence of Rubbing Material on ZDDP Tribofilm Formation

Mao Ueda, Amir Kadiric, Hugh Spikes, Imperial College London, London, United Kingdom

* Session 7G

MATERIALS TRIBOLOGY V

Metallic Materials Fundamentals & Extreme Applications

Session Chair: Nicolas Argibay, Sandia National Laboratories, Albuquerque, NM

Session Vice Chair: TBD

8 – 8:30 am

3279771 * Tribological and Mechanical Properties of High Entropy Alloys

Morgan Jones, Brendan Nation, Ping Lu, Andrew Kustas, Nicolas Argibay, Sandia National Laboratory, Albuquerque, NM

8:30 – 9 am

3276302 * Tribological Behavior of Light Weight Al Matrix Composites Reinforced with Silicon Carbide and Tungsten Disulfide

Juanjuan Zhu, Rob Dwyer-Joyce, The University of Sheffield, Sheffield, United Kingdom

9 – 9:30 am

3284265 * Establishing a Methodology for Studying the Tribological Properties of Cold Sprayed Nanostructured Coatings

Emmanuel Georgiou, Dirk Drees, Falex Tribology NV, Rotselaar, Belgium

9:30 – 10 am

3337937 * Large-Scale Molecular Dynamics Simulations Studies of Microstructural Evolution in Sliding Cu-Ni Surfaces

Daniele Dini, Imperial College London, United Kingdom, Stefan Eder, Carsten Gachot, TU Wien, Vienna, Austria, Manel Rodriguez Ripoll, Ulrike Cihak-Bayr, AC2T Research GmbH, Vienna, Austria

10 – 10:30 am – Break

10:30 – 11 am

3293730 * Reduced Cost NiTi-Alloy Bearings Made via Near Net Shape Powder Metallurgy Processes

Christopher DellaCorte, NASA, Cleveland, OH

11 – 11:30 am

3320997 * Development of Self-Adaptive Lubricating Silver Aluminum Borate Composite for Wide Temperature Range

Ashish Kasar, Pradeep Menezes, University of Nevada-Reno, Reno, NV

11:30 am – Noon

3321728 * Influences of ZrO₂ Crystal Structure on the Tribological Properties of Copper Metal Matrix Composites

Haibin Zhou, Pingping Yao, Central South University, Changsha, Hunan, China

* Session 7H

GEARS I

Session Chair: Jeff Ewin, NAVAIR, Patuxent River, MD

Session Vice Chair: Hyung Yoon, Caterpillar, Peoria, IL

8 – 8:30 am

3285653 * Experimental Study on Lubricants and Methods to Enhance the Survivability of Rotorcraft Gearbox Under Loss of Lubrication Condition

Azhaarudeen Anifa Mohamed Faruck, Carsten Gachot, Michael Weigand, Vienna University of Technology, Vienna, Austria

8:30 – 9 am

3285724 * Approach for the Development of an Alternative Classification Method for Gear Oils for High-Loaded Hypoid Gears According to API GL-5

Alexander Drechsel, Josef Pellkofer, Michael Hein, Karsten Stahl, Technical University of Munich, Garching bei München, Germany

9 – 9:30 am

3305164 * Starvation Tests on FZG Test-Rig: Experimental Method and Thermal Modelisation

Pierre Navet, Fabrice Ville, LaMCoS – INSA Lyon,

Villeurbanne, France, Christophe Changenet, ECAM Lyon, Lyon, France, Dhafer Ghribi, Safran Transmission Systems, Colombes, France

9:30 – 10 am

3313567 * Analysis Method of Pressure Field and Temperature Field Distribution of the Gearbox

Jialiang Yu, Karl Dearn, University of Birmingham, Birmingham, United Kingdom

10 – 10:30 am – Break

10:30 – 11 am

3323607 * The Effect of Contact Conditions on the Initiation and Progression of Micropitting Damage

Benjamin Wainwright, Amir Kadiric, Imperial College London, London, United Kingdom

11 – 11:30 am

3330016 * Influence of Grease Composition on the Service Life of Heavily Loaded Spiral Bevel Gears

Sergei Glavatskih, KTH Royal Institute of Technology, Stockholm, Sweden, Joel Olsson, Per Forsberg, Atlas Copco Industrial Technique AB, Nacka, Sweden, Johan Leckner, Rene Westbroek, Axel Christiernsson International AB, Nol, Sweden

* Session 7J

POWER GENERATION I

Session Chair: Salvatore Rea, Lanxess Corp., Perkasie, PA

Session Vice Chairs: Matthew Hobbs, EPT, Calgary, Alberta, Canada, Jatin Mehta, Fluitec International, Bayonne, NJ

8 – 8:30 am

3332465 * Power Generation Tribological Success Stories

Ken Brown, Eco Fluid Center Ltd., Toronto, Ontario, Canada

8:30 – 9 am

3332098 * Understanding Deposit-Derived Bearing Temperature Excursions

Jatin Mehta, Fluitec International, Bayonne, NJ

9 – 9:30 am

3320199 * Ksp and Thermodynamic Considerations Relevant to Effective Varnish-Removal

Matthew Hobbs, Peter Dufresne, EPT, Calgary, Alberta, Canada



Technical Sessions

9:30 – 10 am

3301562 * **Determination of Relative Concentrations of Phosphate Ester Isomers in Turbine Control Systems by Matrix Assisted Laser Desorption Ionization – High Resolution Mass Spectrometry (MALDI-HRMS)**

John Duchowski, Johannes Staudt, HYDAC FluidCareCenter®, Sulzbach, Saar, Germany, Gerard Palmer, HYDAC Technology Ltd., Witney, Oxfordshire, United Kingdom

10 – 10:30 am – Break

10:30 – 11 am

3272921 * **Salvaging Poorly Stored Turbine Oil**

Nnamdi Achebe, Petrosave Integrated Services Ltd., Amuwo-Odofin, Nigeria

11 – 11:30 am

3332142 * **Using Solvency Enhancing Technology as an Alternative to Traditional Flushing**

Jatin Mehta, Fluitec International, Bayonne, NJ

11:30 am – Noon – Power Generation Business Meeting

* Session 7K

ENGINE AND DRIVETRAIN V

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3286639 * **Developing a Framework to Address LSPI through a Better Understanding of Lubricant and Fuel Effects**

Abhishek Kar, Allen Aradi, Sarah Remmert, Shell Global Solutions US Inc., Houston, TX, Jennifer Kensler, Shell International Exploration and Production, Houston, TX, Karin Haumann, Shell Lubricants, Houston, TX, Robert Mainwaring, Shell Global Solutions (UK), London, United Kingdom

8:30 – 9 am

3325364 * **Friction at Ring-Liner Interface with Systematic Surface Characterization**

Arman Mohammad Khan, Qian (Jane) Wang, Northwestern University, Evanston, IL, Zhe Li, Yuchuan Liu, General Motors Corp., Detroit, MI

* Session 7L

TRIBOTESTING III

Session Chair: TBD

Session Vice Chair: TBD

8 – 8:30 am

3323446 * **Online Surface Topography Evolution of a Unidirectional Dry Sliding Contact Using a Chromatic Confocal 3D Line Sensor**

Timothy Kamps, Mark Gee, John Nunn, Christopher Jones, National Physical Laboratory, Teddington, United Kingdom

8:30 – 9 am

3325120 * **Development of a Friction and Wear Screener for Main Bearings**

Carlos Sanchez, Peter Lee, Southwest Research Institute, San Antonio, TX

9 – 9:30 am

3325243 * **A Glimpse into Smart Tribology Lab**

Deepak Halenahally Veeragowda, Ducom Instruments Europe B.V., Groningen, Netherlands

9:30 – 10 am

3323481 * **Tribology TRL Methodology for Drive System Technologies**

Lavern Wedeven, William Black, Graham Wedeven, Robert Homan, Nelson Forster, Wedeven Associates, Inc., Edgmont, PA

10 – 10:30 am – Break

10:30 – 11 am

3340476 * **A New Test Method for Direct Measurement of Friction in Biomass Material**

M. Cinta Lorenzo Martin, Oyelayo Ajayi, George R. Fenske, Argonne National Laboratory, Lemont, IL, Jordan Klinger, Yidong Xia, Idaho National Laboratory, Idaho, ID, Troy Semelsberger, Los Alamos National Laboratory, Los Alamos, NM

11 – 11:30 am

3325291 * **Effect of Important Surface Texture Parameters on the Initiation of Scuffing Failure Under High Frequency Reciprocating Motion**

Ali Kolivand, Zahed Huq, Emerson, Sidney, OH

11:30 am – Noon

3326341 * **Inorganic Fullerene-Like Nano Tungsten Disulfide (WS₂) as Grease Additives: A Study of Concentration Effects on the Tribo-protective Mechanism**

Manish Patel, NanoTech Industrial Solutions, Lake Charles, LA, Sedhuraman Mathiravedu, Pranesh Aswath, University of Texas at Arlington, Arlington, TX

* Session 7M

NANOTRIBOLOGY IV

Session Chair: Zhijiang Ye, Miami University, Oxford, OH

Session Vice Chair: Sai Bharadwaj Vishnubhotla, University of Pittsburgh, Pittsburgh, PA

8 – 9 am

3286429 * **Invited Talk: The Fascinating Frictional Properties of Layered Materials – Insights from Atomistic Modeling**
Michael Urbakh, Tel Aviv University, Tel Aviv, Israel

9 – 9:30 am

3286643 * **Understanding the Impact of the Structural Ordering of Organic Molecules at 2D Confined Spaces on Nanotribological Properties**

Prathima Nalam, Behnoosh Sattari Baboukani, University at Buffalo, Buffalo, NY, Zhijiang Ye, Miami University, Oxford, OH

9:30 – 10 am

3328462 * **Friction Characteristics of HOPG and 2D Transition Metal Di-Chalcogenides Under Cryogenic Conditions- Role of Interfaces**

Praveena Manimunda, Syed Asif, Douglas Stauffer, Bruker Nano Surfaces, Edina, MN

10 – 10:30 am – Break

10:30 – 11 am

3285286 * **The General Reference Lever: A Simple, Reliable and Traceable Calibration Method for Arbitrary Normal & Friction Forces**

Arnab Bhattacharjee, Nikolay Garabedian, David Burris, University of Delaware, Newark, DE

11 – 11:30 am

3282964 * **Experimental Determination of Pair Potential Parameters Using Frequency**

**Modulation Atomic Force
Microscopy**

Nicholas Chan, Carrie Lin, Philip Egberts, University of Calgary, Calgary, New Brunswick, Canada, Tevis Jacobs, University of Pittsburgh, Pittsburgh, PA, Robert Carpick, University of Pennsylvania, Philadelphia, PA

11:30 am – Noon

3286113 * Inorganic Fullerene-like Tungsten Disulfide (IF-WS₂) Nanoparticles as Performance Additive in an Industrial Lubricant: Field Trial Results, Constraints and Opportunities

Benoit Thiebaut, Frédéric Michel, Stéphane Gavand, TOTAL MS, Solaize, France

*** Session 7N**

ENGINE AND DRIVETRAIN AND LUBRICATION FUNDAMENTALS JOINT SESSION

Lab to Field – Bridging the Gap Between Bench and Engine I

Session Chair: Brendan Miller, Chevron Oronite LLC, Richmond, CA

This session includes papers that cover the transition from lab scale bench tests to full implementation in actual application.

9 – 9:30 am

3285424 * The Tribological Performances of MoDTC with Highly Branched Alkyl Groups and Highly Sulfurized Core in a Fully Formulated Engine Oil

Hui Xiang, Changqi Liu, Guangzhou Jetsun Lubrication Technology Co., Ltd., Guangzhou, Guangdong, China

9:30 – 10 am

3308455 * Interactions Between Nanoparticles and Extreme Pressure Additives: Toward High Performance Low Viscosity Lubricants

Robert Carpick, Meagan Elinski, Parker LaMascus, Andrew Jackson, University of Pennsylvania, Philadelphia, PA, Lei Zheng, Robert Wiacek, Pixelligent LLC, Baltimore, MD

10 – 10:30 am – Break

10:30 – 11 am

3321894 * Correlation of Engine Oil Degradation in Large Scale Alteration Device and Engine Test Rig

Nicole Doerr, Adam Agocs, Serhiy Budnyk, Andjelka Ristic, Marcella Frauscher, AC2T Research GmbH, Wiener Neustadt, Austria

11 – 11:30 am

3324592 * The Use of Microcapsulated Friction Modifier Additives for Fuel Economy Enhancement

Stephen Hsu, Govindaiah Patakamuri, George Washington University, Washington, DC, Tim Cushing, GM, Detroit, MI

11:30 am – Noon

3287491 * Piston Deposit Control: A Fundamental Mechanistic Study

Anil Agiral, Anthony Gilbert, Christopher Kabb, Nico Proust, Binbin Guo, The Lubrizol Corp., Wickliffe, OH

*** Session 8B**

NONFERROUS METALS III

Lubricant Additives and Tribology

Session Chair: Annie King, Total Specialty Lubricants, Linden, NJ

Session Vice Chair: Tom Oleksiak, Novelis, Inc., Kennesaw, GA

1:30 – 2 pm

3298424 * Insights into the Formation of Protective Tribo-Layer on Ti6Al4V in the Simulated Body Fluid Environment

Jiahui Qi, University of Sheffield, Sheffield, United Kingdom

2 – 2:30 pm

3285603 * Structure-Performance Evaluation of Synthetic Metal-working Fluid Additives

Tiffany Meyers, Clariant, Mount Holly, NC

2:30 – 3 pm

3285880 * Lubricant Additive Response Comparisons, in a Commercial Post Lubricant, on 3104 Aluminum D&I Can Stock, Using Twist Compression Tests (TCT)

Ted McClure, Sea-Land Chemical Co., Westlake, OH

3 – 3:30 pm – Break

3:30 – 4 pm

3321043 * Wear-Corrosion Synergism Behavior of Additive Manufactured Ti-6Al-4V Alloy

Pradeep Menezes, Ashish Kasar, Arpith Siddaiah, Pankaj Kumar, Manoranjan Misra, University of Nevada-Reno, Reno, NV



Share your STLE 2020 Annual Meeting Presentation with Submission of an Extended Abstract

In an effort to provide attendees with the opportunity of not missing a presentation, STLE encourages speakers to submit an optional 2-3 page extended abstract or provide digital copies of their presentation slides. We recommend speakers submit materials before **April 3, 2020**, to ensure presentations are available to attendees before the meeting.

Submissions must be in PDF format and can be emailed to Karl Phipps at presentations@stle.org.

For more information about requirements, please visit www.stle.org/annualmeeting.



Technical Sessions

4 – 4:30 pm

3324656 * **Correlation between Microscopic Surface Damage and Frictional Behavior of Lubricants for Stamping Automotive Aluminum Sheet Products**

Mehdi Shafiei, Shania Polson, Novelis, Novi, MI

4:30 – 5 pm

3324704 * **Metal Corrosion: Looking Farther Than the Eye Can See**

Clayton Cooper, Nicole Clarkson, Soraya Kraszczyk, ANGUS Chemical Co., Buffalo Grove, IL

5 – 5:30 pm

3332316 * **Hot Rolling Emulsions and the Importance of Antioxidant Additives**

Bill Pynor, Kaiser Aluminum, Spokane, WA, Annie King, Wayne Jenkins, Total Specialty Lubricants, Linden, NJ

* Session 8C

ENVIRONMENTALLY FRIENDLY FLUIDS III

Session Chair: Daniel Garbark, Battelle Memorial Institute, Columbus, OH

Session Vice Chair: Ashok Cholli, Polnox Corp., Lowell, MA

1:30 – 2 pm

3323643 * **Addressing the Thermo-Oxidative Stability and Other Issues Facing the Biolubricant Formulation**

Ashok Cholli, Polnox Corp., Lowell, MA

2 – 2:30 pm

3290027 * **Lubricity Improvement of the Ultra-Low Sulphur Diesel Fuel with Vegetable Oils**

Andrew Sakyi, University of Pretoria, Pretoria, Gauteng, South Africa

2:30 – 3 pm

3270649 * **Evaluation of Chaulmugra Oil (*Hydnocarpus wightiana*) as a Potential Environment-Friendly Lubricant Base Stock**

Jayadas Haridas, Cochin University of Science and Technology, Ernakulam, Kerala, India

3 – 3:30 pm – Break

3:30 – 4 pm

3279513 * **Bacterial Toxicity and Biodegradability of Ionic Liquids Studied for Using in Lubrication**

David Blanco, Paula Oulego, Javier Faes, Rubén González, Jose Luis Viesca, Antolin Hernández Battez, University of Oviedo, Gijón, Asturias, Spain

* Session 8D

FLUID FILM BEARINGS IV

Session Chair: Aurelian Fatu, Institut Pprime, Angouleme, France

Session Vice Chair: TBD

1:30 – 2 pm

3322976 * **Loading Performance of Metal Rubber-Bump Foil Gas Bearings**

Chuanbing Zhang, Hongrui Ao, Hongyuan Jiang, Harbin Institute of Technology, Harbin, China

2 – 2:30 pm

3323240 * **Coupling Transient Mixed Lubrication and Wear for Journal Bearing Modeling**

Guo Xiang, State Key Laboratory of Mechanical Transmission, Chongqing, China, Yanfeng Han, Chongqing University, Chongqing, China

2:30 – 3 pm

3322243 * **An Optimization Research of Journal Bearing under Steady Operations Using Taguchi and Grey Relational Analysis Methods**

Chongpei Liu, Bin Zhao, Xiquan Lu, Wanyou Li, Harbin Engineering University, Harbin, China

3 – 3:30 pm – Break

3:30 – 4 pm

3322422 * **Optimization of Oil Supply to a Starved Slider Bearing Based on Wettability Gradient**

P.L. Wong, C.L. Liu, City University of Hong Kong, Kowloon, Hong Kong, F. Guo, Qingdao University of Technology, Qingdao, China

4 – 4:30 pm

3338294 * **Simulating the Effect of Micro-Textures for Friction Reductions in Conformal Bearing Systems**

Francisco Profito, University of São Paulo, Sao Paulo, Brazil, Sorin-Cristian Vladescu, Tom Reddyhoff, Daniele Dini, Imperial College London, London, United Kingdom

* Session 8E

WEAR III

Session Chair: Ali Beheshti, George Mason University, Fairfax, VA

Session Vice Chair: Arnab Ghosh, EtaGen, Inc., Menlo Park, CA

1:30 – 2 pm

3322854 * **Insights Learned from Fretting Fatigue FEA Simulations and Surface Characterization of Metal Substrates**

Iyabo Lawal, Matthew Brake, Rice University, Houston, TX

2 – 2:30 pm

3314627 * **Principal Tensile Stress Predicts Locations of Shoe Wear Consistent with Natural Wear Patterns**

Kurt Beschorner, Sarah Hemler, University of Pittsburgh, Pittsburgh, PA, Takeshi Yamaguchi, Tohoku University, Sendai, Miyagi, Japan

2:30 – 3 pm

3318528 * **Elevated Temperature Fretting Wear Analysis of Additively Manufactured Inconel 625 with Surface Strength Improvements**

Manisha Tripathy, Ali Beheshti, George Mason University, Fairfax, VA, Lloyd Hackel, Curtiss-Wright Surface Technology, Livermore, CA, Keivan Davami, The University of Alabama, Tuscaloosa, AL

3 – 3:30 pm – Break

3:30 – 4 pm

3319943 * **Elevated Temperature Fretting Wear Study of Additively Manufactured 17-4 PH Stainless Steel**

Manisha Tripathy, Ali Beheshti, George Mason University, Fairfax, VA, Pooriya Nezhadfar, Nima Shamsaei, Auburn University, Auburn, AL, Keivan Davami, The University of Alabama, Tuscaloosa, AL

4 – 4:30 pm

3340519 * **Effects of Wear on Dynamics Characteristics of Mechanisms with Multi-Clearance Joints**

Zhengfeng Bai, Jijun Zhao, Junsheng Zhou, Harbin Institute of Technology, Weihai, Shandong, China

4:30 – 5 pm

3281561 * Microstructure Based Material Model to Predict Wear Rate and Wear Depth During Manufacturing

Burak Bal, Abdullah Gul University, Kayseri, Turkey

5 – 5:30 pm

3284846 * Adhesive and Abrasive Gear Wear Prediction Models: Utilization of Statistical Analysis

Surapol Raadnuai, KMUTNB, Bangkok, Bang-Sue, Thailand

* Session 8F

LUBRICATION FUNDAMENTALS VIII

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3318381 * Evaluation of Interactions Between Molybdenum-Based Friction Modifiers and Other Additives in Lubricants

Yu Min Kiw, Philippe Schaeffer, Pierre Adam, University of Strasbourg, Strasbourg, France, Benoit Thiebaut, Chantal Boyer, Géraldine Papin, TOTAL MS, Solaize, France

2 – 2:30 pm

3323327 * High-Throughput Design of Organic Friction Reducers in Engine Oils

Jing Yang, Jon Paul Janet, Fang Liu, Heather J. Kulik, Massachusetts Institute of Technology, Cambridge, MA

2:30 – 3 pm

3324150 * Oxidative Stability of Estolides

Travis Thompson, Biosynthetic Technologies, Indianapolis, IN

3 – 3:30 pm – Break

3:30 – 4 pm

3324202 * Practical Considerations for the Development of Amine and Phenol Synergies

Jun Dong, Songwon Industrial Group, Glen Allen, VA

4 – 4:30 pm

3286456 * An Optimization Routine to Obtain Lubricant Parameters from EHD Friction Measurements

Marcus Björling, Andreas Almqvist, Luleå University of Technology, Luleå, Sweden

4:30 – 5 pm

3283796 * A Molecular Dynamics Approach to Predict Pour Points of Fluids

Jannat Ahmed, Jie Lu, Qian (Jane) Wang, Northwestern University, Evanston, IL, Junqin Shi, Northwestern Polytechnical University, Xi'an, China, Ning Ren, Fran Lockwood, Valvoline Inc., Lexington, KY

* Session 8G

MATERIALS TRIBOLOGY VI

Additives & Fluid Lubricated Contacts

Session Chair: Tomas Babuska, Lehigh University, Bethlehem, PA

Session Vice Chair: Tomas Grejtak, Lehigh University, Bethlehem, PA

1:30 – 2 pm

3286543 * Tribological Performance of Hard Coatings in Low Viscosity Fuels

Tyler Torgerson, Asghar Shirani, Thomas Scharf, Diana Berman, University of North Texas, Denton, TX, Satish Dixit, Plasma Technology Inc., Torrance, CA, Stephen Berkebile, Army Research Laboratory, Aberdeen Proving Ground, MD

2 – 2:30 pm

3323741 * Tribological Study of PDA+PTFE Coating in Oil-Lubricated Condition

Sujan Ghosh, Min Zou, University of Arkansas, Fayetteville, AR

2:30 – 3 pm

3320789 * PDA/PTFE + Graphite Particles Coating on 60NiTi: Effect of Coating Thickness and Substrate Roughness

Dipankar Choudhury, Charles Miller, Min Zou, University of Arkansas, Fayetteville, AR

3 – 3:30 pm – Break

3:30 – 4 pm

3303737 * Compatibility of Polar Oils and Anti-Wear Additives with Steel-Coating Contacts

Xin He, Huimin Luo, Jun Qu, Oak Ridge National Laboratory, Oak Ridge, TN

4 – 4:30 pm

3301476 * Slipp Film and Bearing

Hong Liu, Lanzhou Jiaotong University, Lanzhou, China

4:30 – 5 pm

3282835 * Reversible Light Controlled Friction Achieved by Diarylethene Molecules

Shuangxi Tang, Liran Ma, Tsinghua University, Beijing, China

* Session 8H

GEARS II

Session Chair: Michael Blumenfeld, ExxonMobil Research & Engineering, Annandale, NJ

Session Vice Chair: Weixue Tian, ExxonMobil Research & Engineering, Annandale, NJ

1:30 – 2 pm

3285540 * Permissible Water Content of Gear Lubricants Regarding the Pitting Performance of Case-Carburized Gears

Nadine Sagraloff, Thomas Tobie, Karsten Stahl, Technical University of Munich, Munich, Germany, Christian Engelhardt, Patentanwälte von Bezold, Munich, Germany

2 – 2:30 pm

3286616 * Pitch Line Fracture: A Frictional Problem in Polymer Gears?

Sutartip Wittayapiyanon, Karl Dearn, University of Birmingham, Birmingham, United Kingdom

2:30 – 3 pm

3288465 * Sodium Presence in Gearboxes, What are the Inconveniences for Lubrication?

Jorge Alarcon, Bureau Veritas, Stafford, TX

3 – 3:30 pm – Break

3:30 – 4 pm

3298112 * The Appropriateness of Laser Sintered PEEK for Gear Applications

Zainab Shukur, Karl Dearn, University of Birmingham, Birmingham, United Kingdom

* Session 8J

WIND TURBINE TRIBOLOGY I

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3281806 * Detection of White Etching Cracks (WECs) Using Electrostatic



Technical Sessions

Sensing Techniques

Kamran Esmaeili, Ling Wang, Terry Harvey, Neil White, University of Southampton, Southampton, United Kingdom, Walter Holweger, Schaeffler Technologies GmbH & Co. KG, Herzogenaurach, Germany

2 – 2:30 pm

3319018 * Efficiency and Lifetime Improvement for Wind Turbines by Using Silicon-Based Additive Technology

Stefan Bill, REWITEC GmbH, Lahnu, Hesse, Germany

2:30 – 3 pm

3285610 * Early Stage Processes in White Etching Crack Formation

Tarek Lutz, NMI, Reutlingen, Germany

3 – 3:30 pm – Break

3:30 – 4 pm

3337339 * Validation of Combined Analytical Methods to Predict Slip in Cylindrical Roller Bearings

Yi Guo, Jon Keller, National Renewable Energy Laboratory, Golden, CO

4 – 4:30 pm

3318691 * Credibility Analysis of Thermal Coupling Finite Element Model of Friction Pair of Wind Power Spindle Brake Based on Response Surface Method

Ying Liu, Nanchang University, Nanchang, Jiangxi, China

4:30 pm – 5 pm

3365799 * Understanding Main Bearing Failure Modes & Developing Applicable Benchtop Grease Tests

Benjamin Gould, Nick Demas, Robert Erck, Aaron Greco, Argonne National Laboratory

5 – 5:30 pm – Wind Turbine Tribology Business Meeting

* Session 8K

ENGINE AND DRIVETRAIN AND LUBRICATION FUNDAMENTALS JOINT SESSION

Lab to Field – Bridging the Gap Between Bench and Engine II

Session Chair: Piotr Grzyska, Afton Chemical Corp., Richmond, VA

Session Vice Chair: TBD

This session includes papers that cover the transition from lab scale bench tests to full implementation in actual application.

1:30 – 2 pm

3285016 * Optimizing the Piston-Bore Tribology through Honing and Tribofinishing

Boris Zhmud, Applied Nano Surfaces Sweden AB, Uppsala, Sweden, Konstantin Risse, Florian Welzel, Otto-von-Guericke-University of Magdeburg, Magdeburg, Germany

2 – 2:30 pm

3296303 * Piston Ring Coating Development – From Bench to Vehicle

Peter Lee, Southwest Research Institute, San Antonio, TX

2:30 – 3 pm

3286302 * Determination of Scuffing and Wear for Materials in Low-Viscosity Fuels

Stephen Berkebile, Nikhil Murthy, Army Research Laboratory, Aberdeen Proving Ground, MD, Kelly Jacques, Diana Berman, University of North Texas, Denton, TX, Caleb Matzke, Maharshi Dey, Surojit Gupta, University of North Dakota, Grand Forks, ND

3 – 3:30 pm – Break

3:30 – 4 pm

3285127 * Research on Mechanism of Cylinder Score of Diesel Engine Based on Starved Lubrication of Piston Ring Pack

Yongqiang Wang, Xuan Ma, Xiqun Lu, Wanyou Li, Tongyang Li, Harbin Engineering University, Harbin, China

4 – 4:30 pm

3318418 * An Efficient Approach to Estimate the Groove Pressure at the Piston-Ring and Cylinder-Liner Contact

Lyu Xiuyi, Xuan Ma, Harbin Engineering University, Harbin, China, Abdullah Azam, Anne Neville, University of Leeds, Leeds, United Kingdom

4:30 – 5 pm

3302226 * Ionic Liquid-Enhanced Low-Viscosity Engine and Rear Axle Oils in Dynamometer and Vehicle Testing

Jun Qu, Sougata Roy, Chanaka Kumara, Huimin Luo, Oak Ridge National Laboratory, Oak Ridge, TN, Michael Viola, Khaled Zreik, General Motors, Warren, MI, Lake Speed, Driven Racing Oil, Olive Branch, MS

* Session 8L

TRIBOTESTING IV

Session Chair: TBD

Session Vice Chair: TBD

1:30 – 2 pm

3285906 * Tribological Investigation of Nano-Talc as Additive in Oil Nanolubricants

Vinay Saini, Jayashree Bijwe, Indian Institute of Technology (IIT) DELHI, Delhi, India, Sarita Seth, SSV Ramakumar, Indian Oil Corp. Ltd. R&D Centre, Faridabad, Haryana, India

2 – 2:30 pm

3325283 * Investigating Thermal Behavior of Lubricants Using Bench Top Tribometers

Deepak Halenahally Veeregowda, Fabio Alemanno, Ducom Instruments Europe B.V, Groningen, Netherlands

2:30 – 3 pm

3340369 * A Paradigm Shift in Wear Debris Analysis

Ronn Lawrence, GasTOPS Inc., Huntsville, AL

3 – 3:30 pm – Break

3:30 – 4 pm

3321588 * Extracting More Value from Tribofilm Images

Oluwaseyi Ogunsola, Shell Global Solutions (US) Inc., Houston, TX, Chaitanya Pradhan, Aarthi Thyagarajan, Vishal Ahuja, Nitish Nair, Shell India Markets Pvt. Ltd., Bangalore, India

* Session 8M

NANOTRIBOLOGY V

Session Chair: Praveena Manimunda, Bruker Nano Surfaces, Edina, MN

Session Vice Chair: Behnoosh Sattari Baboukani, University at Buffalo, Buffalo, NY

1:30 – 2 pm

3284603 * A Balancing Act: Dispersion and Lubricity Performance of Nanoparticle Additives in Metalworking Fluids

Shilpa Beesabathuni, Yan Zhou, Yixing Philip Zhao, Quaker Houghton, Conshohocken, PA

2 – 2:30 pm

3332656 * Formation and Nanomechanical Characterization of Tribofilms Enhanced by Inorganic Nanoparticles as Lubricant Additives

Kora Farokhzadeh, Praveena Manimunda, Steven Shaffer, Bruker Nano Surfaces, San Jose, CA

2:30 – 3 pm

3286629 * Synergistic Effect of MoS₂ and SiO₂ Nanoparticles in Reciprocating Steel Contacts

James Firth, Karl Dearn, University of Birmingham, Birmingham, United Kingdom

3 – 3:30 pm – Break

3:30 – 4 pm

3321340 * Synergistic Effect of Combining TiO₂ and Montmorillonite Clay Nanoparticles as Lubricant Additives for Milling Processes

Laura Pena-Paras, Demófilo Maldonado, Martha Rodríguez, Marcela Guajardo, Claudia Rico, Gerardo Elizondo, University of Monterrey, San Pedro, Nuevo Leon, Mexico

4 – 4:30 pm

3286669 * Nanoparticle Sintered Tribofilm Removal Study: An Experimental Approach

Steven Thrush, Gary Barber, Oakland University, Rochester, MI, Allen Comfort, James Dusenbury, US Army Ground Vehicle Systems Center, Warren, MI

4:30 – 5 pm

3279178 * Superlubricity of Fullerene Derivatives Induced by Host-Guest Assembly

Shanchao Tan, Yuhong Liu, Tsinghua University, Beijing, China

5 – 5:30 pm

3278471 * Analyzing Lubrication Properties of Magnetic Lubricant Synthesized in Two Lubricating Oils

Kinjal Trivedi, PD Patel Institute of Applied Sciences, Gujarat, India

EARLY CAREERIST POSTERS

3292269 * Tribological Performance of Bearing Bushes Made of Lightweight Mg Matrix Composites

Juanjuan Zhu, Rob Dwyer-Joyce, the University of Sheffield, Sheffield, United Kingdom

3285647 * Lubricants Tribology Measurements on Different Surfaces

Giulio Assanelli, Claudio Barzaghi, Marcello Notari, Paolo Cambise, Eni S.p.A, Milan, Italy

3281005 * Leaf-Surface Wax of Tall Arbor as a Potential Lubricant Additive

Yanqiu Xia, North China Electric Power University, Beijing, China

STUDENT POSTERS

3281017 * Identification and Content Prediction of Lubricating Oil Additives Based on Extreme Learning Machine

Xin Feng, North China Electric Power University, Beijing, China

3283538 * Effect of Surface Energy on Nanofriction of FCC Metal Asperities Contact

Danyang Yu, Yonggang Meng, Tsinghua University, Beijing, China

3284941 * Effect of Surface Structure of Cylinder Liner on Lubrication Performance of Piston Ring-Cylinder Liner Tribo-Pair

Bowen Jiao, Xuan Ma, Xiqun Lu, Tongyang Li, Zhigang Liu, Harbin Engineering University, Harbin, Heilongjiang, China

3285121 * The Influence of Asymmetric Piston Skirt Profile on the Secondary Motion of Piston and the Lubrication Characteristics of Piston Skirt

Yongqiang Wang, Xuan Ma, Xiqun Lu, Wanyou Li, Xiangxu Meng, Harbin Engineering University, Harbin, China

3323496 * Influence of Interfacial Chemistry and Role of Adsorbed Water on the Tribological Behavior of 2D Material – Steel Interfaces

Taib Arif, Guorui Wang, Rana Sodhi, University of Toronto, Toronto, Ontario, Canada, Guillaume Colas,

3Univ. Bourgogne Franche-Comté FEMTO-ST Institute CNRS/UFC/ENSM/UTBM, Besançon, France, Tobin Filleter, University of Toronto, Mississauga, Ontario, Canada

3325688 * An Investigation on Tribological Failure of Conventionally Oil Lubricated Journal Bearings of Sugarcane Crushing Mills

Prashant Nagare, Amrutvahini College of Engineering, Sangamner, Maharashtra, India, Hari Kudal, SND College of Engineering, Yeola, Maharashtra, India, Vishnu Wakchaure, M.A. Venkatesh, Amrutvahini College of Engineering, Sangamner, Maharashtra, India

3285176 * Grease Lubrication Behavior Analysis and Life Prediction at High Temperature Environment

Hyeonju Lee, Byeong Lyul Choi, Byoung-Ho Choi, Korea University, Seoul, Republic of Korea, Jeong Hoon Son, ILJIN Enterprize Co. Ltd., Seoul, Republic of Korea

3285593 * The Influence of Hydrothermal Aging on the Dynamic Friction Model of Cylinder Seals

Jian Wu, Hang Luo, Youshan Wang, Xuebo Yuan, Benlong Su, Zhe Li, Harbin Institute of Technology, Weihai, Weihai, Shandong, China

3285623 * Bearing Characteristics of Journal Bearing with Micro-Structure Inspired by Dragonfly

Kairi Furukawa, Masayuki Ochiai, Hiromu Hashimoto, Tokai University, Hiratsuka, Kanagawa, Japan

3318443 * NMR Investigations (1H, 13C, 31P) of Dithiophosphate/ Dithiocarbamate Ligand Exchange Reactions between Mo and Zn Derivatives

Yu Min Kiw, Philippe Schaeffer, Pierre Adam, University of Strasbourg, Strasbourg, France, Benoit Thiebaut, Chantal Boyer, Géraldine Papin, TOTAL MS, Solaize, France

3318695 * Observation of Oil Film of Floating Bush Bearing Using X-ray CT and Examination of Effect of Oil Film Area on Friction Loss

Shinpei Kotani, Masayuki Ochiai, Tokai University, Hiratsuka, Kanagawa, Japan

Education Courses

The 2020 STLE Annual Meeting & Exhibition features 11 industry-specific education courses offered on two days of the conference: Sunday, May 3, and Wednesday, May 6. The schedule is designed to give attendees more flexibility when planning their conference attendance.

All courses are full day (start at 8 am and end at 5 pm).

STLE education courses are \$400 with a full meeting registration (except for the NLG Grease course which is \$800), \$575 for STLE members without a meeting registration and \$775 for a non-member with no meeting registration. If you have questions regarding these courses, please contact Stefan Carrera, education manager at (847) 825-5536, scarrera@stle.org.

****Please note that course titles and content are subject to change. Visit www.stle.org/annualmeeting and see the Program Guide distributed onsite in Chicago for the most up-to-date information and list of course instructors.***

Sunday, May 3

Advanced Lubrication 301: Advanced Additives

Advanced Lubrication 301 covers the molecular structures and chemistries of lubricant additive types. Additives examined will include antioxidants, rust inhibitors, detergents, dispersants, antiwear additives, extreme pressure additives, friction modifiers and rheology and viscosity modifiers.

Advanced Tribology 310: Nanotribology

This course is designed to cover some fundamentals as well as industrially-relevant and popular topics with nanotribology, namely tribochemistry, nanoparticles, nanoscale solid lubricants and superlubricity, and nanoscale interactions/mechanics. Each module will cover fundamental knowledge corresponding to their respective topics and some of their implications in the industry.

Basic Lubrication 101

Basic Lubrication 101 is primarily for the person entering the lubrication field who needs a broad introduction to the field of lubrication, lubrication principles and lubricating materials. This course is also for individuals not directly involved but who need a broad overview of lubricants and basic lubricating components. This course does not require a formal scientific degree or background, although many technical terms and concepts are covered. Experienced people attend the course to be kept up to date on the latest developments, especially in those areas not directly related to their job function or area of expertise. Thus, Basic Lubrication 101 is usually attended by a broad cross section of people such as technical, technical service, sales, marketing, manufacturing, maintenance and managers who in some way are involved in the industry.

Gears 101

Gears 101 is designed to provide a general understanding of industrial gearing. This course will serve as a guide to establish not only a basic knowledge of gears and their supporting components but also their lubrication. In this course, attendees will learn about gear functions and types, basic gear terminology, the different types of industrial gear lubricants, the factors that affect gear lubrication, industrial gear lubricant requirements and their proper selection, open gear lubrication, gear wear modes and failure analysis, and condition monitoring.

NLGI – Grease 101 (Presented in cooperation with NLGI)

This course is a comprehensive overview of all aspects of lubricating grease. Grease formulation components are thoroughly covered, including base oils and the many different thickener types. Manufacturing technologies are reviewed, as well as grease testing significance and methods. Included is a good discussion detailing how to select the proper grease for different applications, and a variety of examples of both industrial and automotive applications are discussed.

Metalworking 240: Metalworking Fluid Formulation Concepts



This new course is offered in response to the many requests from attendees at STLE's other MWF courses who asked for more specifics on formulation. The course begins with some universal formulating basics, such as experimental design, order of additions for ingredients, and considerations when scaling up from beakers to large blending tanks. Also covered will be base stocks, performance additives, emulsifier selection, HLB, qualification tests, optimization for stability, both in the drum and in use, bioresistance, microbicide selection and use, and recalcitrant functional additives. Finally, instructors will discuss formulating for disposability and for global distribution. While several example formulations will be presented, this course will not be providing specific ready-to-use commercial formulations.

Synthetic Lubricants 204: Base stock Selection and Applications

This course provides an introduction to synthetic lubricant base stocks and applications. It compares the use of these synthetic lubricants to petroleum-based products and compares between types of synthetic lubricants. Synthetic Lubricants 204 is a continuation from the Synthetic Lubricants 203: Non-Petroleum Fluids and Their Uses course, however, attendance of the Synthetic Lubricants 203 course is not a prerequisite.



The largest and most useful meeting covering all aspects of tribology and lubrication engineering.”

Wednesday, May 6

Advanced Lubrication 302: Advanced Lubrication Regimes

Advanced Lubrication 302 goes more in-depth on lubrication regimes, wear and wear mechanisms, as well as lubricant failure analysis. This course includes a series of lubricant failure analysis case studies on automotive engines, gears and bearings.

Automotive Lubrication 202: Gasoline

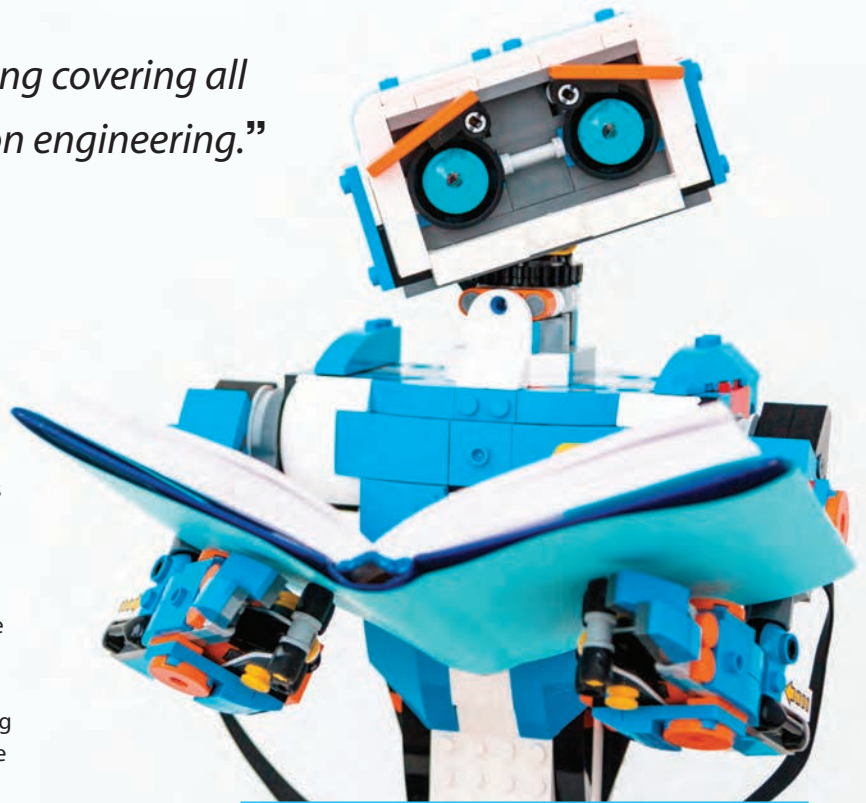
Automotive Lubrication 202 provides an overview of the engine and drivetrain systems and lubrication requirements of these systems. This course will also look at tribology testing of components within these systems, the future of tribology testing for automotive applications and the final module will look at the future of automotive tribology.

Basic Lubrication 102

Basic Lubrication 102 is an overview of equipment systems (gears, bearings, seals, compressors and engines) and their lubrication requirements, including a module on grease. Like Basic Lubrication 101, this course does not require a formal scientific degree or background, although many technical terms and concepts related to the use of lubricants in various mechanical devices are covered. This course is intended for a diverse group, including people involved in technical service, sales, marketing, manufacturing, maintenance and managers who want to know more about how lubricants work in service. This course assumes fundamental knowledge of lubricants and lubrication principles, as presented in the Basic Lubrication 101 course.

Metalworking 105: Metal Forming Fluids

Metalworking Fluids 105 is designed for those involved in developing, working with and using metal forming fluids in the manufacturing environment. This course is very useful for formulators, technical service representatives, shop floor personnel and coolant service managers who need to know more about the fundamental concepts of metal forming fluids. This course is divided into modules covering metal forming operations, metal forming fluid chemistry, metal forming fluid failure mechanisms, controlling contamination and microbial growth, waste treatment and operator acceptance. By the end of the course, participants will have gained a good understanding of metal forming operations, formulation of metal forming fluids, tools for identifying and correcting metal forming fluid failures and waste treatment of metal forming fluids.



STLE *Certification Exams*

Thursday, May 7

All four STLE technical certifications exams: Certified Lubrication Specialist™, Oil Monitoring Analyst I and II™ and Certified Metalworking Fluids Specialist™ will be conducted concurrently on Thursday, May 7, from 9 am to noon. If you are interested in taking an exam during STLE's 2020 Annual Meeting & Exhibition, please contact Gina Cairo at (847) 825-5536 or email certification@stle.org.

Exam Fees:

- **First exam: \$440 (STLE member)
\$590 (Non-member)**
- **Retake exam: \$220 (STLE member)
\$295 (Non-member)**

Networking & Special Events

Please note that all annual meeting events are at the Hyatt Regency Chicago.

Student Networking Reception

Sunday, May 3 • Ticketed Event

Students and young tribologists from around the world gather for an event defined by its networking value, camaraderie and good times. If you're from the next generation of STLE members, come join us for an evening of friendship and relationship building.

Speakers Breakfast

Sunday through Thursday, May 3-7

Lead authors and education course presenters are invited to meet with Session and Paper Solicitation Chairs for a continental breakfast at 7 am on the days of their presentations. This is a great time to review the session schedule and note any last-minute changes. Speakers should plan on attending.



Tribology STEM Camp

Monday, May 4

During STLE's 2020 Annual Meeting, the society is hosting area high school students for its Annual Tribology STEM Camp. Students will have the opportunity to see demonstrations and participate in hands-on experiments, led by STLE members, to learn about areas of research within the fields of tribology and lubrication engineering. The goal of the camp is to engage high school students interested in STEM (science, technology, engineering and mathematics) to careers in tribology and lubrication engineering. If you would like to learn more or to participate, contact Karl Phipps at (847) 825-5536, kphipps@stle.org.



Networking Reception

Monday, May 4

This is the annual meeting's central networking event and a way for you to reconnect with old friends while making new ones. Since people come to STLE's Annual Meeting & Exhibition from around the world, this truly is an international event. Relax, socialize and add to your list of professional contacts through this outstanding networking event.

Exhibitor Appreciation Hour

Back by popular demand, two hours of dedicated exhibit time will occur at this year's show:

Monday, May 4 and **Tuesday, May 5** from 3-4 pm. Refreshments will be served in the trade show. Technical sessions, education courses, Commercial Marketing Forum presentations and all other annual meeting activities will cease at this time. Come support the meeting's exhibitors—and find solutions to your most pressing technical issues.

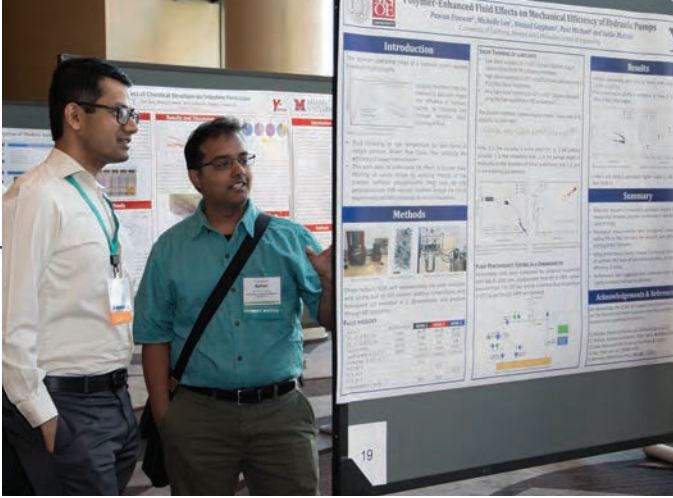
President's Luncheon

Tuesday, May 5 • Ticketed Event

The annual meeting's major business function draws virtually all attendees for a two-hour event honoring STLE's incoming and outgoing presidents, award winners and top volunteers. Come honor 2019-2020 President Mike Duncan with Daubert Chemical Co. Inc. and 2020-2021 President Paul Hetherington with Petro-Canada Lubricants, Inc. A ticket for the Presidents Luncheon is included in your meeting registration and free to STLE Corporate Member representatives (two tickets) and students. Guest tickets for the luncheon are \$50 and can be purchased at the STLE Registration Desk.

STLE is seeking sponsorships for the Networking Reception, President's Luncheon, Welcome Gift, Registration Bags, Education Course Lunches and Refreshment Breaks.

For more information, contact national sales manager Tracy Nicholas VanEe at (630) 922-3459, emeraldcomminc@yahoo.com.



Call for Student Papers

STLE is seeking student posters at its 2020 Annual Meeting & Exhibition. Event organizers are inviting students from all areas of tribology research to participate in a special session dedicated to student posters. Posters must deal with an aspect of tribology research that can be translated into friction, wear and lubrication. Student poster research topics can be co-authored by faculty and other researchers, but only students may exhibit their posters and discuss their work at the session. The posters will be judged by a conference committee, and awards will be given to the best posters.

Submission criteria & information

- Abstract submission deadline: **March 13, 2020** (via www.stle.org/annualmeeting). Notification of acceptance will be sent to students shortly after this date.
- The poster must present original work by the student during the 2019-2020 academic year.
- The student may submit only one poster as the lead author.
- As the lead author of the poster, the student should have performed the major portion of the work.
- Lead authors must be full-time graduate or undergraduate students registered during the 2019-2020 academic year.
- Posters can be no larger than 48 x 48 inches.
- Posters must be set up Sunday afternoon or Monday morning. The author must be present at the poster display during the judging session on Monday, May 4, during lunch and the scheduled conference break that afternoon.

Award category (*three winners in each category)

- **Platinum:** superior scientific and presentation quality (\$300 prize)
- **Gold:** good technical quality (\$200 prize)
- **Silver:** overall quality worthy to be encouraged (\$100 prize)

***Winners will be announced during the President's Luncheon on Tuesday, May 5.**

For additional questions about the student poster session, please contact Merle Hedland at (630) 428-2133 (STLE Conference office), or email mhedland@stle.org.

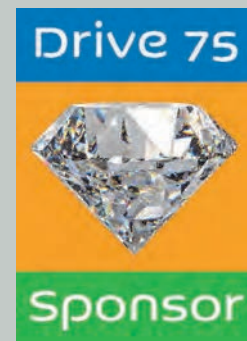


Join a growing group of companies helping STLE celebrate its Diamond Anniversary!

STLE is observing its 75th Anniversary with a year of events and activities, culminating in a festive celebration at the 2020 Annual Meeting & Exhibition in Chicago.

To honor the industry's premier technical association and support this momentous event, your company can become a Drive 75 Sponsor and reap a series of benefits throughout the year!

Your Drive 75 sponsorship includes a special \$100 donation in your company's name to a high school STEM program of your choice with matching funds from STLE!



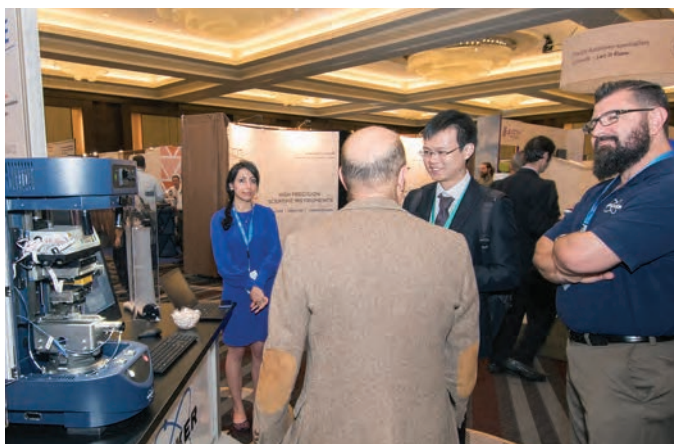
Drive 75 Diamond Sponsors

- Acme Hardesty Co.**
- Afton Chemical Corp.**
- Anhui Trust Chem Co., Ltd.**
- Biosynthetic Technologies**
- ExxonMobil Chemical Co.**
- KAO Chemicals GmbH**
- Münzing**
- Shell Global Solutions (US), Inc.**
- The Lubrizol Corp.**
- The Timken Corp.**

For details, contact Tracy Nicholas VanEe at 630-922-3459 or at emeraldcomminc@yahoo.com.

2020 STLE Annual Meeting Exhibition & Sponsorship Opportunities

Please note that all annual meeting events are at the Hyatt Regency Chicago.



STLE's annual trade show is where you can catch up on the lubricant industry's latest products, services and technologies. Many annual meeting attendees say they have saved thousands of dollars and solved complex lubricant-related problems by making a connection at STLE's trade show.

STLE has several sponsorship and advertising opportunities sure to raise your company's profile in Chicago.

***Booths are 10 x 10 feet and are \$2,675 for STLE Corporate Members and \$3,075 for non-members.**

STLE's exhibition features companies from the following product categories:

- Lubricant additives
- Metalworking fluids and additives
- Environmental services
- Condition monitoring equipment
- Industrial fluids
- Consulting services
- Testing and analysis equipment, supplies and services
- Lubrication management services
- Synthetic lubricants

Commercial Marketing Forum

The Commercial Marketing Forum (CMF) is a series of 30-minute marketing sessions at STLE's 2020 Annual Meeting where participants may promote your company's products and services, something not allowed in the technical sessions. Your CMF session is promoted in the Annual Meeting Program Guide, directing attendees to your presentation. CMF timeslots are sold on a "first-come, first-serve" basis. Pricing for time slots to present is based on membership status and if you are exhibiting at the annual meeting.

Sponsorships

Sponsorships come in all shapes, sizes and prices and are designed to fit everyone's marketing budget.

If you are interested in gaining exposure and raising your company's profile at the annual meeting (thereby reaching some 1,600 members of the lubricants industry), STLE offers several sponsorship opportunities, including:

- Annual Meeting Mobile App **(Sold!)**
- Badge Lanyards **(Sold!)**
- Directional Floor Signs **(Sold!)**
- Education Course Lunches
- Education Course Materials **(Sold!)**
- Exhibitor Appreciation Hour Raffle **(Sold!)**
- Guest Room Keycards **(Sold!)**
- Networking Reception Sponsorships (Monday evening)
- President's Luncheon (Tuesday afternoon)
- Refreshment Breaks Plus Water Stations
- Registration Bags
- Recharging Lounge **(Sold!)**
- Speakers Breakfast **(Sold!)**
- Wi-Fi Service **(Sold!)**
- Welcome Gift

2020 Exhibition Hours

Hyatt Regency Chicago (Riverside Exhibit Hall)

Monday, May 4 • Noon-5 pm

Dedicated hour of trade show time from 3-4 pm. No other annual meeting activity during this time.

Tuesday, May 5 • 9:30 am-Noon & 2-5:30 pm

Trade show closes for two hours for the President's Luncheon & STLE Business Meeting from Noon to 2 pm. Also, there will be a second dedicated hour of trade show time from 3-4 pm. No other annual meeting activity during this time.

Wednesday, May 6 • 9:30 am-Noon

For more information about Annual Meeting exhibit booth reservations, CMF, and sponsorship opportunities, contact national sales manager Tracy Nicholas VanEe at (630) 922-3459, emeraldcomminc@yahoo.com.

Commercial Marketing Forum Pricing:

- \$610 for STLE Corporate Members who exhibit
- \$750 for STLE Corporate Members
- \$890 for individual members
- \$970 for non-members

2020 Annual Meeting Sponsors (As of Dec. 3, 2019)

STLE wishes to thank the following sponsors for their generous support of the 75th STLE Annual Meeting & Exhibition, May 3-7, 2020, at the Hyatt Regency Chicago. Updated signage with sponsors information will be included onsite in Chicago.

◆ These companies also have contributed to **Drive 75** in support of STLE's 75th Anniversary Celebration.

Palladium Plus: More than \$4,000

◆ **Afton Chemical Corp.**

Guestroom Key Cards

Ergon, Inc.

Badge Lanyards

Focus Chemical

Mobile App

◆ **Shell Global Solutions (US), Inc.**

Directional Signs

◆ **The Lubrizol Corp.**

Wi-Fi Service

Titanium Plus: More than \$3,000

Evonik Oil Additives

Exhibitor Appreciation Hour Raffle

Pilot Chemical Co.

Relaxation/Recharging Lounge

Titanium: \$3,000

CRODA Inc.

Educational Course Materials

Platinum: \$2,000

Sea-Land Chemical Company

Networking Reception

Zschimmer & Schwartz

Speakers Breakfast

Gold: \$1,000

American Society of Mechanical Engineers (ASME):

Networking Reception

◆ **ExxonMobil Chemical Co.**

Networking Reception

◆ **The Timken Co.**

Networking Reception

Bronze: \$1,000

◆ **Acme-Hardesty Co.**

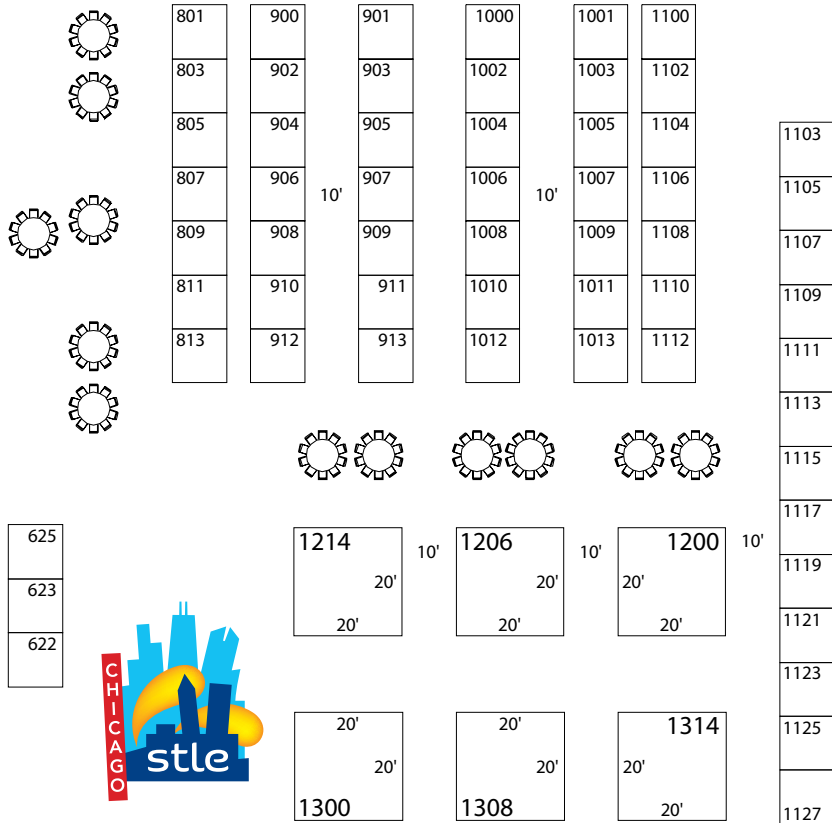
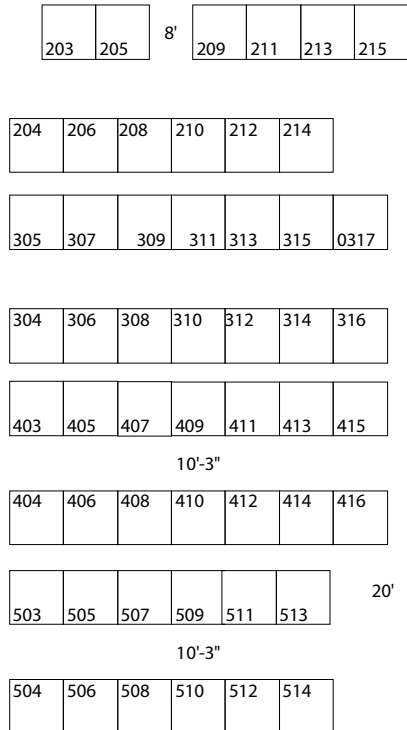
Networking Reception

2020 Chicago Trade Show Floor Plan



Hyatt Regency Chicago Riverside Exhibit Hall

937	938	701	703	705	707	709	711	713	715	717	719	721
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2020 Annual Meeting Exhibitors

More than 120 organizations are expected to display their newest products and services at the 2020 STLE Exhibition. Following is the list of exhibitors as of Dec. 3, 2019. Visit www.stle.org/annualmeeting and see the Program Guide distributed onsite in Chicago for the most up-to-date list.



◆ **Acme-Hardesty Co.**

Advanced Chemical Concepts Inc.

◆ **Afton Chemical Corp.**

ANGUS Chemical Co.

◆ **Anhui Trust Chem Co., Ltd.**

Alytical Instruments

Baron USA, LLC

BASF

Beckman Coulter

◆ **Biosynthetic Technologies**

Bruker

BYK USA Inc.

Calumet Specialty Products Partners L.P.

Cannon Instrument Co.

Chevron Phillips Chemical Co.

Colonial Chemical Inc.

Compass Instruments/Falex Corp.

Ducom Instruments

Eastman

Ele Corp.

Emery Oleochemicals

Ergon, Inc.

Evonik Oil Additives USA, Inc.

◆ **ExxonMobil Chemical Co.**

FedChem, LLC

Fluid Life

Focus Chemical

Functional Products, Inc.

GEO Specialty Chemicals

Italmatch Chemicals

◆ **Kao Chemicals GmbH**

KH Neochem Americas, Inc.

King Industries, Inc.

Koehler Instrument Co. Inc.

LANXESS Corp.

◆ **Münzing**

Napoleon Engineering Services

Oil Filtration Systems

Oleon NV

PCC Chemax, Inc.

Perkin Elmer

Phoenix Tribology Ltd.

Pilot Chemical Co.

PMC Crystal

Polytec, Inc.

Ravago Chemicals

Rtec-Instruments

Sasol Performance Chemicals

Savant Labs & Institute of Materials

Sea-Land Chemical Company

Shanghai Million Chemical Limited

Soltex, Inc.

SONGWON Industrial Group

Tannas Co.

Teknor Apex

The Dow Chemical Corp.

◆ **The Lubrizol Corp.**

Univar Solutions

Vanderbilt Chemicals, LLC

Vantage

Zschimmer & Schwarz

Zygo Corp.

◆ **These companies also have contributed to Drive 75 in support of STLE's 75th Anniversary Celebration.**

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**Superior lubricity,
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TruVis[®] Lubricant Esters for Oil & Grease

Adipate, Trimellitate & Polyol Ester Base Stocks & Additives for Automotive, Industrial and Metalworking applications.

Trimellitate Esters also provide low volatility and improved resistance to oxidation at high temperatures.

Polyol Esters (POE's) offer similar advantages, but perform at very low temperatures required for refrigeration.

TOP STORIES

Biosynthetic® Technologies and SIP Reach Distribution Agreement

Indianapolis-based **Biosynthetic® Technologies** has engaged in a distribution partnership with **SIP**. This partnership will extend Biosynthetic Technologies' footprint in the European market to meet the extensive European demand for biobased base oils.

Biosynthetic® Technologies has teamed up with SIP to market and promote its line of biosynthetic base oils to industrial markets across Europe. Under the exclusive terms of the agreement, SIP will market, sell, warehouse and support Biosynthetic® Technologies' full product portfolio of high-performance, renewable, biodegradable, nonbioaccumulative and nontoxic biosynthetic base oils.

Biosynthetic® Technologies CEO Mark Miller says, "We are incredibly excited about this recent agreement with SIP, as our organizations are very much aligned in our goals and values. We look forward to providing customers in Europe with our high-quality synthetic base oils leveraging the excellent reputation of our new partner, SIP."

Dr. Matt Kriech, COO at Biosynthetic® Technologies, says, "This agreement with

SIP increases the availability of our biosynthetic base oils across Europe, which is essential to Biosynthetic Technologies. We are committed to delivering the highest quality biobased lubricants and, as we expand our global footprint, we will endeavor to put distribution agreements in place that will allow us to meet the needs of our environmentally aware customers. SIP is indeed our partner of choice for across Europe. Its extensive expertise in the biobased lubricant space will enable us to establish a stronghold on the European market."

Palmer Holland appointed distributor for Pinova Solutions

Pinova Solutions (a subsidiary of DRT), a manufacturer of performance specialty rosin, polyterpene resins and key ingredients, appoints **Palmer Holland** as exclusive distributor in the U.S. and Canada.

Palmer Holland is responsible for the promotion and inventory management of Pinova Solutions' portfolio of polyterpene resins, terpene phenolic resins, hydrogenated resins, rosin esters and derivatives, tall oil fatty acids and distilled tall oil. These products are used primarily in the adhe-

sives and sealants, coatings and lubricants markets.

"Formally announcing our partnership with Pinova comes with great excitement. The Pinova products set the standard for performance in a wide variety of specialty markets and applications," says Mike Johnson, business manager, Palmer Holland.

Timken completes acquisition of BEKA Lubrication

North Canton, Ohio-based, **The Timken Co.**, a global leader in engineered bearings and power transmission products, has completed its previously announced acquisition of BEKA Lubrication (BEKA), a leading global supplier of automatic lubrication systems, for approximately \$165 million.

Founded in 1927, BEKA is a leading global supplier of automatic lubrication systems, serving a diverse range of industrial sectors including wind, food and beverage, rail, on- and off-highway and other process industries.

This acquisition positions Timken as the world's second largest producer of industrial automatic lubrication systems, which extend equipment life and improve reliability over manual lubrication methods, reduce ▶

ELGI and STLE sponsor European Tribology Exchange Workshop in Amsterdam

Nearly 50 international participants convened in Amsterdam, The Netherlands, in early November for the first-ever ELGI-STLE-sponsored European Tribology Exchange Workshop. The two-day event featured 18 presentations on topics ranging from industrial applications to biotribology. Due to the positive response, a follow-up event for October 2020 is in the works. For more information on either event, contact manfred.jungk@mj-tribology.com.



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► the environmental impact caused by over-lubricating and lower total costs for equipment and machine owners.

FUCHS acquires Zimmark Inc.

The FUCHS Group, which operates globally in the lubricants sector, is acquiring Zimmark Inc., a Burlington, Ontario, Canada-based company offering value-added services in the lubricants and chemicals process management (CPM) space.

With the acquisition the FUCHS Group expands its service portfolio in the industrial lubricant market and will deploy its processes throughout its other global divisions. The business will operate as a separate CPM division of FUCHS' North American industrial business.

"Today's larger sophisticated customers are looking for an integrated partnership with their lubricant supplier inclusive of a service offering complimenting a fluid solution to their challenges. FUCHS offers many CPM programs throughout Europe and China. We will use ZIMMARK's technical process management, focusing on rigorous control plans, as a nucleus to grow the service component of the business in the U.S.," says Keith Brewer, president & CEO of FUCHS Lubricants Co., USA. "The acquisition, and especially the Zimmark team, significantly enlarges our service offering capability."

Zimmark employs 60 people and generated EUR 4 million in sales in its fiscal year 2018, all of that in North America.

In 2018 the FUCHS Group accounted for EUR 2,567 million sales with staff of 5,446. FUCHS Lubricants Co., USA made EUR 284 million sales with 420 employees.

Afton Chemical completes Japan Technology Center expansion

Afton Chemical Corp., a global marketer in the lubricants and fuel additives market, has completed its Japan Technology Center expansion in Tsukuba. Jon Heese, city councilor for Tsukuba, jointly opened the Japan Technology Center with Regina A. Harm, president of Afton Chemical Corp., and Sean Spencer, vice president and managing director of Afton Chemical Asia.

The investment provides an expansion of the analytical and mechanical laboratories to increase lubricant additive testing capabilities. This includes standardized and bespoke tests for transmission fluids, gear lubricants, passenger cars, motorcycles, commercial and off-road vehicles engine oils as well as industrial hydraulic oils. The expanded facility will provide its customers with enhanced technical services such as sample blending, physical/chemical analysis and performance testing that comply with international and Japan unique test methods like ASTM, JIS, JPI, JASO and JCMAS.

"We are committed to bringing our Passion for Solutions® model to Japan and the Asia-Pacific region to help our customers differentiate their offerings to meet the needs of the local marketplace. The expand-

ed Japan Technology Center, with its integrated technical support and performance testing, will further enhance our ability to provide quick and effective solutions to our customers in Asia and will provide customized solutions 'Made For' key Japan OEM projects," says Harm.

Spencer says, "Afton Japan is a unique market with different needs and challenges. The 'Made For' strategy is built on the intent to understand the dynamics of each individual market and ensure we are developing the correct solutions from a product and services perspective. We constantly track local and global trends impacting the marketplace and partner with our customers to develop innovative additive solutions that exceed industry standards."

Aerospace Lubricants expands grease manufacturing plant

Aerospace Lubricants, serving the specialized grease needs of military and commercial aviation, expanded its grease manufacturing plant. The recent plant expansion will add 10 million pounds of grease production capacity at the Columbus, Ohio, location.

With the added capacity, the company can expand its product offering to open up sales into the industrial, automotive and private label market segments. A dedicated NSF H-1 food machinery grease line provides additional variety to the industrial product range. Ten stainless steel grease kettles are at the center of a plant design

focused on improved product quality, with dedicated production lines by thickener type to prevent cross contamination.

With special emphasis on grease cleanliness, high levels of product filtration have been employed. Products can be processed down to 35-micron filtration prior to packaging. Batch sizes will range from 1,000-10,000 pounds to better align with market needs for small volume customized products.


Aerospace Lubricants has the ability and experience to provide stock or custom formulations for differentiated products. The in-house quality control laboratory carries an ISO 17025 Certification to ensure that all products meet the demanding requirements of the customer. Aerospace Lubricants operates under the quality standards of ISO 9001:2015 and is pursuing the strict international automotive quality standard IATF 16949.

PROMOTIONS & TRANSITIONS

Danfoss Drives appoints Ian Barrie head of sales for Americas

Danfoss Drives has named **Ian Barrie** as its new head of sales for the Americas. In this position, Barrie will build and develop strong regional sales channels and verticals for Danfoss Drives' business within North America and Latin America.

Previously Barrie was head of global key accounts for Danfoss Drives. He has an extensive 25-year history with Danfoss and has held regional and global positions in sales, marketing and business development.

Barrie succeeds Santiago Martin, who has held the position since 2016. Martin plans to relocate to Europe, where he will assume a new position in Danfoss Cooling. 



Ian Barrie

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craft the perfect defoamer for their individual industrial needs, including metalworking fluids, industrial cleaners, antifreeze coolants and industrial lubricants.

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solutions in wetting

agents, dispersants,

rheology modifiers and

waxes. Munzing delivers

exceptional technical

expertise for your foam control

and additive solutions.

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(Photo courtesy of Biosynthetic Technologies.)

Biobased synthetic motor oil

Biosynthetic® Technologies now offers for commercial use a **high-performing biobased synthetic motor oil** using high-oleic soybean oil from soybeans grown by U.S. farmers. The Department of Defense and Washington, D.C., area fleet demonstrations found the product meets or exceeds their performance requirements. Biosynthetic Technologies' motor oil also is recognized as a U.S. Department of Agriculture (USDA) Certified Biobased Product meeting the federally mandated purchasing initiative known as the "BioPreferred Program." Biosynthetic® fully synthetic motor oil, 5W20 and 5W30 is now available for purchase. The United Soybean Board and USDA have supported the soy-based, drop-in, synthetic alternative to petroleum-based motor oil. The biobased alternative is well suited for high-temperature automotive and industrial applications.

Biosynthetic Technologies

Indianapolis, Ind.

(317) 749-0742

www.biosynthetic.com



(Photo courtesy of Bruker.)

Light-sheet fluorescence microscope

Bruker announces the release of the **Luxendo LCS SPIM** light-sheet fluorescence microscope for fast 3D imaging of large, optically cleared samples. Light-sheet fluorescence microscopy has emerged as a powerful method for high-resolution, cleared-sample imaging. The modular Luxendo LCS SPIM has been designed to be compatible with a broad variety of clearing solutions and sample sizes. Its new sample mounting approach and innovative optical design enables unprecedented acquisition times and minimizes sample distortions while seamlessly integrating into existing clearing and sample preparation pipelines. The system's basic configuration offers a cost-effective and flexible solution for cleared sample imaging, while the modular upgradability of the optical layout expands the performance of the system to enable unparalleled speed for high-resolution imaging.

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Learn more at
www.synergexamine.com



EASTMAN

Corrosion tester

Koehler Instrument Co., Inc., introduces the **K9445X series of corrosion testers** conforming to ASTM D6138 and related specifications. The corrosion tester has been developed for testing lubricating greases on their corrosion-inhibiting characteristics in rolling bearings in the presence of either distilled or demineralized water, salt water or synthetic sea water and under no applied load. It also tests corrosion inhibiting characteristics of lubricating oils. The touch screen panel allows easy-to-setup sequences to define your customized test setup or run the standard test. The customize test setup gives the possibility of a free adjustment of running hours and waiting hours. The test can be run with greases and oils and variations with regards to the test medium are possible. The corrosion tester is available in two, four, six or eight test positions with the option to add a two-bearing extension unit at a later time.



(Photo courtesy of Koehler Instrument Co., Inc.)

Koehler Instrument Co., Inc.
Holtsville, N.Y.
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CALL FOR STUDENT POSTERS



Photos courtesy of Dr. Robert Erck.

2020 STLE ANNUAL MEETING & EXHIBITION

THE SOCIETY OF TRIBOLOGISTS AND LUBRICATION ENGINEERS is seeking student posters for its 75th Annual Meeting & Exhibition at the Hyatt Regency Chicago in Chicago, Illinois (USA), May 3-7, 2020.

Event organizers are inviting students from all areas of tribology research to participate in a special session dedicated to student posters. Posters must deal with an aspect of tribology research that can be translated into friction, wear and lubrication. Student poster research topics can be co-authored by faculty and other researchers, but **only students** may exhibit their posters and discuss their work at the session. The posters will be judged by a conference committee, and awards will be given to the best nine posters.

STLE is now accepting abstracts for posters at <https://stle2020.abstractcentral.com>. The deadline for abstract submissions is **March 15, 2020**. Notification of acceptance will be sent to students shortly after this date.



THE CRITERIA FOR POSTER SUBMISSIONS ARE AS FOLLOWS:

- The poster must present original work by the student during the 2019-2020 academic year.
- The student may submit only one poster as the lead author.
- As the lead author of the poster, the student should have performed the major portion of the work.
- Lead authors must be full-time graduate or undergraduate students registered during the 2019-2020 academic year.
- Posters can be no larger than 48 x 48 inches.
- Posters must be set Sunday afternoon or Monday morning. The author must be present at the poster display during the judging session Monday, May 4, during lunch and during the scheduled conference break that afternoon.

THREE AWARDS WILL BE GIVEN IN EACH OF THE FOLLOWING CATEGORIES:

Platinum: superior scientific and presentation quality (\$300 prize)

Gold: good technical quality (\$200 prize)

Silver: overall quality worthy to be encouraged (\$100 prize)

Winners will be announced during the Presidents Luncheon Tuesday, May 5.

For additional questions about the student poster session, please contact Merle Hedland, mhedland@stle.org.

HYATT REGENCY CHICAGO IN CHICAGO, ILLINOIS



May 3-7, 2020

GREASE-N-GO automatic lubricators

Petro-Canada Lubricants, a HollyFrontier business, has launched its new **high-performance automatic lubricator, GREASE-N-GO**, which addresses the persistent issue on the minds of plant operators—how to protect equipment and drive minimal downtime. GREASE-N-GO is available in two sizes (125 ml and 250 ml) and for seven different grease products across the Petro-Canada Lubricants leading PURITY™ FG, PRECISION™ and PEERLESS™ product lines. The automatic lubricators ensure optimum protection of equipment operating in the food manufacturing, general manufacturing, construction, petrochemical and heavy-duty industries. GREASE-N-GO delivers the right amount of lubricant at the right time to ensure superior protection of equipment. This reduces the potential of unplanned maintenance and improves the reliability and performance of equipment to deliver tangible cost savings for equipment operators. The automatic lubricators also present the ideal solution for lubrication points located in difficult to reach areas, such as elevated locations with challenging access, in tight corners, spaces near equipment that is rotating or subject to high or cold temperatures. Once installed, the automatic lubricator can be left in-situ to deliver grease for a chosen lubrication period. This greatly reduces safety hazards and risk of system shutdowns associated with re-greasing in hard to reach locations.

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Base oil development: The next 20 years



Executive Summary

TLT readers cited electric vehicles and the electrification of machinery in general as the key forces that will drive base oil research and development through 2040. More attention will be paid to e-fluids and electrical conductivity properties, and lubricants also will face the higher operating speeds that often accompany electric machinery. Many survey respondents expect future lubricants to do a better job of combining low viscosity and low-temperature properties. As green technology evolves, biobased oils are assured of continuing their rapid growth. Many readers said end-users are looking for oils to handle heavier loads with extended drain intervals. With advances occurring almost too quickly to chart on several technical fronts, many survey respondents stress the importance of acquiring (and providing) accurate and reliable technical information. "More needs to be done to separate fact from opinion," said one.

Q.1

How will research and tribology science on base fluids evolve during the next 20 years?



Reduction in oil capacity for combustion automotive vehicle with addition of oil-cooling system.

Synthetic or biobased esters will combine low viscosity and good low temperature. Low volatility still needed.

Research into transient modes, especially the effect of many factors at the same time on fluid properties, multiphase flows and microflows of such fluids, and flow under high vacuum.

Demand for Group III base oil will increase, and more innovated products of synthetic ester will emerge as a base oil.

Fewer petroleum-based fluids. Lighter-weight, stronger construction materials (e.g., composites).

More biobased lubricant oils.

Conversion of waste materials such as plastics to lubricant raw materials. Evolution of technologies like GTL to produce wider range of viscosities.

Movement away from petroleum. Continued movement toward synthetics.

The refining/re-refining processes should continue to evolve with changes in machinery engineering. Base oil classifications will be a developing topic as well as qualifying tests.

An exponential increase of Groups IV and V base stock use.

Increased insights due to wider adoption of data gathering in industrial application. This will enable better understanding of lubricant quality over time.

There will be a shift from conventional oils (fossil formed) to more products being developed using biobased lubricants, GTL technology and synthetic sources.

Biggest changes: electrically conductive

and lower viscosity while maintaining a good film under high speeds and loads. Crucial for EVs.

Research will continue to design new chemically synthesized base stock molecules tailored to meet the conflicting demands of lower viscosity, lower Noack, better oxidative stability, longer life, reduced wear and lower friction. Smarter users will drive the change. Being wise enough to differentiate “lowest common denominator” specifications (lowest initial cost) from “step-out” lubricants (lowest total overall cost) will be key.

Which base fluids will show the most growth in new products during the next 20 years?	
Group III base oil	39%
Polyalphaolefins	39%
Synthetic esters	52%
Oil soluble polyalkylene glycols	21%
Gas-to-liquids technology	21%
Biobased lubricants	48%

Based on responses sent to 15,000 TLT readers. Total exceeds 100% because respondents were allowed to choose more than one answer.

Base stocks will be tasked to provide protection at increasing lower viscosities along with longer oil drain intervals.

I think we'll see more effective and accurate analysis and more realistic integration to real-world problems.

More synthetic base stocks and associated fluids will be needed for new powertrain technologies. Move toward e-fluids to meet electrification needs.

Developments with synthetic biology could totally disrupt what we are doing now.

High oleic vegetable oils for biobased base fluids.

I am a retired petrochemical chemist. My impression is the performance requirements

for base fluids and metalworking fluids are constantly expanding and increasing. I anticipate the situation will eventually plateau if it hasn't already. To surge ahead, the only route will be with significant improvements in additives. Crude oil is either paraffinic or naphthenic. Distillation is a simple process. Mobil One is an alkylated naphthalene and is, therefore, synthetic.

Lubricants will be greatly improved over the next several years. It is very possible that new lubricants will be developed, maybe some new Group IV oils.

Need for Group III+ and Group IV and V fluids would increase substantially to meet the demands of thinner SAE grades.

New fuels demanding new lubricants and impact to lubrication regimes.

There will be more use of biobased lubricants.

I think with the new synthetic-type base stocks, there will be many changes in the industry moving forward. Biggest challenges are costs and educating end-users to make these changes and extending life of equipment and change intervals.

More needs to be done to separate fact from opinion. OEMs need to focus on making machines, not selling only proprietary lubricants.

Increase in fluids that accommodate specific applications. Electrification is happening at a rapid pace, requiring fluids that enable operation of various components of the electrified vehicles without compromising friction, wear and current attributes.

More LCA and total cost of ownership focus.

I'm hoping for a bit more research on the “minor” differences that make a significant difference in the field, e.g., residual monomer, residual catalyst, purity of feedstock, variation in molecular weight, etc.



Q.2

Can you envision any future technology needs that will require changes in the preferred types of base fluids used?

Smaller, higher-power-density equipment will require greater thermal stability.

Operation under high/low temperature and pressure, operation under high vacuum.

Need low-viscosity base oil for EV systems with multifunctional properties: good corrosion inhibition for copper, cooling effect, compatibility with composite materials, good conductivity and good lubricity.

As the market moves to a cleaner and greener energy source for vehicles, along with industrial products (like tar for roads and roofing), refineries will start to see a slowdown, with some being shut down, reducing the supply of Group I and II oils and driving up prices. This necessitates the need for more synthetics and biobased fluids.

More environmentally friendly lubricants if the Neanderthals evolve.

Electric vehicle driveline fluids need to balance wear/EP and copper corrosion with good electrical and thermal properties.

New engines based in IMO 2020 will need new technology for their oils.

Increased adoption of forced induction to increase efficiency brings a host of challenges.

Higher rpms in new technology need to be accommodated.

The continuing drive toward energy-efficient, higher energy-density power plants will require new fluids that have a combination of lower viscosity, high oxidative stability, low volatility and reduced wear and friction. The eventual transition to electrically powered vehicles will add in the additional requirements of non-corrosion, non-conducting and

efficient heat-transfer. These increased requirements will drive the transition toward chemically synthesized and structured base stocks.

Lower viscosity oils for fuel economy in the automotive and heavy-duty engine platforms.

I suspect that the research into wind turbine bearing and gear reliability will result in further development of lubricants that are currently obscure.

More technology needs pertaining to compatibility with electrification equipment's (e-motors, drives, etc.). Copper compatibility. Thermal compatibility, too.

Pyrolysis/new technologies of waste plastics base into constitute petroleum components.



Outer space applications will require solid film lubricants. Hence, molybdenum disulfide is probably the default lubricant additive.

Equipment in the future will be running at higher speeds and under more demanding loads, which will require wear protection that only full synthetics lubricants can provide. The use of mineral oils will decrease.

Need for fluids having very low volatility and much higher VI ranging between 150-200.

What lubrication and tribology needs will require the most focused research as base fluids evolve during the next 20 years?

Friction properties	55%
Wear control	55%
Oxidation control and deposit reduction	68%
Corrosion and rust protection	34%

Based on responses sent to 15,000 TLT readers. Total exceeds 100% because respondents were allowed to choose more than one answer.

Yes, through analytical breakthroughs.

More gaseous fuels.


Training of maintenance and engineers personnel so that lubrication can be better understood. Lubrication is the most misunderstood issue in the manufacturing world.

Yes, higher pressures and speeds for the equipment and smaller footprints driving the temperatures up in the operations.

Lubricant and fluid conditioning will make most applications fill for life.

Higher temperatures, chemical resistance, material compatibility.

The ever-increasing paraffinicity of base oils will require solvency correction in the form of naphthenics and esters.

Longer service life and/or more demanding operating cycles (e.g., higher temperature, higher speed). Increased efficiency. 

Editor's Note: *Sounding Board is based on an informal poll of 15,000 TLT readers. Views expressed are those of the respondents and do not reflect the opinions of the Society of Tribologists and Lubrication Engineers. STLE does not vouch for the technical accuracy of opinions expressed in Sounding Board, nor does inclusion of a comment represent an endorsement of the technology by STLE.*

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2020 TECHNICAL TRACKS

- 2D Materials - Materials Tribology and Nanotribology Joint Session
- Biotribology
- Commercial Marketing Forum (*purchased time slots*)
- Condition Monitoring
- Engine and Drivetrain
- Engine and Drivetrain Electric Vehicle
- Environmentally Friendly Fluids
- Fluid Film Bearings
- Gears
- Grease
- Lubrication Fundamentals
- Materials Tribology (*including Solid Lubricants*)
- Metalworking Fluids
- Nanotribology
- Nonferrous Metals
- Power Generation
- Rolling Element Bearings
- Seals
- Surface Engineering (*including Hard Coatings*)
- Synthetic and Hydraulic Lubricants
- Testing in Soft Tribology - Tribotesting and Biotribology Joint Session
- Tribochemistry - Materials Tribology and Nanotribology Joint Session
- Tribology of Biomaterials - Biotribology and Materials Joint Session
- Tribotesting
- Wear
- Wind Turbine Tribology.

75th STLE Annual Meeting & Exhibition

May 3-7, 2020

Hyatt Regency Chicago
Chicago, Illinois (USA)

Whether you work in the field or lab—in industry, academia or government—STLE's Annual Meeting has programming designed specifically for you. Please join 1,600 of your peers from around the globe for five unique days of technical training and industry education that could change your career.

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Register now!

Log on to www.stle.org to register for the meeting and make your sleeping room reservation at the Hyatt Regency Chicago.

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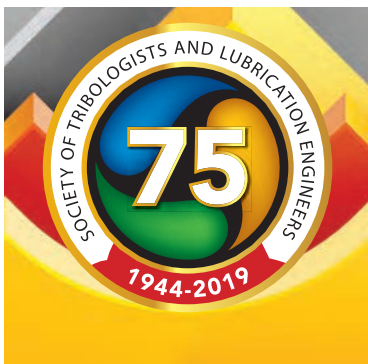


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February

Ad close: Dec. 20
Materials: Dec. 27

- Oil Analysis
- Grease
- Gears
- Biotribology
- Automotive Tribology

March

Ad close: Jan. 24
Materials: Jan. 31

(Bonus Distribution: PittCon, March 1-5, Chicago.)

- Metalworking Fluids
- Condition Monitoring
- Grease
- Lube Cleanliness
- Lube Fundamentals

April

Ad close: Feb. 20
Materials: Feb. 27

(STLE Pre-Annual Meeting issue! Bonus Distribution: ILMA 2020 Engage Spring Conference, April 2-4, Asheville, N.C.)

- Oil Analysis
- Bearings
- Gear Lubrication
- Environmentally Friendly Fluids
- Base Stocks
- Automotive Tribology

May

Ad close: March 23
Materials: March 30

(75th Anniversary Commemorative issue! Salute STLE by placing a special, congratulatory ad where your logo takes center stage! Bonus Distribution: STLE 2020 Annual Meeting & Exhibition, May 3-7, Chicago.)

For information on how to customize a multi-media marketing program that reaches **15,000 lubricant-industry decision-makers**, contact:

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LUBRICATION TECHNOLOGY

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February 12-13, 2020 • Novi (Detroit), MI

This conference will bring stampers and die shops up to date on new lubricants for stamping and tool and die machining, and help them evaluate new formulations and select the right lubricant for the job. Attendees also will come away with an understanding of the various techniques available for applying lubricant, to ensure optimum application while minimizing waste.

Topics include:

- Lubricant selection and use-working within automotive and appliance OEM requirements
- Part-cleaning fundamentals
- Green initiatives
- Matching the lubricant to the workpiece material
- How to evaluate new lubricants for the pressroom
- Lubricants for lightweighting
- Techniques for measuring lubricant thickness
- Developing an overall QA strategy for ensuring reliable sheet metal lubrication
- Applying Internet of Things technology to your lubrication strategy

More information at metalformingmagazine.com/lubetech

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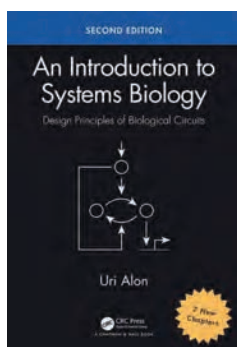
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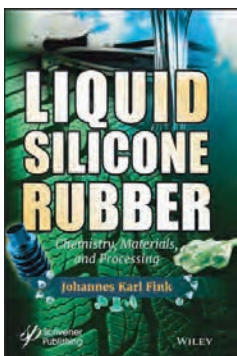
Technical Books

**An Introduction to Systems Biology:
Design Principles of Biological Circuits, Second Edition****Author: Uri Alon***Publisher: CRC Press*

Written for students and researchers, the second edition of this best-selling textbook offers a clear presentation of design principles that govern the structure and behavior of biological systems. It highlights simple, recurring circuit elements that make up the regulation of cells and tissues. Rigorously classroom-tested, this edition includes new chapters on exciting advances made in the last decade. This new edition has 189 exercises and offers new examples relevant to human physiology and disease. Available at www.crcpress.com. List Price: \$179.95 (USD), hardcover.

**Liquid Silicone Rubber:
Chemistry, Materials, and Processing****Author: Johannes Karl Fink***Publisher: Wiley*

The scientific literature with respect to liquid silicone rubbers is collected in this monograph. The text focuses on the fundamental issues such as properties, curing methods, special materials as well as the latest development and provides a broad overview of the materials used therein. In particular, materials and compositions for liquid functional rubbers are discussed. Also, methods of curing and special properties are described, such as tracking and erosion resistance, adhesion properties, storage and thermal stability. Methods of curing are precision casting, hybrid additive manufacturing, peroxide curing, ultraviolet curing, liquid injection molding or hot embossing. The book includes applications including automotive and underwater applications, electrical and optical uses as well as medical uses. Available at www.wiley.com. List Price: \$195.00 (USD), hardcover.



STLE Local Section Meeting Calendar

Events listed here are local section programs. For further details and a full listing of other upcoming section events in your area, visit www.stle.org. Meeting announcements can be sent to TLT Magazine, Attn: Rachel Fowler, rfowler@stle.org.

January

STLE Houston Section: Functional relationships between solid and liquid lubricants - nanoscale reactivity of ionic liquids upon sliding (Speaker: Dr. Filippo Mangolini, University of Texas), Jan. 10, 11 a.m. to 1 p.m. Maggiano's Little Italy, 2019 Post Oak Blvd., Houston, Texas. For more information, visit www.stlehouston.com/2HoustonSTLE/index.shtml.

STLE Philadelphia Section: Amine-based friction modifiers (Speaker: Doug Harkness, Nouryon), Jan. 16, 11:30 a.m. (registration and networking), 12 p.m. (lunch), 1 p.m. (presentations), Sandy Run Country Club, 200 E. Valley Green Rd., Oreland, Pa. For more information and to register, visit www.philadelphia-stle.org.

February

STLE Houston Section: Tribology Testing (Speakers: Michelle Lim and Sitangshu Chatterjee, Ducom Instruments (USA) Inc.), Feb. 14, 11 a.m. to 1 p.m. Maggiano's Little Italy, 2019 Post Oak Blvd., Houston, Texas. For more information, visit www.stlehouston.com/2HoustonSTLE/index.shtml.

STLE Virginia Section: Topic and Speaker TBD, Feb. 19, Virginia Commonwealth University, 907 Floyd Ave., Richmond, Va. More information to come.

STLE Philadelphia Section: Social Event, Feb. 20, Conshohocken Brewing Company KoP, 3100 Horizon Dr., King of Prussia, Pa. For more information and to register, visit www.philadelphia-stle.org.

STLE Certification Exams

STLE is offering a certification exam in the coming months. Here is the information on the exam:

- April 3 at the Inntel Hotels Amsterdam, Provincialeweg 102, 1506 MD Zaandam, Netherlands.

For the online registration form, go to www.stle.org; click on the professional development tab at the top. Then go to certification, then registration. Online registration closes two weeks prior to the exam date. Onsite registration may be available on a first come, first serve basis. For more information and for other methods of registering, you may contact STLE headquarters by emailing certification@stle.org or calling (847) 825-5536.

Industry Conferences

2020 Lubrication Technology for Metal Formers and Die Shops Conference

This conference is Feb. 12-13, 2020, at the Sheraton Detroit Novi Hotel in Novi (Detroit), Mich. It is produced by MetalForming magazine and the Precision Metalforming Association in partnership with STLE. STLE members are invited to submit presentation topics to MetalForming magazine for this important conference aimed at keeping metal stampers, sheet metal fabricators and tool and die shops abreast of the latest developments in lubrication technology. Presentations should be 30-45 minutes in length, and cover either educational topics or present case studies that provide insight into unique and advanced approaches to the use of lubricants and/or lubricant-application technology. Sample topics include lubricant selection and use working within automotive and appliance OEM requirements, part-cleaning fundamentals, green initiatives, matching the lubricant to the workpiece material, how to evaluate new lubricants and more. Submit presentation titles and content summaries (200-400 words) to Brad Kuvin, publisher/editorial director, *MetalForming magazine*: bkuvin@pma.org. To learn more about the PMA conference, visit, www.pma.org. Presentation proposals are due by Nov. 15.

The 12th International Fluid Power Conference

The 12th International Conference on Fluid Power (IFK) will be held in Dresden, Germany, on March 9-11, 2020. The IFK is one of the world's most significant scientific conferences on fluid power control technology and systems. It will be devoted to discuss topics with the theme "Fluid Power – Future Technology!" For more than 20 years, the exhibition has provided an excellent meeting point for professional exchange between scientists, users and manufacturers on an international level. It offers a unique opportunity to network with a large number of experts from the fluid power branch and to find out more about innovative products and system solutions. For more information, visit www.ifk2020.com.

Contact Mechanics International Symposium 2020

The Contact Mechanics International Symposium (CMIS) 2020 is held at the Hotel Prealpina in Chexbres, Switzerland, May 13-15. CMIS started from the desire to gather researchers interested in a broad range of topics in theoretical, computational and experimental contact mechanics. The 10th edition of CMIS will pursue this tradition of interdisciplinary research and foster intense discussions and exchanges by assembling a group of leading researchers in a pristine location. During these three days, discussions will involve a wide panorama of topics in the area of contact mechanics with the objective to reinforce interactions and collaborations between the various communities. For more details, visit <https://cmis2020.epfl.ch/>.

8th International Symposium on Surfactants in Tribology

The 8th International Symposium on Surfactants in Tribology is held in conjunction with The 23rd International Symposium on Surfactants in Solution (SIS-2020). The symposium is June 26-July 1 at Maria Curie-Skłodowska University in Lublin, Poland. The organizers of this event are STLE-members Girma Biresaw and Kash Mittal.

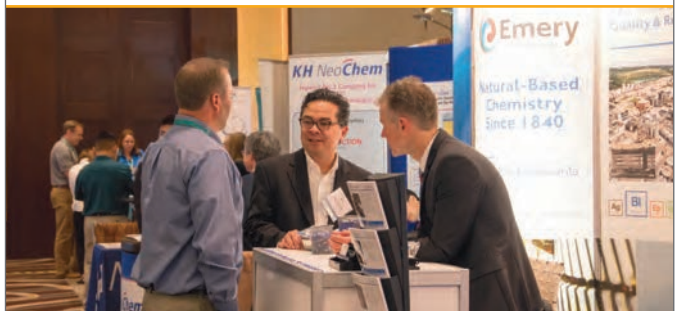
Surfactants perform a wide range of functions in tribology. These include basic lubrication functions such as control of friction and wear as well as controlling a wide range of lubricant properties. Examples of lubricant properties that can be modified with the application of surfactants include emulsification/demulsification, bioresistance, oxidation resistance, rust/corrosion prevention, etc. Surfactants also spontaneously form a wide range of organized assemblies in polar and non-polar solvents.

There is very little information on the subject of surfactants and tribology together, and this symposium is tasked with filling the gap. You are invited to submit your abstract and participate at www.sis2020.umcs.eu. Oral and poster presentations are welcome. Direct questions to Girma Biresaw at girma.biresaw@usda.gov. Be sure to select the Surfactants in Tribology track when submitting your abstract. 🌍

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'Sorry, you're underqualified'

*Lack enough experience?
Try this strategy to convince employers you can do the job.*

By Ken Pelczarski



Most of us have seen an attractive job opening advertised and said to ourselves, "This could be a great step for my career path. However, it appears that I do not have enough experience." Would you typically apply anyway in such a situation? I hope so, especially if you are confident in your capabilities and are passionate about the job.

An employer will usually hire you for one of two primary reasons:

1. You are well experienced and more qualified, capable and accomplished than other candidates.
2. Although you are short on experience, you have the aptitude, motivation and overall potential to be up to speed quickly and maybe become even more successful than a candidate with greater experience.

Which of the following candidates do you think has the better chance of being hired?

Candidate 1. Highly experienced in the same field in the right type of position but questionable on culture fit and does not show passion or enthusiasm.

Candidate 2. Underqualified regarding level of experience but capable of learning and motivated to achieve at a high level.

In my opinion, Candidate 2 has an easier time getting hired because of attitude, reliability, positive effect on other employees, chance of success and long-term potential. In addition, this less-experienced candidate will have an even better chance of being hired in a seller's market where employers have difficulty finding the ideal candidate.

Convince the employer you want to achieve big things.

Primary ways you can be underqualified

- Less leadership experience than desired
- Less experience in the employer's field than desired
- Less experience than desired in the right type of role
- Non-degree when degree is mandatory
- Bachelor's degree when an advanced degree is required.

Nine points to prove

1. Motivation. Convince the employer that you want to achieve big things.
2. History of accomplishments. Show that you have been successful in all your endeavors. Quantify accomplishments when possible.
3. Doing the same job now. If the employer wants more than 10 years of experience and you only have five years, make the case that you have been performing the same responsibilities and have had numerous accomplishments.
4. Ability to learn. Explain your foundation of training. Stress to the employer you will likely be more successful after six months on the job than a more experienced person. Request to be tested for aptitude.
5. Extensive practical experience. If you are short on desired education level, emphasize that your practical experience more than makes up for it. Request that the employer ask you situational/behavioral questions to prove they will have difficulty finding somebody more qualified than you.
6. Transferable skills. Draw parallels between the prospective role and the job you have been doing in a different field.
7. Soft skills. Display some of the more desirable soft skills employers look for such as leadership, communication, work ethic, problem solving, positive attitude, integrity, team player, adaptability, accountability, critical thinking and goal oriented. Give examples of how you have accomplished things through directing others (especially if you have not had an official management title). Provide examples of how you have interacted effectively at different levels internally as well as externally with vendors and customers.
8. Cultural fit. Show the employer that you have a good understanding of their company's culture and explain how you thrive with this kind of work environment and management style.
9. Long-term commitment. Share your long-term career goals openly and explain why this position and company are likely to offer the job satisfaction and challenge you desire for many years to come.

Attempt to prove the points discussed above in all aspects of the hiring process:

- Cover letter. Write a concise and hard-hitting letter that conveys your motivation, capabilities and related accomplishments.
- Resume. Be sure that the top third of your resume clearly lays out your skill set relevant to the position at hand.

- Networking. Express to all contacts your strong desire to attain a specific type of role.
- Telephone interview. Objective is to advance to the next step of the process by convincing the employer you may be more accomplished and desirable than a more-experienced candidate.
- In-person interview. This is your chance to shine by proving that you can achieve company objectives and be an outstanding long-term fit for the employer.
- Interview follow-up. Express clearly that, after digesting interview discussions, you are confident you will be a high achiever in this role.

If you are searching for a high-growth career opportunity, apply for positions that involve the greatest level of responsibility you can handle. Apply even if your experience on paper falls short of the employer's written job requirements. After proving you are a highly desirable candidate, the employer may even customize a new position tailored to your experience.

Ken Pelczarski is owner and founder of Pelichem Associates, a Chicago-area search firm established in 1985 and specializing in the lubricants industry. You can reach Ken at 630-960-1940 or at pelichem@aol.com.

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Deburring metal parts

Vibratory finishing and barrel tumbling are the most frequently chosen options.

By R. David Whitby

Manufacturing metal parts can involve many types of production engineering processes, including milling, grinding, turning, cutting and drilling. Some of these methods can leave the parts with rough edges or protrusions of material. These imperfections are known as burrs.

The process of removing burrs is called deburring. Left alone, metal burrs potentially can cause costly issues for manufacturers. Deburring is essential to ensure the quality and functionality of metal parts.

Making flat metal parts from sheets using stamping, blanking, punching, shearing or laser cutting almost always results in the generation of small burrs or sharp edges. There are a number of ways to remove these from metal parts, but the two most often used are vibratory finishing and barrel tumbling. Both rely on the effects of friction and wear.

Both types use pre-formed media such as stone, ceramic or plastic. Water is added to carry away burrs and dirt and to carry the media. Chemicals also might be used to improve the action or to clean parts. An abrasive is often added to enhance the cutting and deburring ability of the tumbling media. The abrasive does not act mostly on the parts but helps to keep the tumbling media rough enough to do the job.

A barrel tumbler rotates a load so the parts slide down the barrel like rocks down a hill. It can remove large exposed burrs but is not ideal for parts with recesses. In the process, the parts are abraded and deburred as they bump and scrape against the media and each other.

A vibratory tumbler creates a scrubbing action of surrounding media against the parts and is generally used for very smooth



Making flat parts from metal sheets almost always generates small burrs and sharp edges that can cause costly manufacturing problems.


surfaces. A vibratory tumbler produces an action similar to filing, applying an upward, angular force that causes a shearing action where parts and media rub together. The larger the parts or media, the faster the cutting action will be. A vibratory tumbler grinds at an applied force that is five to 10 times the force exerted by the free-falling action of a barrel tumbler. Compared with a barrel tumbler, a vibratory tumbler is very effective for recessed areas and is faster. The cutting action of a barrel tumbler occurs on about 20%-30% of the load, while the entire load is cut with each pulse of a vibratory tumbler, giving a shorter cycle time.

A vibratory tumbler can be used on fragile parts with small radiuses, since there is no tearing action or unequal forces to cause bends or distortion. A barrel tumbler excels at deburring parts with heavy radiuses or where more material needs to be removed and corners can be rounded off. While the speed and amplitude of vibration used will vary in different machines, high speeds and small amplitudes are generally used

for fine finishes or delicate parts, while large amplitudes are used for heavier cutting. High speeds and large amplitudes can roll burrs in orpeen metal into holes and mushroom edges.

Other deburring processes can be used, including media blasting, sanding, wire brushing, abrasive flow machining and electrochemical, thermal energy and manual deburring. In the last process, a skilled craftsperson can remove burrs by hand using specialized tools. This is flexible and cost effective, but it requires a significant investment of time, making it unsuitable for finishing a large quantity of parts.

Thermal deburring burns away burrs in a sealed chamber, quickly targeting burrs on multiple surfaces and many pieces at once. The process uses the thermal energy of an explosive gas mixture. The parts are loaded into an explosion-proof chamber, which is then sealed, clamped with approximately 220 metric tons, evacuated of air and filled with an oxygen and fuel mix, which is pressurised to 0.5 to 1.9 MPa (73 to 276 psi). An electrical igniter then ignites the mixture, causing all burrs to burn away. The peak temperature reaches 3,000 C (5,432 F).

Electrochemical deburring is used on precision work pieces and edges that are hard to reach, such as intersecting holes. The process uses a salt or glycol solution and electricity to dissolve the burr. The electric current is applied with a specialized tool to reach the burr location. Burrs are removed in five to 10 seconds, while the rest of the work piece is unaffected. 

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