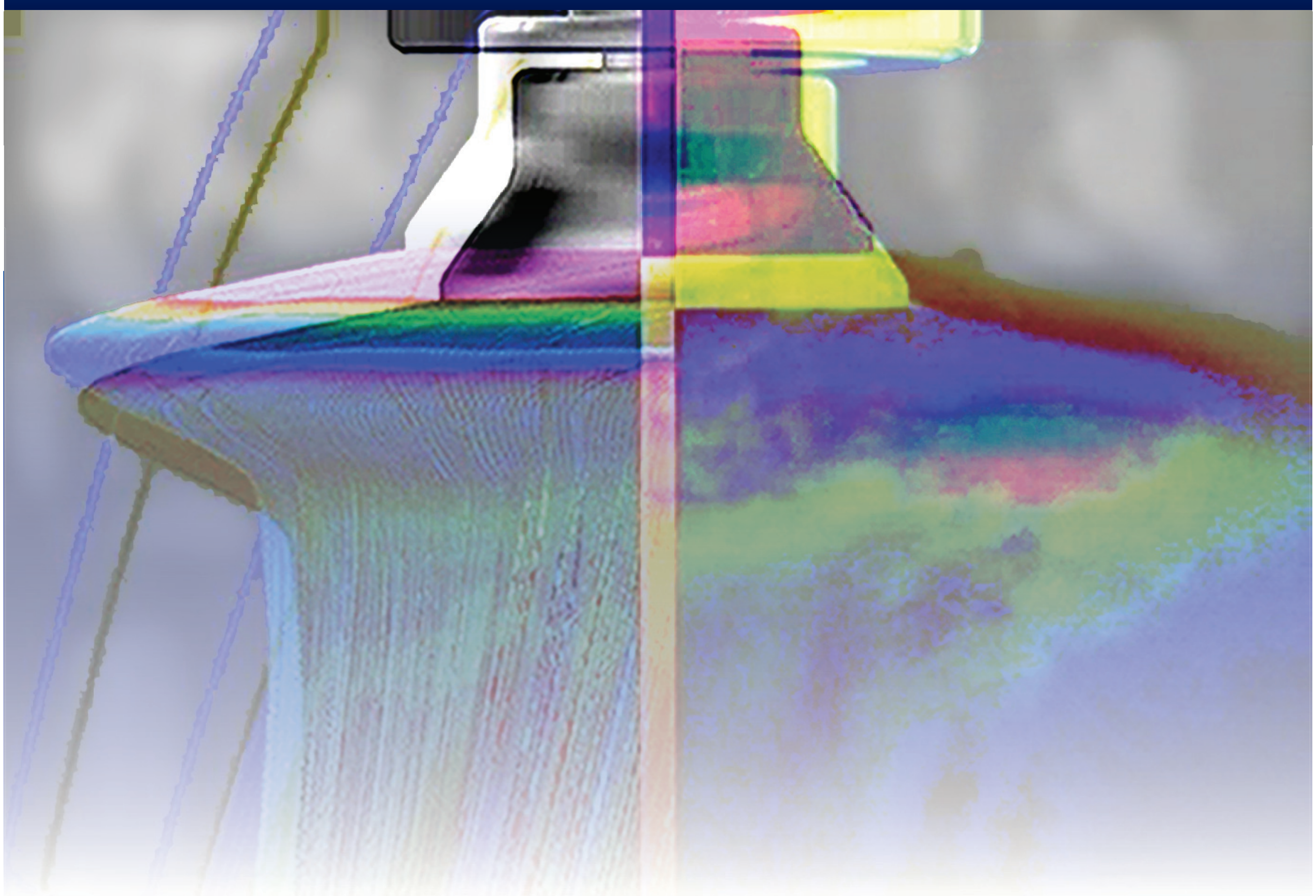
PTW2018
Painting Technology Workshop

October 2-3, 2018

Program



Lexington, Kentucky

www.engr.uky.edu/ir4td

Institute of Research for Technology Development
College of Engineering
University of Kentucky

UK College of Engineering

Notes

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Director's Message

Dr. Kozo Saito, Director IR4TD

Professor, Mechanical Engineering
University of Kentucky

The Painting Technology Workshop, initiated in 2000, is sponsored by the Institute of Research for Technology Development (IR4TD). It is an annual event organized as a forum for technical presentations and critical discussions regarding common painting and coating technology problems in manufacturing industries.

Workshop participants include individuals from industry, academia, and government laboratories and agencies who are interested in solving painting/coating-related problems.

This workshop has dual aims:

1. The exchange of information on the current and future painting and surface inspection technology, and
2. The development of a network system that allows for mutually beneficial collaboration among users of painting technology, paint booth manufacturers, paint equipment manufacturers and paint product companies.

The dialogue generated at the Workshop has led to innovative solutions.

Kozo Saito completed his degrees (B.S. 1975, MS 1977, Ph.D. 1980) at Seikei University, Japan. After completing his education, he came to the University of California at San Diego to conduct post graduate study. In 1981, he moved to Princeton University as Research Associate to conduct experimental combustion research, and later was promoted to Prof. Research Staff there.

Saito directs the Institute of Research for Technology Development (IR4TD), which houses two programs: Lean Systems and R&D, both initiated by the sponsorship from Toyota in 1994.

Saito is a fellow of the American Society of Mechanical Engineers, chair of the International Scale Modeling Committee, and a former committee member of the National Research Council. He holds visiting lectureship with Nippon Steel Corp, University of Tokyo, had an IPA assignment at the National Institute of Standards and Technology, and was a joint research collaborator with NASA and USDA Forest Service. Saito is the holder of total of several international patents.

Keynote Speakers

Industrial Keynote
Doug Bush, Toyota

Paint Technology from a Manufacturing Perspective: 2018 Version

Doug Bush has been with Toyota since 1992. During that time, he has managed paint engineering groups within a plant, and also for Toyota's North American Engineering and Manufacturing Headquarters. (TEMA) He has also led project teams for Toyota new plant construction projects in Tijuana, Mexico, and San Antonio, Texas. Since 2008, Doug has been the Paint Engineering Department Head at TEMA. He manages a 100 member team with responsibility for introduction of new materials and technologies, model and capacity changes, and other major capital projects for Paint Shops at Toyota's seven North America vehicle manufacturing plants. Doug has a BS in Mechanical Engineering from California Polytechnic State University, and an MS in Mechanical Engineering from California State University, Long Beach.

Keynote Speakers

Academic Keynote
Cheryl Jones, Lean Practitioner

Lean Systems Program
University of Kentucky

Toyota Paint Application 101

Standardized work is the critical foundation for every organization practicing lean or undertaking a lean implementation. It's vital to build that into the training and development of new hires. With the addition of job instruction training, it becomes possible to teach each new employee to perform their job safely, while achieving the same level of quality and productivity as a veteran employee, in a short training time period.

Cheryl G. Jones joined Toyota Motor Manufacturing in 1987. She began her career as an assembly manufacturing supervisor, eventually achieving Vice President of Manufacturing during her 22 years with the company. Cheryl retired in 2009. Her extensive knowledge of the Toyota Production System encompasses final vehicle assembly, robotic painting using solvent borne and waterborne paints, and parts delivery from supplier to final vehicle assembly. She has a degree in Business Management from the University of Kentucky and a degree from Northwood University in Information Systems Management and Business Management.

Keynote Speakers

Dinner Keynote
Nelson Akafuah, Associate Director

Institute of Research for Technology Development, University of Kentucky

Educating the Next Generation of Painting Engineers

Engineering has two aspects and two traditions. The first is the master craftsman, which is the practical art handed down from master to apprentice and the road to mastery involves hard work, with experience its measure. This approach develops the hands-on skill that cannot be taught in a classroom. The second is the scientific and mathematical approach which fits well within our current engineering curricula. From this scientific and mathematic approach has come most of the strikingly new ideas of engineering. However, when these approaches meet, engineering takes significant leaps forward with great bounds. We are focused on how to create an engineering curriculum that brings these two approaches into training painting engineers.

Nelson Akafuah holds a PhD Degree in Mechanical Engineering from the University of Kentucky (2009) and is currently a Research Assistant Professor in the Mechanical Engineering Department. Dr. Akafuah, who specializes in paint application and fire spread is also the Assistant Director of IR4TD.

Martin Nieto-Perez, Professor Researcher

Instituto Politecnico Nacional - CICATA

Plasma Technologies for the Paint Application and Manufacturing Industry

Plasmas are outstanding tools for surface processing of materials thanks to their unique chemistry given by their non-thermal equilibrium nature. Plasmas are efficient at generating ions, molecular fragments and electromagnetic radiation that ranges from UV to IR; the generation of species can be tailored by selecting the plasma forming mechanism and the operating conditions such as geometry, operating pressure and plasma gas feed composition. Exposure of surfaces to plasmas leads to the modification by any number of processes that include ion implantation, chemical and physical erosion, metal deposition, surface polymerization, incorporation of functional groups to the surface and photochemistry. In this talk, two potential applications of high pressure (i.e. atmospheric) will be highlighted: a technology dealing with the modification of powder surfaces that leads to changes in the behavior of the powder in suspension, and the modification of surfaces by the use of atmospheric plasmas that changes the wetting properties of the surface. These two technologies may have an important industrial impact, both on the paint manufacturing and paint application ends.

Professor Nieto has a BS in Chemical Engineering (1997) from Universidad Autonoma Metropolitana in Mexico City, and MS (2001) and PhD (2004) degrees in Nuclear Engineering, emphasis in plasma engineering, from the University of Illinois at Urbana-Champaign. He held a postdoctoral appointment at Argonne National Laboratory from 2004 to 2007 working on plasma-mirror interactions in EUV lithography systems for microelectronics manufacture. He returned to continue his career in his home country after working at ANL, and he has been staff at CICATA Queretaro – IPN since 2008, where he has advised 15 graduate students and performed multiple research projects devoted to plasma applications and novel energy systems. He is a former Fulbright Scholar, an IEEE Senior Member and recipient of an Early Career Award at IPN in 2010. He has over 30 publications dealing with plasma material interactions in the context of nuclear fusion devices and industrial applications of plasmas. He has participated in two US-Mexico programs aimed at strengthening industry-academia relations: the binational NSF/CONACyT I-CORPS/NOBI training program for technology commercial viability, and as a leader of the bilateral NSF/CONACyT IUCRC/COBI initiative for establishing a binational plasma consortium with industry.

Presentations

Ahmad Salahmieh, Research Assistant Professor

Institute of Research for Technology Development

University of Kentucky

Effect of Carbon Nanotube Size and Type on Paint Curing Energy Efficiency Using Radio Frequency Heating

Paint quality and durability is affected by the curing process, Curing is achieved by providing energy to polymerize the paint, in the current state of the art this energy is delivered by thermal energy over a prolonged heating in a convection based or infrared radiation based oven.

The current process, consuming a large portion of total energy in manufacturing operation of up to 20% of the overall energy of the assembly plant. Preceded only by the paint booth, the process currently heats both the vehicle's structure and the paint there by reducing the overall curing efficiency. A reduction of energy use could be provided by selective heating, ideally heating of the paint only. In this work we study the effect of introducing nanoparticles such as carbon nanotubes (CNT) and carbon nano-powder into epoxy resin samples and use a radiofrequency generator for selective heating. In this study the carbon nanotubes wall configuration, aspect ratio, and concentration is studied and modeled by quantifying the temperature history while heating the samples with a radio frequency at 13.56 MHz.

This work will help to identify how nanoparticles release heat in polymer matrices while heated in induction heating systems, ultimately being used to reduce the curing time and energy in an automotive production setting.

Ahmad Salaimeh joined the University of Kentucky IR4TD in 2006, to pursue his MSc and PhD degrees. He graduated in December 2011 with a PhD from the University of Kentuckyand has been working on paint related projects since then. In April, 2015 he became a research assistant professor at the University of Kentucky Mechanical Engineering Department. In October, 2018 he became the Director of the Painting Technology Consortium. His research focus is thermal and high speed imaging from spray atomization and non-destructive testing.

Presentations

Mark Doerre
Institute of Research for Technology Development
University of Kentucky

Advances in Conversion Coating and Challenges with Multicomponent Body Structure

Automotive conversion coatings consist of layers of materials that are chemically applied to body structures of vehicles before painting to improve corrosion protection and paint adhesion. These coatings are a consequence of surface-based chemical reactions and are sandwiched between paint layers and the base metal; the chemical reactions involved distinctly classify conversion coatings from other coating technologies. Although tri-cationic conversion coating bath chemistry that was developed around the end of the twentieth century remains persistent, environmental, health, and cost issues favor a new generation of greener methods and materials such as zirconium. Environmental forces driving lightweight material selection during automobile body design are possibly more influential for transitioning to zirconium than are the concerns with the body coating process. The chemistry involved in some conversion coatings processing has been known for over 100 years. However, recent advances in chemical processing, changes in the components used for vehicle body structures, environmental considerations and costs have prompted the automobile industry to embrace new conversion coatings technologies. These are discussed herein along with a historical perspective that has led to the use of current conversion coatings technologies. In addition, future directions for automobile body conversion coatings are discussed that may affect conversion coatings in the age of multi-material body structures.

Presentations

Bobby Meade, Research Investigator
Ted Hopwood, Program Manager for Bridge Preservation
Kentucky Transportation Center

University of Kentucky

Spot Painting to Extend the Life of Highway Bridge Coatings

Bobby Meade retired from the UK Transportation Center in 1999 with 29 years of service and accepted a position with the Kentucky Transportation Cabinet. Mr. Meade was responsible for the Cabinet's bridge maintenance painting program from which he retired in 2007.

Since 2007, Mr. Meade has worked part time for the University of Kentucky Transportation Center in the Bridge Preservation Program and part time for the Greenman Pedersen Company providing project development, project management and inspection services for the Cabinet's bridge painting program.

Mr. Hopwood is the Program Manager for Bridge Preservation at the Kentucky Transportation Center, a research center attached to the College of Engineering at the University of Kentucky. He obtained his BS degree in mechanical engineering at the University of Kentucky in 1969 and an MS degree in Metallurgy at the University of Kentucky in 1975. He previously held positions in private industry and with the Kentucky Transportation Cabinet. He has been employed at the Transportation Center since 1981.

Mr. Hopwood has been conducting coatings research related to bridge painting for over 20 years. He has worked on a wide variety of transportation research subjects including coatings development and testing, corrosion analysis and prevention, environmental issues, facilities management, nondestructive testing, maintenance practices, and project development.

Presentations

Rob May, Associate Professor
College of Pharmacy

Shining a Light on Coating Thickness Measurement with Terahertz

Presentations

Joseph Alexander

Triblue

Potential Applications of Emerging Technologies within the Petroleum Processing to Automotive Paint Booths

Presentations

Kevin Haulata

Graco

Manufacturing Paint Line Improvements with the Use of Automation

Continuous improvement is an important part of manufacturing. At Graco we are always looking at how we can improve the current processes in manufacturing with the use of new technology. One area we have invested recently is adding automation to our current manufacturing paint line. As part of the presentation I will talk about the benefits of adding a robot and Graco spray equipment to help improve our manufacturing paint process. Improvements that help reduce manufacturing cost include labor savings, increased line density and reduction in material usage. Other important benefits with this project include ergonomic improvements; reduction in VOC's and better process control and quality improvement. The presentation will include specifics on the equipment used including the Graco ProBell, Graco PD2k Automatic Proportioner system along with the Fanuc Robot. Other details regarding automation safety, part tracking and RFID technology will be mentioned on how it was integrated into the project.

Presentations

YT Cheng, Professor

Materials Engineering Department

University of Kentucky

Working Towards Making Better and Cheaper Lithium-ion Batteries by Electrostatic Spray Deposition

We have recently investigated an electrostatic spray process for making lithium-ion battery electrodes. This process does not use organic solvents that are used in the conventional slurry mixing and casting process, thus eliminating the cost associated with solvent evaporation and recovery. Our results suggest that the dry coating process is a promising alternative to the conventional wet process of making electrodes.

Yang-Tse Cheng is the Frank J. Derbyshire Professor of Materials Science and professor of physics and astronomy (joint appointment) at the University of Kentucky. Prior to joining UK in the fall of 2008, he was a technical fellow and laboratory group manager for engineered surfaces and functional materials at the General Motors R&D Center.

Cheng has made significant contributions over a broad range of materials science and engineering areas, including nanoindentation modeling and measurement of mechanical properties; growth, structure and properties of nanostructured materials (e.g., amorphous materials, nanocomposites, epitaxial single crystals, single crystal nanowires); microscopic shape memory and superelastic effects; magnetorheological fluids; superhydrophobic and superhydrophilic surfaces; ion-solid interactions and ion beam modification of materials; automotive applications of new materials and processes, such as electrical contacts, high power-density engines and transmissions, environmentally friendly machining processes, hydrogen sensors, fuel cells, metal hydride batteries and lithium ion batteries.

Cheng holds 48 U.S. patents, several of which have been utilized by General Motors. He has published 168 articles and edited eight books and special volumes and serves as a principal editor for the Journal of Materials Research. Cheng is a fellow of the Materials Research Society and the American Physical Society.

Presentations

S. Himori

Hirosaki University

Effect of Impinging Angle on Atomization Characteristics of a Liquid Jet Across Sheet-Like Air Flow

A rotary bellcup atomizer is widely used in automotive spray painting because of the finishing high quality and the high coating efficiency. In a rotary bellcup atomizer, ligaments are stretched from a bellcup edge and then atomized by the impinging air flow. Although many researchers have studied the atomization of a ligament by an air flow, the impinging angle between an air flow and a liquid jet is 90 degree in almost all studies. In a practical bellcup atomizer, the impinging angle is not always 90 degree. Therefore, in this study, we investigated the effect of the impinging angle on the atomization characteristics. Experimental conditions were as follows: the liquid jet diameter was 0.1 mm, flow rate was 5 ml/min and test fluid was water. We varied the air velocity from 50 to 120m/s and the impinging angle from 60 to 120 degree. We used a high-speed video camera with a backlight imaging to observe the breakup phenomena of a ligament. The spray angle and the droplet diameter were calculated by the image processing method of MATLAB. As a result, the spray angle converges at the constant value with increasing the air velocity at the impinging angle more than 90 degree and increases with increasing the impinging angle at low air velocity. This change in spray angle with the impinging angle can be explained as follows: at the impinging angle less than 90 degrees, most of the spray droplets are ejected to the same direction. On the other hand, at the impinging angle more than 90 degrees, the large droplets kept their initial velocities due to their large inertia, while the small droplets follow the air flow.

Presentations

Ahmad Salahmieh, Research Assistant Professor

Institute of Research for Technology Development

University of Kentucky

Effect of Cup Edge Design on Atomization Characteristics

Electrostatic Rotary bell (ESRB) atomizers are used as the dominant means of paint application by the automotive industry. They utilize the high rotational speed of a cup to induce primary atomization of a liquid along with shaping air to provide secondary atomization and transport. Rotary bell atomizers have a wide droplet size distribution, bimodal type distribution is commonly observed both of which affect the transfer efficiency and the appearance.

In order to better understand the fluid breakup mechanisms involved in this process, Shadowgraph imaging was used to visualize the edge of three different types of cups a serrated, straight unserrated, and a fillet unserrated edge cup at speeds varying between 20,00 and 50,000 RPM and with a varying flow rate from 250 ccm to 750 ccm. A multi-step image processing algorithm was developed to differentiate between ligaments and droplets during the primary atomization process.

The method was used to identify the effects of flow rate, rotational speed, and cup edge design on the formation of bimodal droplet size distribution. The effect was more pronounced for serrated edge cups with high flow rates.

Ahmad Salaimeh joined the University of Kentucky IR4TD in 2006, to pursue his MSc and PhD degrees. He graduated in December 2011 with a PhD from the University of Kentuckyand has been working on paint related projects since then. In April, 2015 he became a research assistant professor at the University of Kentucky Mechanical Engineering Department. In October, 2018 he became the Director of the Painting Technology Consortium. His research focus is thermal and high speed imaging from spray atomization and non-destructive testing.

Presentations

Adnan A. Darwish

University of Kentucky

Shaping Air Impact on Droplet Atomization and Transport: A Visualization Approach

The interface between a thin film and a substrate has been a major focal point of materials science and engineering over the last few decades. The principal consideration for design or material selection depends on a host of purposes: protection, adhesion, lubrication, thermal and electrical conductivity, magneticity, absorbance, reflectance, etc. From thermal barrier coatings on gas turbine engine blades to submarine anti-fouling materials to the much smaller length scales found in microelectronic devices, thin film interfaces are ubiquitous. The mismatch of properties at interfaces between dissimilar materials causes this junction to be susceptible to failure. Therefore, the reliability of interfaces is a critical concern for thin film on substrate systems. The ability to dynamically load thin film coatings in a non-contact manner provides a powerful assessment tool for thin film performance..

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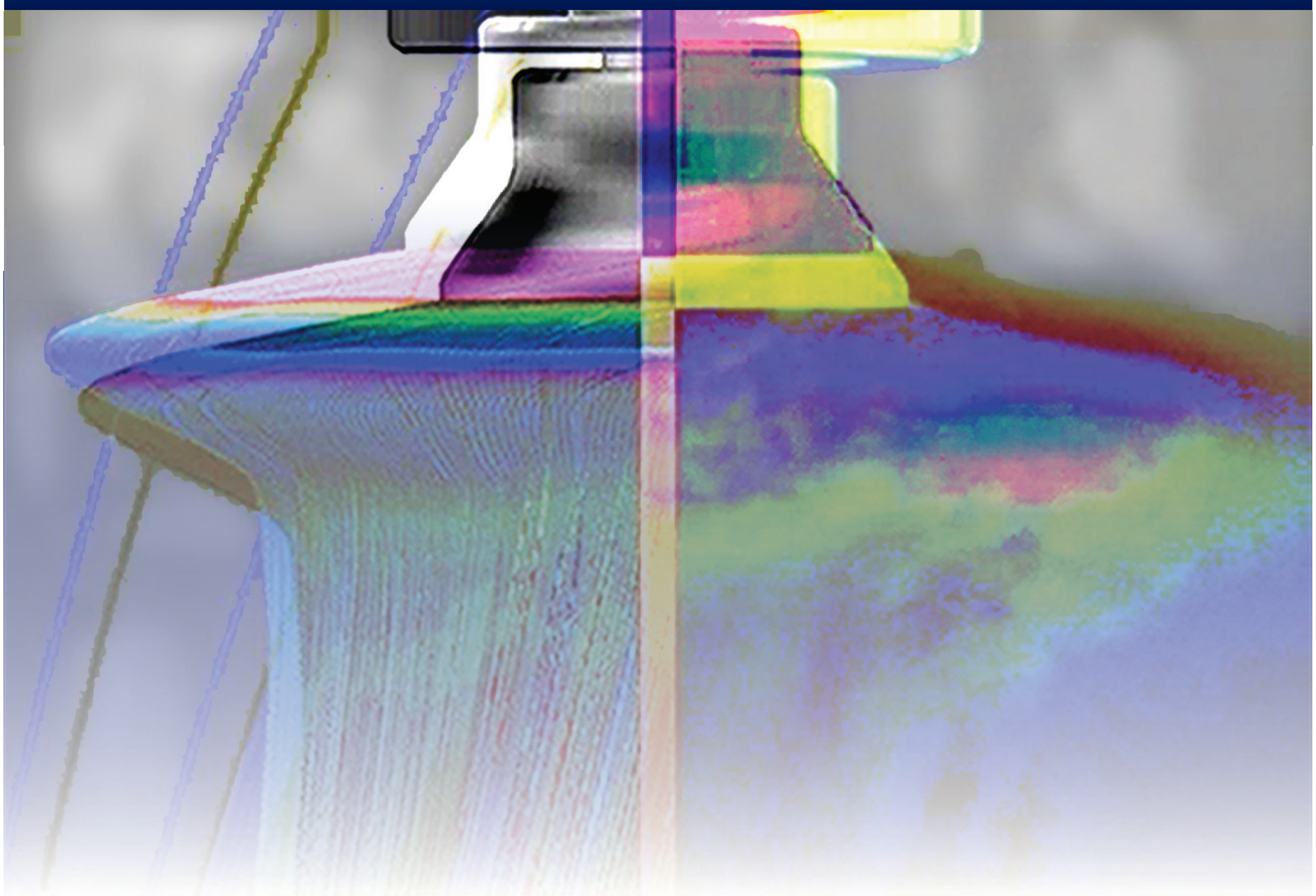

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