

Final Program

**32nd International
Conference on
Electrical Contacts**
together with
**69th IEEE Holm
Conference on
Electrical Contacts**



6-10 OCTOBER 2024
Graduate Hotel Annapolis
Annapolis, MD, USA



IEEE



Sponsored By:
The Electronics Packaging Society
of The Institute of Electrical and
Electronics Engineers, Inc.

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J. G. Zhang, **Emeritus Member**

Purpose

To provide a forum for the presentation and discussion of the latest developments in the field of electrical contacts, as well as the application of recent advances in materials and processes in electrical, electronic and telecommunications equipment.

For Whom

Practicing designers, engineers, physicists, and research scientists those new to the field and those experienced. The 32nd International Conference on Electrical Contacts together with the 69th IEEE Holm Conference will include excellent papers authored by outstanding technical people in this field. The international contributors come from Austria, Canada, China, France, Germany, India, Italy, Japan, Kazakhstan, Netherlands, South Korea, Switzerland, United Kingdom and USA. These papers will provide the attendees with up-to-date information on a wide range of subjects that makes this conference so attractive to the practicing engineer.

Background

The Holm Conference on Electrical Contacts began in 1953 as the Holm Seminar. It was a forum for the discussion of electrical contact phenomena. In 1968, the conference was named the Holm Conference in honor of Dr. Ragnar Holm after his death. His contributions to the field of electrical contacts spanned 50 years and forms the foundation of the electrical contacts field. Dr. Holm was the inspiration and guide of the Conference from its inception until his death in 1970.

In addition to the Annual Conference, the Conference Organization regularly conducts an intensive course on electrical contacts and participates in the biannual International Conference on Electrical Contacts.

The first International Conference on Electric(al) Contacts was organized by Prof. R. E. Armington and Dr. Erls Shobert in 1961 and held at the University of Maine, in Orono, USA. The second International Conference occurred in Graz, Austria in 1964. Since then, the Conference has been held every two years in Europe, Asia, and the Americas. When in the United States the ICEC and the Holm Conference are held together.

Registration

All participants are encouraged to pre-register to avoid lines at conference and to obtain the discounted fee.

CONFERENCE REGISTRATION

IEEE Member	US\$1000
Non- Member	US\$1075
Student/ Life Member	US\$415
Student/ non- Member	US\$500

CONFERENCE REGISTRATION HOURS

Sunday 6 October	6:00PM – 8:00PM
Monday 7 October	7:00AM – 5:00PM
Tuesday 8 October	8:00AM – 4:00PM
Wednesday 9 October	8:00AM – 4:00PM
Thursday 10 October	8:00AM – 11:00AM

Registration can be completed online:

<https://cvent.me/y1x9Xg>

Registration payments:

Checks are to be made out to the IEEE HOLM in US\$.
Visa, MasterCard, Discover, and American Express are
accepted

For additional information please contact Holm Registrar, at:

US and Canada: +1 800 810 4333

Elsewhere: +1 732 465 7810

Email: holmreg@ieee.org

Welcome Reception

All conference attendees are invited to register early and to attend our welcome reception on Sunday, 6 October from 6:00 PM – 8:00 PM at the Atrium of the Graduate Hotel.

Hotel Accommodations

The 2024 conference meets in Annapolis, Maryland at the Graduate Hotel, where meeting facilities are well suited to the conference sessions and other activities. The hotel is offering special rates of US\$239* single/double occupancy to conference attendees. Rates are subject to state and local tax. To make a reservation please use the Holm Conference link

<https://tinyurl.com/HolmGraduateHotel>

Graduate Annapolis immerses you in local history and Navy traditions with creative interiors and college nostalgia. Located in the Arts District, a short stroll from the U.S. Naval Academy and Chesapeake Bay, our hotel is the perfect base for exploring. Enjoy amenities like Malin + Goetz bath essentials, bike rentals, and pet-friendly accommodations.

Check in time: 4:00PM EST

Check out time: 11:00AM EST

Self Parking: \$30.00/night

Valet Parking: \$35.00/night

Graduate Hotel
126 West St.
Annapolis, MD 21491 USA
+1 (410) 263-7777

Transportation

Taxi, Rideshare, and driving distance from major Airports:

**FROM BALTIMORE/WASHINGTON THURGOOD
MARSHALL INTERNATIONAL AIRPORT**
~ 38 MINUTES /25 MILES

**FROM RONALD REAGAN WASHINGTON NATIONAL
AIRPORT**
~ 1 HOUR/36 MILES

FROM DULLES INTERNATIONAL AIRPORT
~ 2 HOURS/64 MILES

For specific driving directions consult:

<https://ieee-holm.org/venue/>
or call the hotel directly at +1 (410) 263-7777

Conference Banquet

Carrol's Creek Cafe

**9 October 2024
6:00 PM EST**



Charles Carroll of Carrollton was Maryland's most famous signer of the Declaration of Independence. He grew up in the Carroll Mansion, still situated on the peaceful banks of the St. Mary's church grounds. Once a commanding site on the sloping banks of this peaceful creek, the Carroll Mansion now overlooks the Spa Creek Bridge and the active waterway that is home to many boats.

While most know this waterway as Spa Creek, historic documents indicate that this was not always so. A map discovered in France and brought to Annapolis in 1976 — titled "Plan of the Harbour and City of Annapolis with the Encampment of the Light Troops Under Major General Marquis de la Fayette" — shows Spa Creek as Carrol's Creek. Unfortunately, the cartographer dropped the final "l" from the Carroll family name. The map was dated 1781.

Carrol's Creek Restaurant does not take the heritage of its name lightly. From our historic location that overlooks the waters of one of America's most charming and historic cities, we offer the riches of the bay and the land in a new American style of cooking that emphasizes flavor and innovation in a style that is fitting of our nation's most treasured traditions.

Carrol's Creek brings you a new American tradition of dining that is founded in the time-honored heritage of a colonial town rich with seafood, culture, and style.

The ICEC/Holm Banquet will be held in the restaurant, which overlooks the Spa Creek and Annapolis Harbor.

Each conference attendee will receive a ticket to attend the Banquet. Additional tickets may be purchased through the registration portal.

ICEC/Holm Conference Companion Program

For companions not attending the technical sessions, several social activities are available throughout the course of the conference. Detailed description of the activities can be seen by clicking on “Companion Program” at:

<http://www.ieee-holm.org/>

For additional information during the conference, please visit the registration desk.

7 October 2024

9:30am – 11:30am “Explore the Heart of Annapolis” guided tour via electric cart (\$30/per person)

One of America’s oldest cities is a little town packed with hidden gems. This guided tour will provide an overview of Annapolis’ history & its role in the building of America, showcase its colonial architecture including the original homes of four signers of the Declaration of Independence and provide panoramic views of Annapolis Harbor & Chesapeake Bay. This is a special discounted conference rate. Meet in the hotel lobby at 9:15am.

11:30am Lunch at the Café Normandie (self-pay) (a 10 minute walk from the hotel)

French country cuisine with Maryland seafood specialties. Vegetarian & gluten free options are available.

2:00pm–3:00 Maryland State House – guided tour (Free)

Docent guided tour of the oldest state capitol in continuous legislative use & the only state house to have also served as the nation’s capitol (from November 1783 – August 1784). See where George Washington resigned his commission & where the Treaty of Paris was ratified, marking the official end of the Revolutionary War.

8 October 2024

11:15am – 12:45 Lunch Boatyard Bar & Grill (self-pay)

Meet in the hotel lobby at 11:00 & travel together to the restaurant. Vegetarian & gluten free options are available.

3:30pm – 4:30pm Annapolis Maritime Museum (\$5/per person)

Learn about Chesapeake Bay ecology with our large scale, vibrant aquariums and learn about harvesting seafood from the waters of the Chesapeake Bay.

9 October 2024

10:30 – 11:30am Hammond Harwood House guided tour (\$10/per person)

Built in 1774 by William Buckland, Hammond-Harwood House is a museum of 18th and early 19th century architecture and art. Meet in the hotel lobby at 10:00.

Holm Conference Ragnar Holm Scientific Achievement Award

The Ragnar Holm Scientific Achievement Award derives its significance and prestige from the scientist whose name it carries. The contributions of Dr. Ragnar Holm to electrical contact theory and application are renowned the world over. The award, created in 1971 by the Steering Committee of the Holm Conference, honors the memory of the founder of modern electrical contact science by recognizing outstanding scientists and engineers in the field of electrical contacts or related technologies.



2024 RAGNAR HOLM SCIENTIFIC ACHIEVEMENT AWARDEE

George Flowers

George T. Flowers is a Professor in the Department of Mechanical Engineering at Auburn University and the Dean of the Graduate School. He received the BME degree from Auburn University in 1984 and the MSME and Ph.D. degrees from the Georgia Institute of Technology in 1985 and 1988, respectively, where he was a General Electric Graduate Fellow. He was an Assistant Professor with the Department of Mechanical Engineering at the University of South Florida from 1988 to 1990. He joined the faculty of the Department of Mechanical Engineering at Auburn University in 1990. Dr. Flowers has also held visiting positions at NASA Marshall Space Flight Center and the Air Force Research Laboratory at Wright Patterson AFB and at Kirtland AFB.

He has been an active member of IEEE, ASME, and AIAA for over 30 years. He is an ASME fellow and an AIAA Associate Fellow. He was the Conference Co-Chair for the 2009 ASME International Design Engineering Technical Conferences and Computers in Engineering Conference. He has served as chair of the ASME Technical Committee on Vibration and Sound and as an associate editor for the ASME Transactions on Vibration and Acoustics.

Dr. Flowers is currently a member of the IEEE Holm Conference Steering Committee and the Technical Program Committee. He has been an active participant in the IEEE Holm Conferences since 2002, and has served as both the Holm Conference Chair and the Technical Program Chair.

His research is in the general area of vibration, dynamics, and control, with an emphasis on electronic packaging particularly regarding electrical contacts. He has published over 200+ refereed research articles. He has had a long-term affiliation with the Auburn University Center for Advanced Vehicle and Extreme Environment Electronics (CAVE3), which has been a key sponsor for much of his electronic packaging research. He is the director of the Vibrations Laboratory in the Auburn University Department of Mechanical Engineering. His work has included detailed studies of fretting corrosion, tin whisker initiation, growth, and mitigation, and Pb-free solder reliability for harsh environment applications.

Holm Conference Ragnar Holm Scientific Achievement Award Nomination Guidelines

History: The Ragnar Holm Scientific Achievement Award was created by the 1971 Holm Conference Steering Committee in honor of the memory of Dr. Ragnar Holm, the founder of the modern science of electrical contacts. This award is to be granted to the living scientist or engineer who has made significant contributions to the theory or practice of electrical contacts, or for work in related technologies which is directly applicable to contacts. In considering a person's work and selecting a recipient preference will be given for: a.) Nominees that have made contributions to the technology over many years, b.) the originality and scientific importance of contributions, and c.) achievements that have found a high degree of practice. Provided worthy candidates are found, the Award will be granted annually.

Eligibility: Any person may be nominated for this award regardless of IEEE membership. Members of IEEE Holm Awards Committee are not eligible to be considered for the award while serving on this committee. Nominations are not accepted for persons deceased. Candidates must have made contributions to the electrical contact field for a period spanning at least ten years.

Nominator Eligibility: Any person may nominate a candidate for this award, with the following exception: members of the award committee.

Nomination Support Materials

Endorsers: At least two letters of endorsement are required. One is from the nominator and the others are from the endorsers selected by the nominator. Endorsers should be in a position to substantiate the candidate's contributions by providing explicit detail from personal knowledge. The nominator is responsible for submission of the letters of endorsement.

Candidate Personal Data/Education/Work: "Name", provide complete name of candidate, not initials. "Personal", provide date of birth, and citizenship. "Education", list year and exact degree of institute. "Society Membership", list various professional society affiliations. Under society activities list officers and major committee work. "Professional History", list present occupation followed by previous career experiences. Indicate positions held, years, and briefly explain each responsibility.

Technical Accomplishments: "Technical Publications", such as books, papers, reports, and standards are to be listed in chronological order giving author's names, title, book, journal, or proceedings. "Patents", should be listed by date, number,

title, and country of origin. Documentation authentication “Development of Products or processes”, may be listed for items not covered by patents. “Technical Presentations”, such as keynote addresses or courses developed by the candidate should also be listed.

Significant Contributions: Describe the candidate’s outstanding contributions in terms of specific items. Provide a short paragraph to each one including a general description of the item, the degree of originality and creativity, and importance of the work to the electrical contact field and the time period over which the contribution was made. Also, state cases of examples of practices which were developed or modified through contributions of the candidate.

Forward Nominations To: IEEE Holm Nominations Committee, c/o IEEE Holm Conference Planner, 445 Hoes Lane, Piscataway, NJ 08854 USA

2025 Nominations Deadline: 1 February 2025

The Armington Recognition Award

The Armington Recognition Award was established in honor of Dr. Ralph Armington, who organized the first Holm Seminar on Electrical Contacts in 1953 and established the framework that sustains the conference which is now known as the IEEE Holm Conference on Electrical Contacts. The Armington Recognition Award is presented to individuals who have made significant contributions for sustaining the quality of the IEEE Holm Conference. This includes service on the technical, prize paper, operating, awards, and steering committees.

Forward Nominations To: IEEE Holm Nominations Committee, c/o IEEE Holm Conference Planner, 445 Hoes Lane, Piscataway, NJ 08854 USA

2025 Nominations Deadline: 1 February 2025

Holm 2025

The 70th IEEE Holm Conference on Electrical Contacts

The 70th IEEE Holm Conference on Electrical Contacts will be held from October 15th - 22nd, 2025 at the Hilton Palacio del Rio, San Antonio, TX, USA.

IEEE uploads the Holm Conference Proceedings to all relevant databases including the Engineering Index. Prospective authors should submit a brief abstract (200 words maximum) online before February 14, 2025. For abstract submissions and the latest information regarding the conference, please visit the Holm Conference Website at:

www.ieee-holm.org

IMPORTANT DATES

February 14, 2025	Abstract Deadline
February 28, 2025	Notification of Acceptance
May 9, 2025	Completed Paper Deadline
October 15, 2025	Conference Begins

The 4-day **Intensive Course on Electrical Contacts** is not held at the 2024 conference and will be held next at the 2025 Holm Conference in San Antonio. The course covers all aspects of Electrical Contacts, including:

- Contact fundamentals and materials
- Friction, wear, fretting and lubrication
- Electric arc fundamentals and dynamics
- Power and electronic connector technologies
- Guidelines for electrical and electronic connector design

CORRESPONDENCE ADDRESS

IEEE Meeting & Conference
Management 65th IEEE Holm
Conference (2019)
445 Hoes Lane
Piscataway, NJ 08854
tel: +1 800 810 4333 or
fax: +1 732 465 6447
email: holmreg@ieee.org

Morton Antler Lecture

The Morton Antler Lecture is an annual technical presentation given at the IEEE Holm Conference on a topic of special interest to the electrical contact community. The lecture series was established in honor of Dr. Morton Antler, a longtime member of the Holm Steering Committee and participant in the Holm Conference. Dr. Antler was a distinguished scientist and lecturer in the fields of electrical contacts, tribology, corrosion, and electrodeposition.

Recent Advances of Industrial AI For Smart and Resilient Industrial Systems: *technologies, tools, and talents*

Jay Lee

Clark Distinguished Professor &
Director of Industrial AI Center
University of Maryland



Abstract:

Artificial intelligence (AI) is one of the most powerful technologies of our time. AI embodies a field within cognitive science that enables the discovery of numerous intelligent methods for emulating human sensory and cognitive functions. Industrial artificial intelligence (Industrial AI) is a system engineering approach to bring about high value impacts in speed and scale in broad

applications with capabilities to predict and avoid the invisible problems, ultimately creating a worry-free and resilient industrial system.

This presentation will introduce Industrial AI and Large Knowledge Model for industrial systems. First, Industrial AI systematic approach will be introduced. Case studies on lessons learned from diversified industrial systems including semiconductor, electronics manufacturing, EVs, and healthcare/medical systems, etc. will be given. In addition, we will address the promise and perils of industrial AI systems across many domains, including training industrial AI skills through data foundry for high performance and real-time data analytics in future talents will be discussed.

Dr. Jay Lee is Clark Distinguished Professor in the Mechanical Engineering of the Univ. of Maryland College Park. He is also the founding director of Industrial AI Center (www.iaicenter.com). Previously, he served as Ohio Eminent Scholar, L.W. Scott Alter Chair, and Univ. Distinguished Professor at Univ. of Cincinnati, and was the founding director of National Science Foundation (NSF) Industry/University Cooperative Research Center (I/UCRC) on Intelligent Maintenance Systems (www.imscenter.net) in partnership with over 100 global company members.

Erle Shobert Prize Paper

The Holm Conference Prize Paper Award was established in 1970. At that time, the Conference Steering Committee recognized that at each Conference there was at least one paper that stood out from the others in its technical content and quality of presentation. Therefore, the Prize Paper Award Committee was established. The Committee's purpose is to review each paper, listen to each presentation and then judge which paper should receive the Prize Paper Award. The award is presented to the authors of the Prize Paper at the following year's Holm Conference.

2024 IEEE Erle Shobert Prize Paper Award

System level and Multiphysics approaches to simulate low voltage circuit breaker interruption

Pierantonio Arrighetti, ABB S.p.A, Italy;
Pierre Corfdir, ABB Switzerland Ltd, Switzerland;
Teodora Ilic, Hitachi Energy Switzerland Ag;
www.doi.org/10.1109/HOLM56075.2023.10352272

Paul and Dee Dee Slade Young Investigator Award

The Paul and Dee Dee Slade Young Investigator Award was established in 2011 with the objective to recognize outstanding achievement of young investigators in the field of Electrical Contacts and to encourage young scientists and engineers to enter this field. To be eligible for the Award, the candidate must be under the age of 35 as of the closing date of the conference, and present a paper at the conference in which she/he is either the sole author or the first author of a multi-author paper. The award is presented at the conference awards luncheon and will be prominently mentioned in the proceedings of the following conference.

2023 Paul and Dee Dee Slade Young Investigator Award

Marcel Mainka
for

M. Mainka and T. Wielsch, "Polymers in industrial LVDC power systems - aging and polymer-metal interaction effects," *2023 IEEE 68th Holm Conference on Electrical Contacts (HOLM)*, Seattle, WA, USA, 2023, pp. 1-8.
www.doi.org/10.1109/HOLM56075.2023.10352282

**Sponsors of The 32nd International
Conference on Electrical Contacts
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Technical Program

MONDAY, 7 October 2024

8:00AM – 8:10AM

INTRODUCTION AND OPENING REMARKS

ROBERT JACKSON, 2024 ICEC/Holm Conference Chair

8:10AM – 10:10AM

YOUNG INVESTIGATOR SESSION

CHAIR: DIEGO GONZALEZ

CO-CHAIR: PAT LEES

- 1.1 **Encapsulation Insulation Failure Mechanisms of IGBT Power Module in Circuit Breakers**
Boya Zhang, Kaixuan Li, and Xingwen Li, Xi'an Jiaotong University
- 1.2 **Experimental investigation of the influence of different magnetic field alignments on the DC arc**
Maximilian Schima, Matthias Glock, Frank Berger
Technische Universität Ilmenau
- 1.3 **An analytical model for the total contact resistance of cross-contacted stranded conductors**
Robert Scherr, Marcel Mainka, Thomas Wielsch
Weidmuller Group
- 1.4 **Impact of different surface finishes on the serviceability of bolted connections after high temperature exposure**
Marcella Oberst, Marjorie Myers, Isabell Buresch, and Frank Ostendorf, TE Connectivity
- 1.5 **Re-thinking Cu-Cr electrical contacts microstructure: from manufacturing to properties**
Lucas Varoto^{1,2}, Sophie Roure¹, Anthony Papillon¹
¹Schneider Electric Industries, ²Univ. Grenoble Alpes
- 1.6 **An Experimental Study of the Influence of a Uniform External Magnetic Field on Electric Arcs in Low Voltage dc Switching**
Mingli Yan, Suleiman M. Sharkh, John W. McBride
University of Southampton

10:10AM – 10:25AM

BREAK

10:25AM – 11:25AM

HOLM AWARD

CHAIR: BOB MALUCCI

CO-CHAIR: ROB JACKSON

Understanding Sn Whisker Growth Mechanisms and Influencing Factors

George Flowers

11:25AM – 11:40AM

BREAK

11:40AM – 12:40PM

CONNECTORS I

CHAIR: TIMO MUTZEL

CO-CHAIR: JIAN SONG

2.1 Experimental and model-based investigation on the design of compression connections for stranded aluminum conductors on their electrical-thermal operating behaviour

Markus Gödicke¹, Christian Hildmann¹, Stephan Schlegel¹, Rouyu Xu², ¹IEHH TU Dresden, ²GEIRI Europe GmbH

2.2 Impact of Fuzz Button Degradation on Mechanical and Electrical Characteristics

Wenjia Wang¹, George T. Flowers², Jinchun Gao¹, Chaoyi Wang¹, ¹Beijing University of Posts and Telecommunications, ²Auburn University

2.3 Design, construction and laser contacting of a bus bar for electrically and mechanically stable coil connection for use in power-dense, flat wired stators

Alexander Vogel¹, Marcel Baader¹, Felix Wirthmann¹, Alexander Kuehl¹, Joerg Franke¹, Florian Kassel², ¹University Erlangen-Nuremberg, ²SciMo – Elektrische Hochleistungsantriebe GmbH

12:40PM – 2:10PM

Lunch (on your own)

YOUNG INVESTIGATOR POSTER SESSION

(FOR JUDGES & CANDIDATES ONLY)

2:10PM – 3:10PM

MATERIALS

CHAIR: WERNER JOHLER

CO-CHAIR: AVINASH RAJ KOLA

3.1 Material characterization of contact springs for finite element analysis

Kartik Thakur and Peter Dirk Jaeger, TE Connectivity Nederland B.V.

3.2 Influence of long term thermal and mechanical loads on the Young's modulus of Cu-alloys – determination of stress relaxation in electrical connectors

Karolin Bunting, Abhay Shukla, Jian Song, Ostwestfalen-Lippe University of Applied Sciences and Arts

3.3 Carbon Nanotube Reinforced Silver-Copper Hybrid Metal Matrix Composites as Bimetallic Electrodes

Bruno Alderete¹, Léane Chastagner¹, Frank Mücklich^{1,2}, Sebastian Suarez^{1,3}

¹Saarland University, ²SurFunction GmbH, ³Materials Engineering Center Saarland (MECS)

3:10PM – 3:25AM

BREAK

3:25PM – 4:25PM

ARC CONTACTS

CHAIR: GUANG YANG

CO-CHAIR: Z. K. CHEN

4.1 Mobility of arc roots on copper and steel surfaces at low DC currents

Pierre Corfdir, Jarmo Kalilainen, Patrick Sütterlin, and Martin Gouron, ABB Switzerland Ltd

4.2 Contact resistance behavior of silver-based contact materials under short break arc conditions of a hybrid switch

Timo Mützel and Havva Cinaroglu, DODUCO Contacts and Refining GmbH

4.3 Break arc duration characteristics and arc behavior observations of AgSnO₂ contacts in an inductive load circuit up to DC20V

Reo Oikawa, Yuya Asari and Makoto Hasegawa, Chitose Institute of Science and Technology

4:25PM – 4:40PM

BREAK

4:40PM – 6:00PM

RELIABILITY

CHAIR: PAUL SLADE

CO-CHAIR: GEORGE FLOWERS

5.1 Investigation of Gas-Tightness of Bimetallic Busbar Joints by Utilizing Percolation Theory

Moritz Ullrich, Christian Hildmann, Stephan Schlegel
Components of Intelligent Energy Networks, TU Dresden

5.2 Vibration of wire-connector systems and its influence on micro motion of electrical contacts

Roman Probst, Jian Song, Ostwestfalen-Lippe
University of Applied Sciences and Arts

5.3 Electrochemical Models for Connector Degradation

David M. Williams, Matthew Jimkoski, Mary Williams,
Nexteer Automotive

5.4 Ultrasonic Welding of Al Busbars to Cu Contacts: The Role of Laser Structuring and Connection Reliability in Meeting IEC 60352-9 Standards

Christian Gregor, R&D Connectors Schaltbau GmbH

8:00AM – 9:00AM

ARC SIMULATIONS

CHAIR: GEORGE FLOWERS

CO-CHAIR: Z. K. CHEN

6.1 Three-Dimensional Arc MHD Simulation of MCB Considering Electrodes and Splitter Plates ablation

Qing Zhang¹, Weidong Cao¹, Chaojie Luo¹, Xingwen Li¹, Jianning Yin², Jindong Huo³, ¹Xi'an Jiaotong University, ²Xi'an University of Technology, ³University of Connecticut

6.2 Influence of Radiation Modelling on the Simulation of Wall Stabilized Electrical Arc.

F. Ouchar^{1,2}, C. Van de Steen², Ph. Riviere¹, T. Lebey², A. Soufiani¹, ¹CentraleSupélec, Paris-Saclay University, France, ²Safran Tech, Safran Group

6.3 Multiphysics arc simulation of a miniature circuit breaker for prediction of short circuit interruption performance

Rakesh B. Chechare¹, Christian Ruempler², Salah A. Sabri¹, Saurabh J. Barot¹ and Avadhoot Kittur¹
¹Eaton India Innovation Center, ²Eaton Industries GmbH

9:00AM – 9:15AM

BREAK

9:15AM – 10:15AM

MORTON ANTLER LECTURE

Recent Advances of Industrial AI For Smart and Resilient Industrial Systems: *technologies, tools, and talents*

Jay Lee, University of Maryland

10:15AM – 10:30AM

BREAK

10:30AM – 11:50AM

FRETTING, SLIDING & LUBRICATION I

CHAIR: SOPHIE NOEL

CO-CHAIR: JOHN MCBRIDE

- 7.1 A Phenomenological Approach to Fretting Corrosion**
Roland S. Timsit, Timron Advanced Connector Technologies
- 7.2 Influence of Ionic Liquids as Lubricant Additives on Electrically-Induced Bearing Damage**
Sudip Saha¹, Jack Janik¹, German Mills¹, Jun Qu², Robert L. Jackson¹
¹Auburn University, ²Oak Ridge National Laboratory
- 7.3 Accelerated lifetime testing of the tribo-electrical properties of a lubricated tin contact system**
Marcel Mainka, Thomas Wielsch, Weidmüller Group
- 7.4 Impact of Nickel Interlayers on the Durability of Precious Metal Sliding Contact Systems: A Comparative Study**
Jochen Schuster, Dennis Seibert, Heraeus Precious Metals GmbH & Co. KG

11:50AM – 1:30PM

Lunch (on your own)

1:30PM – 2:30PM

ARC INTERRUPTION I

CHAIR: WERNER JOHLER

CO-CHAIR: DIEGO GONZALEZ

- 8.1 From pressure measurements in external cabinet to pressure inside to arc chamber**
Pierantonio Arrighetti¹, Pierre Corfdir², Teodora Ilic¹, and Gianpietro Ghiroldi³, ¹ABB S.p.A. Via Pescaria 5, ²ABB Switzerland Ltd, ³Politecnico di Milano
- 8.2 Hot plasma decay and electrical breakdown in a miniature relay during hybrid switching operation**
Miroslav Horky¹, Stanislav Kadlec¹, Sandy O. Jimenez², ¹Eaton European Innovation Center, ²Eaton PA, USA
- 8.3 Analysis of DC arc characteristics in an advanced measurement setup**
Simon Mayr, Daniel Huber, Manuel Gradauer, Reinhold Fink, Christian Krell, Reimar Pfeil, Fronius International GmbH

2:30PM – 2:45PM

BREAK

2:45PM – 4:05PM

CONTACT AND SWITCH DESIGN I

CHAIR: JOHN MCBRIDE

CO-CHAIR: TUSHAR DAMLE

9.1 Temperature rise and wear of metallized carbon contact strips under electric current of up to 1000A

Yoshitaka Kubota and Fumiko Morimoto,
Frictional Materials Laboratory Railway Technical
Research Institute

9.2 Mathematical model of the dynamics of closure of electrical contacts in vacuum

S.N. Kharin, T. Nauryz, Institute of Mathematics and
Mathematical Modeling, Kazakhstan

9.3 Variational Quantum Neural Network for modeling and solving Heat and Mass transfer problems occurring in Electric Contact Phenomena

Merey M. Sarsengeldin¹, Zeeshan Ahmad², Ulas
Bagci³, ¹University of Central Florida, ²Sigma
Labs, LLC, ³Northwestern University

9.4 Mathematical modeling of hybrid switching devices for investigation of different function principles

Arno Bernhardt, Frank Berger,
Electrical Switchgear, Components and Systems
Engineering Group Technische Universität Ilmenau

4:05PM – 5:00PM

TC1 MEETING

CHAIR: GERALD WITTER

5:00PM – 7:00PM

INTERNATIONAL ADVISORY COMMITTEE MEETING

7:00PM – 10:00PM

**INTERNATIONAL ADVISORY DINNER
(BOARD MEMBERS INVITED ONLY)**

The Chop Tank

8:00AM – 9:00AM

ARC FAULT DETECTION I

CHAIR: DIEGO GONZALEZ

CO-CHAIR: GUANG YANG

10.1 Adaptive detection method for arc faults in low voltage power supply systems

Silei Chen¹, Yutian Liu¹, Jiahao Mi¹, Zhou Ruixing Wang¹, Ping Gao², Xingwen Li³, ¹Xi'an University of Technology, ²Zhejiang Tengen Electric Co. Ltd., ³Xi'an Jiaotong University

10.2 A Comprehensive Analysis of Electromagnetic Characteristics for DC Arc Fault Detection

Yu Meng¹, Haowen Yang¹, Silei Chen², Khizar Hayat¹, Xingwen Li¹, ¹Xi'an Jiaotong University, ²Xi'an University of Technology

10.3 Research on Multi-load Arc Fault Detection Based on Dual-tree Complex Wavelet Transform

Zhengyuan Fei¹, Yu Meng¹, Qiyun Cheng², Qian Wang³, Xingwen Li¹, ¹Xi'an Jiaotong University, ²Guangdong Power Grid Co. Ltd., ³Xi'an University of Technology

9:00AM – 9:15AM

BREAK

9:15AM – 10:35AM

DC SWITCHING

CHAIR: ROD MARTENS

CO-CHAIR: TUSHAR DAMLE

11.1 Experimental verification of a bidirectional Hybrid DC Breaker Setup up to 800V and 500A with copper contacts in Hydrogen environment and transversal magnetic field in combination with an IGBT-Module

Dieter Volm¹, Maximilian Kraus¹, Matthias Streck², Bernhard Fauth¹, Frank Nothnagel², Daniel Bastl¹
¹Panasonic Industry Europe GmbH, ²Technische Universität Ilmenau

11.2 The RUL prediction model for high-power DC contactors based on BiLSTM

Hangyu Ma¹, Huimin Liang¹, Yu Wang¹, Fubiao Luo², Yujie Tang², Yushou Zhao², ¹Harbin Institute of Technology, ²GA Technologies Co. Ltd.

11.3 Identification of Key Mechanism Behind Arc Re-ignition in LC Commutator-Based DC Circuit Breakers

Jing Nan, George Chen, Igor O. Golosnoy, University of Southampton

11.4 A Study on Switching Performance associated with Structure of Quenching Chamber in DC 1500V Air Circuit Breakers

Dongkyu Shin, Yongsu Kim, Dongwook Kim, HD Hyundai Electric

10:35AM – 11:50AM
BREAK

11:50AM – 12:10PM
FRETTING, SLIDING & LUBRICATION II
CHAIR: MARCEL MAINKA
CO-CHAIR: TIMO MUTZEL

12.1 Rolling Element Damage and the Influence of Test Conditions and Conductive Nanoparticle Grease Additives

Jack R. Janik, Sudip Saha, Robert L. Jackson, German Mills, Auburn University

12.2 Durability of connector contact pairs based on the analysis of the friction and wear mechanisms occurring in the interface

S. Noël¹, A. Brézard Oudot¹, Thierry Leblanc¹, A. Fares Karam², D. Comte², J. Toran³, ¹Université Paris-Saclay, ²Amphenol CS Besançon, ³Amphenol CS, Etters,

12.3 Wear and corrosion of electrical connectors caused by mechanical operations in high temperature environment

Yicheng Han, Yuan Meng, Chao Zhang, Wanbin Ren, Harbin Institute of Technology

12.4 A Semi-Analytical Transient Model of Elasto-Hydrodynamic Mixed Lubrication Bearings under Electrical Loads

Robert L. Jackson, Jack R. Janik, and Sudip Saha, Auburn University

12:10PM – 1:30PM
Lunch (on your own)

1:30PM – 2:30PM
CONNECTORS II
CHAIR: MAGNE E RUNDE
CO-CHAIR: ROD MARTENS

13.1 Assessment of press-fit zones with diverse platings to study their respective strengths

Akshata Sangle¹, Stefan Goetz¹, Christian Horwath², Florian Bruhn², ¹RPTU Kaiserslautern-Landau, ²Iwis smart connect GmbH

13.2 Consideration of Voltage Drop in Power Contacts

RD Malucci, RD Malucci Consulting

13.3 Vibration analysis for flexible beam structures with cantilever-Hertzian contact boundary conditions

Yinnan Zhang, Wanbin Ren, Chao Zhang, Yuan Meng Harbin Institute of Technology

2:30PM – 2:45PM
BREAK

2:45PM – 3:45 PM

ARC INTERRUPTION II

CHAIR: BRETT RICKET

CO-CHAIR: MAKOTO HASEGAWA

14.1 Analysis of Breakdown Mechanisms in Heated Short Air Gaps During Contact Opening in Compact DC Circuit Breakers

Jing Nan, George Chen, Igor O. Golosnoy,
University of Southampton

14.2 Post Arc Conductance Determination of a Spark Gap for DC Protection by UV Spectroscopy

Ralf Methling¹, Diego Gonzalez¹, Sergey Gortschakow¹, Sebastian Schmausser², Marco Kellermann², Arnd Ehrhardt², ¹Leibniz Institute for Plasma Science and Technology (INP),
²DEHN SE

14.3 An equivalent heat source calculation model for HSER under overload conditions based on transient arcing process

Li Bo¹, Liang Huimin¹, Shi Libing², Zhu Yuelin¹, Wang Aobo¹ and You Jiaxin¹, ¹Harbin Institute of

3:45PM – 4:00PM

BREAK

4:00PM – 5:00 PM

MEMS

CHAIR: AVINASH RAJ KOLA

CO-CHAIR: WERNER JOHLER

15.1 The Influence of Opening Velocity Profile on the Duration of Molten Metal Bridge for Gold Coated Contacts in a Low Power (<100mW) MEMS Contact Testing Platform

T.G. Bull¹, J.W.McBride¹ & Y.Yang², ¹University of Southampton, ²TaiCaan Technologies Ltd

15.2 Absence of electrical contact resistance degradation in a MEMS relay subject to hot switching

Deepak Kuma and Maarten P. de Boer
Carnegie Mellon University

15.3 Friction and Wear Behavior of Polymer-Gold Contact Pairs in a Micromechanical Switching Element Under Fretting Load

Soma Roy and Michael H. Azarian
Center for Advanced Life Cycle Engineering (CALCE), University of Maryland

6:00PM – 9:00PM

Conference Banquet

Carrol's Creek Cafe

THURSDAY, 10 October 2024

8:00AM – 9:00AM

ARC FAULT DETECTION II

CHAIR: TUSHAR DAMLE

CO-CHAIR: MAKOTO HASEGAWA

16.1 On the problematic of serial arc fault detection in aircraft under the presence of switching devices

Raul Carreira Rufato^{1,2,3,4,5}, Malyk Benmouffok⁶, Cyril Van de Steen¹, Thierry Ditchi^{2,3,4,5}, Thierry Lebey¹, Yacine Oussar^{2,3,4,5}

¹Safran Tech/Safran Group, ²LPEM, ³ESPCI Paris – PSL, ⁴CNRS, ⁵Sorbonne Université, ⁶IRT Saint Exupery

16.2 Multi-criteria analysis of series arc faults in a low-voltage electrical network

Patrick Schweitzer, Abdel Maoukouf, Etienne Tisserand, Yves Berviller, Serge Weber
University of Lorraine, CNRS, Institut Jean Lamour (IJL)

16.3 Efficient and Lightweight Convolutional Neural Network-based Series DC Arc Fault Protection for PV Systems

Kamal Chandra Paul¹, Jiale Zhou¹, Shen-En Chen¹, Chen Chen², Tiefu Zhao¹, ¹University of North Carolina at Charlotte, ²University of Central Florida

9:00AM – 9:15AM

BREAK

9:15AM – 10:35AM

SYSTEM CONSIDERATIONS

CHAIR: PAT LEES

CO-CHAIR: BRETT RICKET

17.1 Electric-thermal stresses in three-phase loaded plug-in connectors considering an uneven contact resistance distribution

Michelle Pomsel¹, Christian Hildmann¹, Stephan Schlegel¹, Tom Kufner², Toni Israel²,

¹Intelligent Energy Networks TU Dresden Science and Technology, ²Stäubli Electrical Connectors

17.2 Research on residual current location method based on BP neural network optimized by genetic algorithm

Jiaxin Liu¹, Silei Chen², Jing Wang³, Xingwen Li¹

¹Xi'an Jiaotong University, ²Xi'an University of Technology, ³Shenzhen Power Supply Bureau Co. Ltd

17.3 Determine the backup protection value of low voltage switchgear by computational calculation of the limit load

Armin Strahl¹, Michael Anheuser¹, Frank Berger², Lisa Malterer¹, Sebastian Vogl¹, ¹Siemens AG, ²Technical University Ilmenau

17.4 Damage to photovoltaic DC connectors due to improper disconnection at high voltages and low currents

Toni Israel¹, Julian Angel Czajor¹, Tom Kufner¹, Matthias Schuerch¹, Dominic Buergi¹, Joachim Hirmke¹, Christof Bucher², Matthias Burri², Sina Spring², ¹Stäubli Electrical Connectors AG, ²Bern University of Applied Sciences

**10:35AM –10:50AM
BREAK**

**10:50AM – 12:10PM
CONTACT AND SWITCH DESIGN II**

CHAIR: TIMO MUTZEL

CO-CHAIR: PAT LEES

18.1 Deep reinforcement learning based optimization algorithm for electromagnetic relays

Han Yingzhu, Liang Huimin , Wei Zitong, Zhai Guofu, Harbin Institute of Technology

18.2 Influence of manufacturer and orientation on weld behavior of AgC

Christoph Kenel, Jean-Marc Oppliger, Cornelia Lang, Markus Hoidis, ABB Switzerland AG

18.3 Research on Assessment Method of Pick-up Voltage Qualification Rate for Batch Balanced Force Relays Considering Permanent Magnet Degradation

Yufei Qiao¹, Guofu Zhai¹, Leyu Chen¹, Jie Zhang², Qifeng Wang², Xiaochen Wang³

¹Harbin Institute of Technology, ²Guizhou Space Appliance Co. Ltd, ³University of California, Davis

18.4 Magnetron discharge characteristics for fixed shield and floating shield vacuum interrupters

Tushar Damle, Rami Jaber, Erik Taylor, Kip Benson, S&C Electric

**12:10PM
CLOSING REMARKS**

ROBERT JACKSON, 2024 ICEC/Holm Conference Chair

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