

# Final Program

## **52ND IEEE HOLM CONFERENCE ON ELECTRICAL CONTACTS 2006 25-27 SEPTEMBER 2006**

*ALONG WITH THE*  
**INTENSIVE COURSE ON  
ELECTRICAL CONTACTS  
28-30 SEPTEMBER 2006**



Delta Centre-Ville  
Montreal, Canada



**IEEE**



Sponsored By:  
The Components, Packaging, and  
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## **Purpose**

To provide a forum for the presentation and discussion of the latest developments in the field of electric 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 2006 IEEE Holm Conference will include excellent papers authored by some of the outstanding technical people in this field. The international contributors come from the USA, Austria, Belgium, Canada, China, Finland, France, Germany, Greece, Hong Kong, Italy, Japan, Korea, Netherlands, Norway, Poland, Switzerland, and United Kingdom. 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.

Additionally, the 2006 IEEE Holm Conference will make it possible for any attendee to discuss personally, with any author, either additional details concerning the work presented by the author at the conference or any subject related to the author's field of expertise.

## **Background**

The Holm Conference began in 1953 as a forum for the discussion of electrical contact phenomena and related fields. In 1968, the conference was named the Holm Conference in honor of Dr. Ragnar Holm. Dr. Holm, whose contributions to the field of electrical contacts spanned 50 years and forms the foundation of the electrical contacts field, 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 one week course on contacts and participates in the biannual International Conference on Electrical Contacts.

# **Intensive Electrical Course on Contacts**

28 - 30 September 2006

Delta Centre-Ville  
Montreal, Canada

**Dr. P.G. Slade,  
Course Director, Arcing & Power Contacts**

**Dr. R.S. Timsit,  
Contact Fundamentals & Connectors**

The 2006 Intensive Course has been completed revised to reflect recent needs in understanding very low contact force phenomena and the effects of high frequency currents. While doing this, the Course still covers the broad range of electrical contact situations, which are listed below:

- Making contact and surface finish effects
- Making connections and connector design [low and high current]
- Switching contacts ac and dc design considerations [low and high current]
- Contact materials for connectors and for switching contacts
- Contact finishes
- Contact failure mechanisms and how to analyse them
- Corrosion and the effects of ambient environments

The Course includes class problem-solving exercises so that participants will learn how the Course material can be applied. A participant in this Course will thus leave the sessions with a thorough and broad knowledge of the subject. Our teaching approach will allow practicing engineers to use detailed knowledge of contact technology to resolve their own practical design problems.

# COURSE AGENDA

## Day 1

### Morning

- Contact Fundamentals

### Afternoon

- The Electric Arc

### Evening

- Q & A Session

## Day 2

### Morning

- Contact Materials for Arcing Contacts
- Non Arcing Power and Non-Permanent Power Connectors
- Electronic Connectors and Metallic Coatings

### Afternoon

- Switching Contact Guidelines
- Connector Design Guidelines

### Evening

- Q & A Session

## Day 3

### Morning

- Introduction to Tarnishing and Corrosion
- Experimental Evaluation of Corrosion

### Afternoon

- Experimental Evaluation of Corrosion (continued)
- Corrosion and Power Arcing Contacts and Connectors

## Registration

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

<b>CONFERENCE</b>	<b>Prior To 8/12/2006</b>	<b>After 8/12/2006</b>
IEEE Member	\$600	\$650
Non-Member	\$650	\$700
Student	\$250	\$300
Extra Proceedings	\$70	\$70
Monday Social	\$100	\$100

### **INTENSIVE COURSE ONLY**

IEEE Member	\$1100	\$1300
Non-Member	\$1150	\$1350

### **INTENSIVE COURSE w/Full Conference Registration**

IEEE Member	\$950	\$1150
Non-Member	\$1000	\$1200

### **INTENSIVE COURSE – ONLY – with 3 or more from the same organization**

IEEE Member	\$1025	\$1225
Non-Member	\$1075	\$1275

### **REGISTRATION HOURS**

Sunday, 24 September	4:00 p.m. – 6:00 p.m.
Monday, 25 September	7:30 a.m. – 5:00 p.m.
Tuesday, 26 September	8:00 a.m. – 5:00 p.m.
Wednesday, 27 September	8:00 a.m. – 11:00 a.m.

**Registration can be completed online:  
[www.ewh.ieee.org/soc/cpmt/tc1](http://www.ewh.ieee.org/soc/cpmt/tc1)**

Registration payments: Checks are to be made out to the IEEE HOLM in U.S. funds. Visa, MasterCard and American Express. Please mail your payment along with the enclosed registration form to:

**IEEE Holm Conference**  
IEEE Conference Management Services  
445 Hoes Lane  
Piscataway, NJ 08854  
Or fax to +1 732 465 6447

For additional information please contact Holm Registrar, at +1 732 562 5337, via fax to +1 732 465 6447, or email: [c.colobaugh@ieee.org](mailto:c.colobaugh@ieee.org)

## Hotel

The conference this year meets in Montreal, Quebec, Canada at the Delta Centre-Ville Montreal where meeting facilities are well suited to the Conference Sessions and other activities. The hotel is offering special rates of \$194.00 Canadian dollars single/double occupancy to conference attendees. Rates are subject to applicable City, Provincial Hotel Room and Federal Goods & Services Taxes: approximately 16%. To make a reservation please call the Delta Centre-Ville at +1 800 268 1133 or directly to the hotel at +514 879 1370 and identify yourself as part of the IEEE Holm Conference in order to receive the special group rate. The special rate is valid until August 25, 2006, reservations received after this date are subject to space and availability.

Check in time: 3:00 p.m.      Check out time: 12:00 p.m.

The Delta Centre-Ville Montreal  
777 University Street  
Montreal, Quebec, Canada H3C 3Z6  
1-800-268-1133 or 514-879-1370

## Travel Arrangements

Please contact the IEEE Travel Services Department at 1 800 TRY IEEE ( 1 800 879 4333) or 1 732 562 5387 if calling from outside the US to obtain negotiated airfares on Continental, United Airlines and American Airlines.

## Transportation From Airports

### **Taxis:**

Travel between Trudeau International Airport (Dorval) and downtown is easy – by taxi, limousine service or airport shuttle. Please refer to [http://www.autobus.qc.ca/anglais/aeroportuaire\\_an.html](http://www.autobus.qc.ca/anglais/aeroportuaire_an.html) for additional information. Average taxi fare is \$35 from the airport.

### **Driving:**

If you are arriving by your own transportation and you wish to park at the Delta Centre-Ville Montreal Hotel parking at \$20/day For specific driving directions, consult Mapquest at <http://www.mapquest.com> or call the hotel directly at +514 879 1370.



## Social Events

### **Le Bateau-Mouche** **Monday, September 25, 2006** **7:00 PM**

Enjoy a relaxing and elegant gourmet dinner-cruise along the St. Lawrence River aboard Le Bateau-Mouche. This glass-enclosed cruising vessel, constructed in the style of the classic Parisian river boat, affords sweeping panoramic views of the city of Montreal while serving a superb 5-course meal. For a truly unique dining experience, Le Bateau-Mouche provides passengers with a memorable and magical evening under the stars. The cruise departs from the Jacques-Cartier Pier in the Old Port of Montreal at 7pm.



# IEEE 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 and Nomination Committee are not eligible to be considered for the award while serving on these committees. 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 Administrator, 445 Hoes Lane, Piscataway, NJ 08854 USA

**Nominations Deadline:** November 15, 2006

The 53rd IEEE Holm Conference on Electrical Contacts will be held 17 – 19 September 2007 at the Sheraton Station Square Hotel, Pittsburgh, PA

Prospective authors should submit a brief abstract (200 words maximum) online before December 8, 2006. Authors will be notified concerning acceptance of abstracts in mid-February 2007. Please include complete contact information for all correspondence to be sent.

**Abstracts are to be submitted through the IEEE  
Conference eXpress website:  
<http://www.ieee.org/conferencepublishing>  
Enter Conference ID – holm07  
(please use lower case)**

#### **Important Dates**

December 8, 2006	Abstract Deadline
February 15, 2007	Notification of Acceptance
April 17, 2007	Completed Paper Deadline
September 17, 2007	Conference Begins

#### **Correspondence Address**

IEEE Conference Management Services  
IEEE Holm Conference (2007)  
445 Hoes Lane  
Piscataway, NJ 08854  
tel: +1 800 810 4333 or +1 732 981 3428  
fax: +1 732 465 4667  
email: [e.cabrera@ieee.org](mailto:e.cabrera@ieee.org)

**Holm Web site:  
[www.ewh.ieee.org/soc/cpmt/tc1/](http://www.ewh.ieee.org/soc/cpmt/tc1/)**

# Morton Antler Lecture

The Morton Antler Lecture is an annual lecture given at the IEEE Holm Conference on a topic of special interest to the electrical contact community. This lecture series was established in honor of Dr. Morton Antler, a long time 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.

## 2006 Morton Antler Lecture

### The Design Challenges Involved in Miniturization of Electromechanical Relay

Werner Johler, Senior Member IEEE  
Tyco Electronics Logistics AG – Werk AXICOM Au  
Seestr. 295  
CH 8804 Au – Waedenswil, Switzerland  
werner.johler@tycoelectronics.com



**WERNER JOHLER** Werner Johler received his Ph.D. degree in electrical engineering from the Technical University of Vienna, Austria in 1988 and his MBA in 2003.

From 1984 to 1988 he was a scientific staff member at the Institute of Switchgear at the Technical University of Vienna. Since 1988 he has been with Tyco Electronics AXICOM in Au, Switzerland. He is Director for AXICOM relays. He has been Chairman of the Technical Committee TC94 “All or nothing relays” within CENELEC since 1999, member of the Board of Directors of IRSTC (International Relay and Switch Technology Conference) since 2002 (former NARM) and member of the board of the Swiss Information Technology Society since 2003. He received the Scientific Award from the state of Vorarlberg, Austria in 2004 and the Albert Keil Award from VDE in 2005.

He has published more than 60 papers on relay technology, miniaturization of electromechanical devices, contact physics and reliability of electromechanical relays

**The 52nd IEEE Holm  
Conference on Electrical  
Contacts Contributors**

**Gold Level**

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Chugai USA, Inc  
TMI

**Silver Level**

ECL  
Eaton Electrical  
Olin Corporation  
RES-ECCT  
Rockwell Automation  
UMICORE

**Bronze Level**

Brainin Advance Industries, Inc.  
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Hyogo University of Teacher Education	United States Naval Academy
	Xi'an Jiaotong University

# Technical Program

**MONDAY, SEPTEMBER 25, 2006**

**8:00am**

## **INTRODUCTION and OPENING REMARKS**

Henry Czajkowski, 2006 Holm Conference Chair

**8:15am**

## **Holm Award**

### **Developments in Fretting Studies Applied to Electrical Contacts**

John McBride, University of Southampton, Southampton, UK

**9:15am – 9:30am**

## **Break**

**9:30am – 10:45am**

## **Contact Material I**

**Chair:** Robert Malucci

**Co-Chair:** Richard Moore

**1.1 Electrical and Tribological Properties of Tin Plated Copper Alloy for Electrical Contacts in Relation to Intermetallic Growth**

S. Noel, N. Lecaude, Universites de Paris, France and S. Correia, P. Gendre, A. Grosjean, PEM, France

**1.2 Mass Material Transfer of Ag-SnO<sub>2</sub> Contact Material in DC Level**

F. Meng, J. Lu, N. Lu, Y. Zhu, Z. Chen, Q. Huang, Hebei University of Technology, China and Hongfa Electroacoustic Co. Ltd, China

**1.3 A Comparison of Contact Erosion for Opening Velocity Variations for 13 Volt Circuits**

Z. K. Chen and G. Witter, Chugai USA Inc., Waukegan, IL, USA

**1.4 Mechanism of Ultra Low Force Probing on Al Electrodes**

K. Kataoka, Tokyo Electron AT Ltd, Nirasaki, Japan and T. Itoh, T. Suga, University of Tokyo, Japan

**1.5 Accelaration and Suppression Factors for Contact Failure Due to Silicone Contamination**

T. Tamai, Hyogo University, Japan

**10:45am-11:05am**

## **Break**



**11:05am – 12:05pm**

## **Arc Interruption**

**Chair:** Xin Zhou

**Co-Chair:** Henry Czajkowski

- 2.1 Electrical Switching Life of Vacuum Circuit Breaker Interrupters**  
P. G. Slade, R. K. Smith, Eaton Electrical, Horseheads, NY, USA
- 2.2 Investigation on the Properties of CuCr Contact Material after Cryogenic Treatment**  
W. Yongxing, Z. Jiyan, C. Jiyuan, W. Yi and W. Xiumin, Dalian University of Technology, China
- 2.3 Dynamic Simulation of Operating Mechanism for Molded Case Circuit Breaker**  
C. Degui, Xi'an Jiaotong University, China
- 2.4 New Algorithm for Electronic Short-Circuit Detection**  
T. Mutzel, G. Berger, TU Ilmenau, Germany and M. Anheuser, Siemens AG, Amberg, Germany

**12:05pm – 1:35pm**

## **Lunch on Your Own**

**1:35pm – 2:50pm**

## **Reliability/Safety**

**Chair:** Paul Slade

**Co-Chair:** Milenko Braunovich

- 3.1 Glowing Contact Physics**  
J. J. Shea, Eaton Corporation, Pittsburgh, PA, USA
- 3.2 Study on Reliability Test Method of Over-load Relay**  
J. Zhao, J. Lu, H. Wang, G. Liu, Hebei University, Tianjin, China
- 3.3 Electrical Behavior of Flexible Cables with Intermittent Faults**  
K. H. Ip, C. P. Tang, ASM Assembly Automation Ltd., Hong Kong, China
- 3.4 Research on the Failure Diagnostics Parameters and the Reliability Prediction Model of the Electrical Contacts**  
F. Yao, J. Lu., Hebei University of Technology, Tianjin, China and J. Zheng, Z. Huang, Appliances Group Incorporated Company, Zhejiang, China

**3.5 Electrical Contacts Condition Diagnostics Based on Wireless Temperature Monitoring of Energized Equipment**

B. H. Chudnovsky, Schneider Electric, West Chester, OH, USA

**2:50pm – 3:10pm**

**Break**

**3:10pm – 4:25pm**

**Modeling**

**Chair:** John McBride

**Co-Chair:** Chi Leung

**4.1 Numerical Computation of Surface Melting at Imperfect Electrical Contact Between Rough Surfaces**

W. Kim and Q. J. Wang, Northwestern University, Evanston, IL, USA

**4.2 Mechanical Analysis of the Crimping Connection**

S. Ogihara, K. Takata, Y. Hattori, Auto Networks Technologies, Ltd., Suzuka, Japan and K. Yoshida, Sumitomo Electric Industries, Ltd., Osaka, Japan

**4.3 A Coupled-Field Simulation of an Electrical Contact during Resistance Welding**

A. Monnier, CNRS, Gif-Sur-Yvette, France, B. Froidurot, C. Jarrige, Schneider Electric, Grenoble, France, and R. Meyer, P. Teste, CNRS, Gif-Sur-Yvette, France

**4.4 Theoretical and Experimental Determination of Erosion Rate Due to Arcing in Electrical contacts**

M. Abbaoui, A. Lefort, Université Blaise Pascal, Aubiere, France, D. Sallais, and N. Ben Jemaa, University of Rennes, France

**4.5 Thermal Analysis of Hermetically Sealed Electromagnetic Relay in High and Low Temperature condition**

R. Wanbin, H. Liang and G. Zhai, Harbin Institute of Technology, China

**6:30pm**

**Social – Le Bateau-Mouche au Vieux-Port Inc.**

The Bateau-Mouche has its home port at the Jacques-Cartier wharf in Port of Montreal

**TUESDAY, SEPTEMBER 26, 2006**

**8:00am – 9:15am**

**Contact Materials II**

**Chair:** Gerald Witter

**Co-Chair:** Thomas Schoepf

**5.1 Nanoscale Mechanical Properties of Intermetallics in Lead-Free Systems**

M. Braunovic, MB Interface, Montreal, QC, Canada and D. Gagnon, L. Rodrigue, IREQ, Varennes, QC, Canada

**5.2 Contact Resistance Characteristics of High Temperature Superconducting Bulk - Part V**

H. Fujita, K. Fukuda, K. Sawa, Keio University, Japan, M. Tomita, Railway Technical Research Institute, Japan, M. Murakami, Shibaura Institute of Technology, Japan, N. Sakai, I. Hirabayashi, Superconductivity Research Laboratory/ISTEC, Japan

**5.3 Preparation of Ag/SnO<sub>2</sub>+ La<sub>2</sub>O<sub>3</sub>+ Bi<sub>2</sub>O<sub>3</sub> Contact Material**

H. Wang, J. Wang, M. Wen, J. Zhao and G. Liu, Hebei University of Technology, Tianjin, China

**5.4 Microstructure Analysis and the Effect of Cr Additive on Electrical Performance of (C\_P-Nb)/Cu-Cd Electrical Contact Materials**

Y. S. Cui, Y. Wang, W. Z. Shao, L. Zhen, Harbin Institute of Technology, China, and V. V. Ivanov, Krasnoyarsk State University, Russia

**5.5 High Current Erosion of Ag/SnO<sub>2</sub> Contacts and Evaluation of Indium Effects in Oxide Properties**

C. Leung, E. Streicher, D. Fitzgerald and J. Cook, AMI DODUCO, Export, PA, USA

**9:35am – 10:35am**

**Morton Antler Lecture**

**The Design Challenges Involved in Miniaturization of Electromechanical Relays**

Werner Johler, Tyco Electronics AXICOM, Au-Wadenswil, Switzerland

**10:35am – 10:55am**

**Break**

**10:55am – 11:45am**

## **Relays**

**Chair:** Benn Jema Nouredine

**Co-Chair:** William Balme

- 6.1 An Experimental Study on Minimum Arc Current of Relay Contacts and Possible Re-interpretation of the Meaning T hereof**  
M. Hasegawa, Y. Tamaki, Y. Kamada, Chitose Institute of Science and Technology, Hokkaido, Japan
- 6.2 Some Factors That Influence Film Growth on Sealed Relay Contacts**  
Z. Chunyan, H. Junjia, L. Jin, Z. Hanming, Huazhong University of Science and Technology, Wuhan, China, and L. Chengyan, W. Lizhong, G & A Technologies Co., Ltd., Guilin, China
- 6.3 Bouncing of a Reed Switch due to Coulomb's Electrostatic Force**  
N. Wakatsuki, A. Yamamoto, Ishinomaki Senshu University, Japan

**12:00pm – 2:00pm**

## **Awards Luncheon**

### **Ragnar Holm Scientific Achievement Award**

John McBride

### **Dr. Morton Antler Lecture**

Werner Johler

### **2005 IEEE Erle Shobert Prize Paper**

**“Pore Corrosion Model for Gold Plated Copper Contacts”,**

A.C. Sun, H.K. Moffat, D.G. Enos and C. S. Glauner,  
Sandia National Labs, Albuquerque, NM

**2:00pm – 3:00pm**

## **Arc Interruption**

**Chair:** John Shea

**Co-Chair:** Z.K. Chen

- 7.1 The Influence of Bonding Area of Welded Contact Tips on Contact Erosion**  
D. Spath, V. Behrens, M. Finkbeiner, O. Lutz, AMI DODUCO GmbH, Pforzheim, Germany

- 7.2 Determination of Best Closing Phase Angle for AC Contractor Based on Game Theory**  
S. Xiuping, L. Jianguo, G. Bingjun, L. Guojin, L. Wenhua, Hebei University of Technology, Tianjin, China
- 7.3 Study of the Influence of Arc Ignition Position on Arc Motion in Low Voltage Circuit Breaker**  
L. Xingwen, Xi an Jiaotong University, China
- 7.4 Motion of Break Arcs Occurring Between Silver Electrical Contacts in DC 42 Volt Resistive Circuit**  
J. Sekikawa and T. Kubono, Shizuoka University, Hamamatsu, Japan

**3:00pm – 3:20pm**  
**Break**

**3:20pm – 4:35pm**  
**Connectors**

**Chair:** Brett Rickett

**Co-Chair:** Edward Smith

- 8.1 Wave Propagation and High Frequency Signal Transmission across Contact Interfaces**  
R. D. Malucci, RD Malucci Consulting, Naperville, IL, USA and A. P. Panella, Molex Incorporated, Lisle, IL, USA
- 8.2 Bending Test of Contact Materials**  
J. Song, University of Applied Sciences, Lemgo, Germany, Ch. Helmig, J. Feye-Hohmann, Phoenix Contact, Blomberg, Germany and A. Schulz, University of Applied Sciences, Lemgo, Germany
- 8.3 Press-fit Connector for Automobile ECUs**  
Y. Nomura, Y. Saitoh, K. Furukawa, Y. Minami, K. Horiuchi and Y. Hattori, AutoNetorks Technologies, Ltd., Suzuka, Japan
- 8.4 Modelling the Insulation Displacement Process - Results of a Finite-Element Model Study-**  
S. Jorgens, H. Taschke, LumbergConnect GmbH & Co., KG, Schalksmuhle, Germany
- 8.5 Rating Power Connectors using End-of-Life Voltage Drop**  
R. Malucci and F. Ruffino, Molex Inc., Lisle, IL, USA

**4:50pm**  
**TC1 Meeting**

**WEDNESDAY, SEPTEMBER 27, 2006**

**8:00am – 8:45am**

**Sliding Contact**

**Chair:** Steve Cole

**Co-Chair:** George Drew

**9.1 A Study of Metal Fiber Brush Operation on Slip Rings and Commutators**

L. Brown, United States Naval Academy, Annapolis, IL, USA and D. Kuhlmann-Wilsdorf, W. Jesser, University of Virginia, Charlottesville, VA, USA

**9.2 Comparizon of Brush Contact Drop Characterisitics with copper Ring and Steel Ring, Considering Sparks and Collector Ring Hazard**

N. Morita, Nippon Institute of Technology, Japan

**9.3 Characteristics of Carbon Flat Commutator with Condenser for Arc Quenching**

K. Sawa, T. Shigemori, Keio University, Yokohama, Japan

**8:45am – 9:05am**

**Break**

**9:05am – 10:05am**

Applications and Properties of Nanomaterials in Electrical Contacts

Holm Conference Panel Discussion

**PANEL ORGANIZERS:**

Robert D. Malucci, Consultant, Naperville IL

Bretton Rickett, Molex, Inc., Lisle IL

This panel discussion covers the subject of nano-structures and their potential application in electrical contacts. It consists of a series of four short talks provided by experts in the field of nano-technology. The talks briefly cover the areas of **Electrical Contacts at Nano-Scales, Tribological Behavior of Nano-Structures, Electrical and Thermal Behavior of Nano-scale Materials and Chemical Properties of Nanoscale Layers**. Each talk will be followed by a short question period to give the audience a chance to clarify details that were covered in the talk. Subsequently, a 20-minute open discussion will follow the talks to debate the benefit of using nano-scale structures in electrical contacts.

It is intended that the electrical contact community become familiar with this relatively new field and understand how this technology may be applied to improve electrical contacts. In the

tradition of the Holm Conference, the panel discussion goal is to provide an interactive forum for a lively debate on nano-technology and its potential uses in electrical contacts.

## **PANEL MEMBERS:**

**Prof. Mark C. Hersam**, Materials Science and Engineering, Northwestern University

- "Electrical Contacts at the Nanometer Scale"

**Prof. D.Y. Li**, Chemical and Materials Engineering, University of Alberta

- "Tribological Behavior of Nanostructured Materials and Tribological Processes Under Light Loads"

**Prof. Timothy Fischer**, Mechanical Engineering & Birck Nanotechnology Center, Purdue University

- "Nanoscale Carbon Materials For Enhanced Thermal and Electrical Interfaces"

**Prof. W. Robert Ashurst**, Chemical Engineering, Auburn University

- "Passivating Properties of Molecular and Nanoscale Layers"

**10:20am – 11:20am**

## **Fretting**

**Chair:** George Flowers

**Co-Chair:** Robert Malucci

### **10.1 Impact of Corrosion on Fretting Damage of Electrical Contacts**

T. Liskiewicz, A. Neville, University of Leeds, UK and S. Achanta, Katholieke Universiteit Leuven, Belgium

### **10.2 Electrical Contact Behaviour of Power Connector During Fretting Vibration**

N. Ben Jemaa, E. Carvou, University of Rennes 1, France

### **10.3 Factors Influencing the Fretting Corrosion of Tin Plated Contacts**

T. Ito, M. Matsushima, K. Takata and Y. Hattori, AutoNetworks Technologies, Ltd., Suzuka, Japan

### **10.4 On the Relationship between Surface Wear and Intermittency during Fretting in Electrical Contacts**

J. W. McBride, University of Southampton, UK

**11:35am**

## **Closing Remarks**

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