

# **2015 IEEE 61st Holm Conference on Electrical Contacts (Holm 2015)**

**San Diego, California, USA  
11-14 October 2015**



**IEEE Catalog Number: CFP15HLM-POD  
ISBN: 978-1-4673-9342-3**

**Copyright © 2015 by the Institute of Electrical and Electronic Engineers, Inc  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\*This publication is a representation of what appears in the IEEE Digital Libraries. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP15HLM-POD
ISBN (Print-On-Demand):	978-1-4673-9342-3
ISSN:	1062-6808

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

## TABLE OF CONTENTS

<b>Foreword .....</b>	<b>xvi</b>
<b>Morton Antler Lecture .....</b>	<b>xvii</b>
<b>Erle Shobert Prize Paper Award .....</b>	<b>xx</b>
<b>Armington Recognition Award .....</b>	<b>xxiii</b>
<b>Young Investigator Award .....</b>	<b>N/A</b>
<b>Ragnar Holm Scientific Award .....</b>	<b>xxv</b>

**Mathematical Models of Heat and Mass Transfer in Electrical Contacts .....** 1  
S.N. Kharin, Kazakh-British Technical University, Almaty, Kazakhstan

### YOUNG INVESTIGATOR SESSION

CHAIR: TIMO MUETZEL

CO-CHAIR: PETER HALE

<b>1.1 Effect of Fretting Damage in RF Connectors Subjected to Vibration: DC Contact Resistance and Phase-Noise Response .....</b>	<b>22</b>
R. Enquebecq, Ecole Centrale de Lyon, LTDS, Femto-ST, TF Dept, Radiall; S. Fourny, Ecole Centrale de Lyon, LTDS; E. Rubiola, Femto-ST, TF Dept; M. Collet, Ecole Centrale de Lyon, LTDS; L. Petit, Radiall; J. Legrand, Radiall; L. Boillot, Radiall	
<b>1.2 Validity of the Voltage-Temperature Relation for Contact Elements in High Power Applications.....</b>	<b>29</b>
Michael Gatzsche, Technische Universität Dresden; Nils Lücke, Technische Universität Dresden; Steffen Großmann, Technische Universität Dresden; Tom Kufner, Multi-Contact AG; George Freudiger, Multi-Contact AG	
<b>1.3 Numerical Methods for Detecting DC Arc Fault in Lithium-Ion Batteries.....</b>	<b>39</b>
Amaury Augeard, Clermont Université, SAFT, France; Tchapo Singo, SAFT, France; Philippe Desprez, SAFT, France; M'hammed Abbaoui, Clermont Université	
<b>1.4 Perfectly Elastic Axisymmetric Sinusoidal Surface Asperity Contact.....</b>	<b>47</b>
S. Saha, Auburn University; Y. Xu, Auburn University; R.L. Jackson, Auburn University	
<b>1.5 Influence on Sn Whiskering of Controlled Bismuth Additions to Sputtered Sn Films.....</b>	<b>54</b>
E.K. Snipes, Auburn University; G.T. Flowers, Auburn University; P. Lall, Auburn University; M.J. Bozack, Auburn University	

## **FUNDAMENTALS**

CHAIR: MAKOTO HASEGAWA  
CO-CHAIR: GEORGE FLOWERS

<b>2.1</b>	<b>Particle Size Determination in Electrical Arcs with Ag and AgSnO<sub>2</sub> Electrodes Using X-Ray Scattering.....</b>	59
	E. Carvou, University of Rennes; J.L. Le Garrec, University of Rennes; E.Yee Kin Choi, University of Rennes; J.-M. Jouvard, Laboratoire Interdisciplinaire Carnot de Bourgogne; M. Kerkar, Université Abderrahmane Mira – Béjaïa, Algérie; J.B.A. Mitchell, University of Rennes	
<b>2.2</b>	<b>If Holm Had Used a Scanning Tunneling Microscope: What the Nanoscientists are Teaching Us about Electrical Contacts.....</b>	63
	Glenn Dorsey, Moog, Inc.	
<b>2.3</b>	<b>Electric Characteristics and Contact Area Features of Melting when Making and Breaking Contacts.....</b>	76
	Noboru Wakatsuki, Ishinomaki Senshu University; Tomohiro Watanabe, Ishinomaki Senshu University	
<b>2.4</b>	<b>Calculation of the Electrical Parameters from 3D Visualisation Data of Non-Disassembled Contact Interfaces.....</b>	82
	Constantinos Roussos, Heriot-Watt University; Jonathan Swingler, Heriot-Watt University	
<b>2.5</b>	<b>The Influence of the Thickness of Electrodes on Constriction Resistance in Nanofabricated Sample for Physical Simulating of the Electrical Contacts.....</b>	90
	Yasuhiro Fukuyama, National Institute of Advanced Industrial Science and Technology; Norihiko Sakamoto, National Institute of Advanced Industrial Science and Technology; Nobu-hisa Kaneko, National Institute of Advanced Industrial Science and Technology; Takaya Kondo, Yazaki Parts CO., LTD; Masanori Onuma, Yazaki Parts CO., LTD	

## **ARCING CONTACTS I**

CHAIR: GERALD WITTER  
CO-CHAIR: XIN ZHOU

<b>3.1</b>	<b>The Contact Force to Prevent Large Area, Closed, Vacuum Interrupter Contacts from Welding when Passing High Fault Currents of up to 4 Seconds Duration.....</b>	95
	Paul G. Slade, LFIEEE, Consultant	
<b>3.2</b>	<b>Arcing Voltage for a Medium-Voltage Air Load Break Switch.....</b>	101
	Nina Støa-Aanensen, Norwegian University of Science and Technology, SINTEF Energy Research; Magne Runde, SINTEF Energy Research; Anders Dall'Osso Teigset, Sweco	
<b>3.3</b>	<b>Surge Load Experiment Design and Results Analysis of Relay.....</b>	107
	Huimin Liang, Harbin Institute of Technology; Haidan Yu, Harbin Institute of Technology; Guangcheng Ma, Harbin Institute of Technology; Zhaowen Cai, G&A Technologies Co., Ltd.; Yujie Tang, G&A Technologies Co., Ltd.; Chunqing Zhao, G&A Technologies Co., Ltd.	

<b>3.4</b>	<b>Influence of Opening Velocity on Various Characteristics in DC High Voltage Ag Break Arc.....</b>	111
	Kiyoshi Yoshida, Nippon Institute of Technology; Koichiro Sawa, Nippon Institute of Technology 1, Keio University; Kenji Suzuki, Fuji Electric FA Components & Systems Co., Ltd.; Koetsu Takaya, Fuji Electric FA Components & Systems Co., Ltd.	
<b>3.5</b>	<b>Breaking Performance Investigation of Hybrid DC Circuit Breakers: An Experimental Approach.....</b>	117
	Dirk Bösche, University of Technology Braunschweig; Ernst-Dieter Wilkening, University of Technology Braunschweig; Hendrik Köpf, University of Technology Braunschweig; Michael Kurrat, University of Technology Braunschweig	

## **CONNECTORS I**

CHAIR: BRETTON RICKETT  
CO-CHAIR: MARJORIE MYERS

<b>4.1</b>	<b>A Multi-Variable Parametric Study on the Performance of Bolted Busbar Contacts.....</b>	124
	James Gatherer, Intel Corporation; Robert L. Jackson, Auburn University	
<b>4.2</b>	<b>Understanding the Fretting Failure Mechanisms in Gold-Plated Contact Materials.....</b>	132
	Wanbin Ren, Harbin Institute of Technology; Hongxu Zhi, Harbin Institute of Technology; Li Cui, G&A Technology Co., Ltd.	
<b>4.3</b>	<b>Deterioration Mechanism of Connectors Used in Long Driven Vehicles.....</b>	141
	Shigeru Sawada, AutoNetworks Technologies, Ltd.; Yasushi Saitoh, AutoNetworks Technologies, Ltd.; Kazuo Iida, Mie University	
<b>4.4</b>	<b>Adaption of the Ultrasonic Welding Technique to the Process of Joining Insulated Copper Wires with Standardized Tubular Cable Lugs.....</b>	147
	Simon Spreng, Friedrich-Alexander-University; Tobias Gläsel, Friedrich-Alexander-University; Jörg Franke, Friedrich-Alexander-University	

## **ARCING CONTACTS II**

CHAIR: PAUL SLADE  
CO-CHAIR: HENRY CZAJKOWSKI

<b>5.1</b>	<b>Fundamental Characteristics of Arc Extinction by Magnetic Blow-Out at DC Voltages (&lt;500V) II.....</b>	154
	Koichiro Sawa, Nippon Electric Control Equipment Industries Association; Shigeru Tsujimura, Nippon Electric Control Equipment Industries Association; Shigeki Motoda, Nippon Electric Control Equipment Industries Association	

<b>5.2</b>	<b>Dependence of Contact Weld Force on Arc Energy Supplied to Contact Surface in Low Voltage Switches.....</b>	160
	Katsuki Hotta, Mitsubishi Electric Corporation; Takashi Inaguchi, Mitsubishi Electric Corporation	
<b>5.3</b>	<b>Influences of Contact Opening Speeds in the Range of 0.5 to 200mm/s on Break Arc Behaviors of AgSnO<sub>2</sub> Contacts in DC Conditions.....</b>	166
	Makoto Hasegawa, Chitose Institute of Science & Technology; Hiroya Sonobe, Chitose Institute of Science & Technology; Nanami Ohkawa, Chitose Institute of Science & Technology	
<b>5.4</b>	<b>The Influence of Switching Arcs on Contact Resistance of Ag/SnO<sub>2</sub> Materials.....</b>	171
	Timo Mütsel, Umicore AG & Co. KG; Ralf Niederreuther, Umicore AG & Co. KG	

## **POSTER SESSION**

CHAIR: DANIEL GAGNON

CO-CHAIR: GEORGE FLOWERS

<b>6.1</b>	<b>Composition Characteristics of Bronze Coating Systems and Their Influence on Contact Properties in Electrical Applications.....</b>	176
	Frank Ostendorf, HARTING KGaA; Michael Hermsen, HARTING KGaA; Alexander Meyerovich, HARTING KGaA	
<b>6.2</b>	<b>Research on Degradation Modeling of Pick-Up Time for Aerospace Electromagnetic Relay in Long-Term Stockpile.....</b>	182
	Zhaobin Wang, Zhejiang Sci-Tech University 1, Jiangsu University of Science and Technology; Shang Shang, Jiangsu University of Science and Technology; Xiaoyi Huang, Beijing Institute of Information Technology; Guofu Zhai, Harbin Institute of Technology; Wenhua Chen, Zhejiang Sci-Tech University	
<b>6.3</b>	<b>Experiment Research on Re-Strike Phenomenon Occurred during High-Voltage Direct-Current Breaking Process under Transverse Magnetic Field.....</b>	187
	Xinglei Cui, Harbin Institute of Technology; Xue Zhou, Harbin Institute of Technology; Mo Chen, Harbin Institute of Technology; Kai Bo, Harbin Institute of Technology; Xiyuan Peng, Harbin Institute of Technology	
<b>6.4</b>	<b>Research on the Dynamic Calculation Model for a DC Solenoid Electromagnetic Contactor and its Contact Characteristics in Break Process.....</b>	191
	You Jiaxin, Harbin institute of Technology; Liang Huimin, Harbin institute of Technology; Ma Guangcheng, Harbin institute of Technology; Chen Shuqing, G&A Technologies Co. Ltd.; Cai Zhaowen, G&A Technologies Co. Ltd.	
<b>6.5</b>	<b>Investigation on the Mechanism of the Infiltration Process of Contact Material.....</b>	195
	Zhenyang Song, Fuda Alloy Materials Co., LTD.; Xiufang Zhang, Fuda Alloy Materials Co., LTD.; Xiaoping Bai, Fuda Alloy Materials Co., LTD.; Wei Weng, Fuda Alloy Materials Co., LTD.	
<b>6.6</b>	<b>Power Contact Arc Suppression: An Investigation into the Relative Effectiveness of Snubbers vs. an Engineered Electronic Power Contact Arc Suppressor.....</b>	199
	Reinhold Henke, Arc Suppression Technologies, LLC.; Robert P. Thorbus, Arc Suppression Technologies, LLC.	

<b>6.7</b>	<b>Improvement of the High Temperature Oxidation Resistance and Anti-Arc Erosion of Pure Cu with the Addition of La and Graphite.....</b>	209
	Haiyan Li, Xi'an Jiaotong University; Xuan Zhou, Kettering University; Yaping Wang, Xi'an Jiaotong University; Xueqiong Lu, Xi'an Jiaotong University	
<b>6.8</b>	<b>The Development of a Finite Element Contact Model of a Rough Surface Applied to a Au-Coated Carbon Nanotube Composite.....</b>	214
	Hong Liu, University of Southampton Malaysia Campus; John W. McBride, University of Southampton; Michael P. Down, University of Southampton; Suan Hui Pu, University of Southampton Malaysia Campus	
<b>6.9</b>	<b>Micro-Contact Performance and Reliability under Low Frequency, Low Amplitude, Alternating Current (AC) Test Conditions.....</b>	222
	Tod V. Laurvick, Air Force Institute of Technology; Ronald A. Coutu, Air Force Institute of Technology	

## **SLIDING CONTACTS**

CHAIR: RODNEY MARTENS

CO-CHAIR: TAOSHA JIANG

<b>7.1</b>	<b>Electron Beam Characterization Techniques for the Study of Wear in Sliding Contacts .....</b>	227
	C. Holzapfel, Schleifring und Apparatebau GmbH; C. Pauly, Universität des Saarlandes; M. Engstler, Universität des Saarlandes; F. Mücklich, Universität des Saarlandes	
<b>7.2</b>	<b>Experimental Investigation of the Electrical Contact Characteristics in Rolling Contact Connector.....</b>	235
	Junxing Chen, Xi'an Jiaotong University; Fei Yang, Xi'an Jiaotong University; Kaiyu Luo, Xi'an Jiaotong University; Yi Wu, Xi'an Jiaotong University; Mingzhe Rong, Xi'an Jiaotong University	
<b>7.3</b>	<b>Degradation Phenomenon of Electrical Contacts by Using a Micro-Sliding Mechanism.....</b>	241
	Shin-ichi Wada, TMC System Co. Ltd.; Koichiro Sawa, Nippon Institute of Thechnology	
<b>7.4</b>	<b>Fluctuation Components of Contact Voltage at AgPd Brush and Au-Plated Slip-Ring System with Lubricant.....</b>	250
	Koichiro Sawa, Nippon Institute of Thechnology; Yutaka Takemasa, Nippon Institute of Thechnology; Yoshitada Watanabe, Nippon Institute of Thechnology; Takahiro Ueno, Nippon Institute of Thechnology; Masaru Yamanoi, Nippon Institute of Thechnology	
<b>7.5</b>	<b>Experimental Research on Radiated Electromagnetic Noise of Pantograph Arc.....</b>	256
	Zhiyong Wang, Liaoning Technical University; Fengyi Guo, Liaoning Technical University; Xili Wang, Liaoning Technical University; Yanli Zhang, Liaoning Technical University; Baowei Wang, Liaoning Technical University; Xiaoming Yan, Northeastern University	

## **MEMS AND MICROCONTACTS I**

CHAIR: RONALD COUTU  
CO-CHAIR: ED SMITH

<b>8.1</b>	<b>Investigation of Electrical Contacts on a Nanometer Scale Using a Nano-Manipulator in Scanning Electron Microscope.....</b>	262
	Takaya Kondo, Yazaki Parts CO., LTD.; Jun Toyoizumi, Yazaki Parts CO., LTD./ National Institute of Advanced Industrial Science and Technology; Masanori Onuma, Yazaki Parts CO., LTD.; Kikuo Mori, Yazaki Corporation; Tetsuo Shimizu, National Institute of Advanced Industrial Science and Technology; Sumiko Kawabata, National Institute of Advanced Industrial Science and Technology; Norimichi Watanabe, National Institute of Advanced Industrial Science and Technology	
<b>8.2</b>	<b>Finite Element Modeling of Nickel Oxide Film for Au-Ni Contact of MEMS Switches.....</b>	266
	Hong Liu, University of Southampton Malaysia Campus; Dimitri Leray, NSA-Toulouse; Stéphane Colin, NSA-Toulouse; Patrick Pons, LAAS, CNRS	
<b>8.3</b>	<b>Interactions between Materials, Environment and Contaminant in Microswitches.....</b>	273
	Maarten P. de Boer, Carnegie Mellon University; Vitali Brand, Carnegie Mellon University	
<b>8.4</b>	<b>Electrical Breakdown Voltage in Micro- and Submicrometer Contact Gaps (100nm - 10μm) in Air and Nitrogen.....</b>	280
	Alexis Peschot, Université Grenoble Alpes/ CEA LETI/ CNRS/ University of California, Berkeley; Christophe Poulaing, Université Grenoble Alpes/ CEA LETI; Nelly Bonifaci, Université Grenoble Alpes/ CNRS; Olivier Lesaint, Université Grenoble Alpes/ CNRS	
<b>8.5</b>	<b>Electrical Fretting Wear Performance of New Silver Composite Coatings.....</b>	287
	J. Laporte, Ecole Centrale de Lyon; S. Fouvry, Ecole Centrale de Lyon; A. Chavanne, IREIS; J. Sautel, RADIALL; J. Legrand, RADIALL	

## **CONNECTORS II**

CHAIR: KOICHIRO SAWA  
CO-CHAIR: ROBERT JACKSON

<b>9.1</b>	<b>The Impact of Coaxial Connector Failures on High Frequency Signal Transmission.....</b>	298
	Rui Ji, Beijing University of Posts and Telecommunications; Jinchun Gao, Beijing University of Posts and Telecommunications; Gang Xie, Beijing University of Posts and Telecommunications; George T. Flowers, Auburn University; Qiuyan Jin, Beijing University of Posts and Telecommunications	
<b>9.2</b>	<b>Statistical Analysis of Voltage from Constriction to Micro-Arc Values during Aging by Fretting.....</b>	304
	S. El Mossouess, Physics Institute of Rennes/ Valeo; E. Yee Kin Choi, Physics Institute of Rennes; N. Benjemâa, Contelec; R. El Abdi, Physics Institute of Rennes; L. Doublet, Valeo; T. Rodari, Valeo; E. Carvou, Physics Institute of Rennes	

<b>9.3</b>	<b>Basic Investigations on Joints with Cylindrical Aluminum Conductors made by Press- and Shrink-Fit for High-Current Devices.....</b>	309
	Alexander Ramonat, Technische Universität Dresden; Stephan Schlegel, Technische Universität Dresden; Steffen Großmann, Technische Universität Dresden; Matthias Kudoke, ABB Switzerland LtD.	
<b>9.4</b>	<b>Impact of Corrosive Environment on Contact Resistance of Infrequently Mated Connectors.....</b>	317
	Karumbu Meyyappan, Intel Corporation; Alan McAllister, Intel Corporation; Vasu Vasudevan, Intel Corporation; Anil Kurella, Intel Corporation; Balu Pathangey, Intel Corporation; Sumit Soni, Intel Corporation	

## ELECTRICAL SAFETY

CHAIR: JOHN SHEA

CO-CHAIR: HENRY CZAJKOWSKI

<b>10.1</b>	<b>Recognition of Series Arc Fault Based on the Hilbert Huang Transform.....</b>	324
	Changken Chen, Liaoning Technical University; Fengyi Guo, Liaoning Technical University; Yanli Liu, Liaoning Technical University; Zhiyong Wang, Liaoning Technical University; Yanjun Chen, Liaoning Technical University; Haihong Liang, State Grid Liaoning Electric Power supply CO., LTD.	
<b>10.2</b>	<b>Forensic Analysis of Thermally Stressed Crimp Connections.....</b>	331
	David M. Williams, Whirlpool Corporation; Michael E. Range, Whirlpool Corporation; Vincent C. Pascucci, TE Connectivity; Justin T. Savrock, TE Connectivity	
<b>10.3</b>	<b>Research on Thermoelectric Characteristics and Recognition Methods of Looseness Fault in Coal-Mine Bolted Cable Joint.....</b>	338
	Zhiyong Wang, Liaoning Technical University; Fengyi Guo, Liaoning Technical University; Yanjun Chen, Liaoning Technical University; He Wang, Liaoning Technical University; Zhiqiang Zheng, Liaoning Technical University	
<b>10.4</b>	<b>Modelling of Sparking Contacts for Hazardous Area Applications.....</b>	347
	Rajiv Shekhar, Physikalische-Technische Bundesanstalt/ The University of Queensland; Carsten Über, Physikalische-Technische Bundesanstalt	

## **MEMS AND MICROCONTACTS II**

CHAIR: SOPHIE NOEL

CO-CHAIR: ROLAND TIMSIT

<b>11.1 Experimental Validation of External Load Effects on Micro-Contact Performance and Reliability.....</b>	353
Tod V. Laurvick, Air Force Institute of Technology; Ronald A. Coutu, Air Force Institute of Technology	
<b>11.2 Effectiveness of Oxygen Plasma Versus UHV Bakeout in Cleaning MEMS Switch Surfaces.....</b>	358
Changho Oh, Carnegie Mellon University; Frank Streller, University of Pennsylvania; Robert W. Carpick, University of Pennsylvania; Maarten P. de Boer, Carnegie Mellon University	
<b>11.3 Novel Materials Solutions and Simulations for Nanoelectromechanical Switches.....</b>	363
Frank Streller, University of Pennsylvania; Graham E. Wabiszewski, University of Pennsylvania; Daniel B. Durham, University of Pennsylvania; Fan Yang, University of Pennsylvania; Jing Yang, University of Pennsylvania; Yubo Qi, University of Pennsylvania; David J. Srolovitz, University of Pennsylvania ;Andrew M. Rappe, University of Pennsylvania; Robert W. Carpick, University of Pennsylvania	

## **CONTACT MATERIALS**

CHAIR: ED SMITH

CO-CHAIR: TIMO MUETZEL

<b>12.1 Degradation of a Single Aluminum Junction due to Electro-Migration.....</b>	370
Robert Malucci, RD Malucci Consulting	
<b>12.2 Electromechanical Investigation into the Influence of MWCNT Height on the Performance of Au/MWCNT Composites for Electrical Contacts.....</b>	376
Adam P. Lewis, University of Southampton; Michael P. Down, University of Southampton; Hong Liu, University of Southampton Malaysia Campus; Liudi Jiang, University of Southampton; John W. McBride, University of Southampton 1, University of Southampton Malaysia Campus	
<b>12.3 Contact Resistance of Sn-Film and Sn-Bulk Investigated by Microscopic Analysis.....</b>	381
Ayako Omura, National Institute of Advanced Industrial Science and Technology; Megumi Fukuta, National Institute of Advanced Industrial Science and Technology; Koji Miyake, National Institute of Advanced Industrial Science and Technology; Takaya Kondo, Yazaki Parts CO., LTD.; Masanori Onuma, Yazaki Parts CO., LTD.	
<b>12.4 Nickel-Free Option for Electrical Contact Plating Stack Using a Nano-Crystalline Silver Alloy.....</b>	386
Zheng Zhou, Xtalic Corporation; George Eichman, Xtalic Corporation; John Cahalen, Xtalic Corporation; Tim Martin, Xtalic Corporation; Trevor Goodrich, Xtalic Corporation; Kathy Bui, Xtalic Corporation; Taher Hasanali, Xtalic Corporation	

## **MODELING**

CHAIR: GUENTHER HORN  
CO-CHAIR: ROBERT MALUCCI

<b>13.1 Numerical Simulation of Arc Splitting Process in a LV Switching Device Considering Thermo-Field Emission Mechanism.....</b>	391
Abhimanyu Kumar Singh, Larsen & Toubro Ltd.; Md. Naim Ahmmed, Larsen & Toubro Ltd.; Manaf Atharparvez, Larsen & Toubro Ltd.	
<b>13.2 Explicit FEM Analysis of a New Contacting Method for Electronic Devices with Novel Wiring Harnesses.....</b>	400
M. Spahr, Friedrich-Alexander Universität Erlangen-Nürnberg; J. Bönig, Friedrich-Alexander Universität Erlangen-Nürnberg; T. Gläsel, Friedrich-Alexander Universität Erlangen-Nürnberg; S. Spreng, Friedrich-Alexander Universität Erlangen-Nürnberg; T. Ebert, Friedrich-Alexander Universität Erlangen-Nürnberg; J. Franke, Friedrich-Alexander Universität Erlangen-Nürnberg	
<b>13.3 Prediction of Wear Volume on Sliding Contacts Using Cellular Automata.....</b>	408
Keiji Mashimo, Furukawa Electric Co., Ltd.; Hiroyasu Nishikubo, FITEC Corporation; Yasuyuki Ishimaru, FITEC Corporation; Yoshikazu Okuno, Furukawa Electric Co., Ltd.; Shingo Kawata, Furukawa Electric Co., Ltd.	
<b>13.4 Three-Level Multi-Scale Modeling of Electrical Contacts: Sensitivity Study and Experimental Validation.....</b>	414
Vladislav A. Yastrebov, PSL Research University; Georges Cailletaud, PSL Research University; Henry Proudhon, PSL Research University; Frederick S. Mballa Mballa, UPMC and Paris-Sud Universities; Sophie Noël, UPMC and Paris-Sud Universities; Philippe Testé, UPMC and Paris-Sud Universities; Frédéric Houzé, UPMC and Paris-Sud Universities	
<b>13.5 A Mathematical Model to Simulate an Arc Erosion of Electrical Contact in Switchgear Device.....</b>	423
Amol Kale, Larsen & Toubro Ltd; Mahesh Ranade, Larsen & Toubro Ltd	
<b>Author Index .....</b>	431