

## Report of the 23th International Conference on Electrical Contacts ICEC2006 in Sendai Japan, together with the 6th international session on Electromechanical Devices IS-EMD2006

The number of papers has been 108, presented in serial fashion, 45 from Japan, 19 from Germany, 16 from China, 6 from USA.

The number of participants was about 200, of which 70 from outside Japan.

Short summaries from interesting papers from the point of view of connector technology:

**2.6 Factors Influencing the Fretting Corrosion of Tin Plated Contacts.** Tetsuya Ito, Masato Matsushima, Kensaku Takata, Yasuhiro Hattori; Auto Networks Technologies, Ltd, Japan

A report on a Taguchi experiment on fretting, it shows that force and tin layer thickness have the strongest influence on the contact resistance. Other factors, temperature, humidity, fretting amplitude and frequency, dimple diameter and pre-aging show little effect on the fretting behaviour.

**4.5 The Loaded Surface Profile: A New Technique for the Investigation of Contact Surfaces.** John W. McBride; University of Southampton, UK

John McBride presents a technique of pressing a contact surface against a glass plate and measuring the surface profile under adjustable mechanical load with a 3D laser profiler through the glass plate.

**5.1 Voltage Distribution and Aging of Wires in Connectors for Stranded Power Cable Conductors.** Ake Bohlin, Bertil Larsson; ABB Kabeldon, Sweden, Kazuhisa Hagusawa; University of Tsukuba, Japan

Describes a measurement method and measurement to establish the voltage distribution between the 127 strands of a 300 mm<sup>2</sup> copper conductor, crimped with 200 kN in a hexagonal crimp configuration.

**5.4 Structural Analysis of Electrical Contacts Based on Displacement Energy of Atoms and Its Application to Sheet Contact with Low Contact Load.** Tomishige Tai, Mitsuo Koguchi; Japan Aviation Electronics Industry, Limited, Japan

A new theory with at least a severe mistake in the mechanical part leads to a contact concept similar to ampliflex/fleximatch. The article shows some measurements of the contact resistance from pure soft gold at low force (mN range)

**6.1 An Experimental Study of Arcing between Electrical Contacts on Automobile Connector by the High Voltage Battery System.** Takaya Kondo, Tomohiro Shimada, Shinya Matsuura, Hiroshi Kawasaki; Yazaki Parts Co., Ltd., Japan

Experimental evidence is presented that greasing contacts reduces the damage due to arcing. The best grease in this test is Organic Bentonite (scale-like shape), it can withstand 120°C.

**6.2 Magnetic Pressure Welding of Aluminum Plate and Wire - Plate to Stranded Wire.** Kenichi Hanazaki; Yazaki Corporation, Tomokatsu Aizawa; Tokyo Metropolitan college of Technology, Japan, Mehrdad Kashini; Tokyo Metropolitan college of Technology, Iran

Magnetic pressure welding is used to connect aluminium wire to copper terminals. It is a cold welding method using an eddy current pulse (220 kA) to provide magnetic pressure to move the parts to be welded together in millisecond cycle time without any mechanical means. The collision speed is about 600 m/s (2000 km/hr).

- 6.3 Adhesion and Attaching of Particles at the Failed Connector Contacts.** J.G. Zhang, J. C. Gao, C.F. Feng, Beijing University of Posts & Telecommunications, China

This article adds a new phenomenon to the already known problems of contamination of contacts by dust and finger touching. It concerns the fact that sodium lactate from human sweat can make dust particles adhere to the contact surface rather than being loosely attached. Particularly this combination of dust and adhesive causes contact failure in the Chinese communication environment.

- 6.4 Accelerated Disgn Process for Insulation Displacement Connectors Using the Finite-Element-Method.** Stefan Jorgens, Henning Taschke; Lumberg Connect GmbH, Germany

This article describes a finite element simulation of an ID-contact with a solid copper wire insertion suitable for currents up to 25 Amps. A similar investigation for stranded wire is still under investigation.

- 6.6 Calculation and Optimization of Uniform Flexible and Tapered Cantilever Beams for Electrical Connectors Analyzing the Maximum of Safety against Overstressing the Material Yield Strength Limit.** Achim Brenner; HARTING KGaA, Horst F. Nowacki; University of Applied Sciences, Germany

Horst Nowacki presents the basic mechanical formula's for flat and circular-section spring cross-sections. Upon my question he agrees that overstressing beyond the yield stress is admissible in many instances.

- 7.1 Correlation between Wear and Electrical Behaviour of Contact Interfaces during Fretting Vibration.** Nouredine Ben Jemaa; University of Rennes 1, France , Jonathan Swingler; University of Southampton , UK

Describes fretting experiments where a relation is explored between wear and electrical resistance for Sn, Ag and Au. I have asked after the pre-treatment and it appears that the contacts have been thoroughly degreased just before the experiments. Wear has been similar for the three metals and contact resistance increased strongly after a few thousand cycles. With 1 Hz there was more wear than with 100 Hz.

- 7.2 Enhanced Friction and Wear Behaviour of Electrical Contacts Via Bio Inspired Microstructure Control Produced by Laser Interference Metallurgy.** Frank Mucklich, A. Lasagni; Saarland University, Germany , C. Daniel; Ridge National Laboratory, USA

Reports on efforts to improve wear characteristics by modifying surface morphologies by laser interference.

- 7.3 Simulation of Steady and Unsteady State Surface Temperatures under Sliding Imperfect Electric Contact between Rough Surfaces.** Wan-Sik Kim; Northwestern University, Korea, Q. Jane Wang; Northwestern University, US, Shuangbiao Liu; Caterpillar Inc., China, Mark Asta; Univ. of California, USA

This concerns a very detailed analytical approach wherein friction heating and electrical joule heating may be separately calculated and then summed based on Fast Fourier Transformation.

- 7.4 Study on New Type of Pantograph Contact Strips.** Fengyi Guo, Ne Dong, Zhonghua Chen, Zhaoyuan Shi; Liaoning Technical University, China

Contact wear on pantographs systems for railways is reduced by the use of dual-lubricating copper-based powder metallurgy contact strips against aluminium wire.

- 8.1 A Novel Method for Accurate Measurement of Elastic and Plastic Properties of Contact Spring Materials.** Piet van Dijk; PVDIJK Consultancy BV , NL

A measurement method and measurements are shown using 10x10 mm test strips to measure the elastic and plastic properties of contact spring materials. It concerns a bending test for thin strip material that can be measured parallel and transverse to the rolling direction, back and forth.

**8.2 Long Time Behaviour of Static High Current Plug-In Connectors with CuCo<sub>2</sub>Be Helical Spring.** Falk Blumenroth; Technische Universitat Dresden, Germany , Matthias Kudoke; ABB Schweiz, Switzerland

Creep/Relaxation has been simulated in ANSYS and compared to experiment, after 30 years 46% from the contact force remains while the contact resistance is unaffected. The experiment and simulation concerned a static test at a constant temperature.

**8.3 Precipitation Hardened High Copper Alloys for Connector Pins Made of Wire.** Robert Zauter, Dmitry V. Kudashov; Wieland-Werke AG, Germany

Wieland alloy K55, well known in strip form for contact spring applications, is now also available as square wire, featuring a combination of high conductivity, high strength and good formability. Also K88 will be available in wire soon.

**8.4 Investigation of Au/Pd-Ni/Ni Plating on Electrical Contacts.** Osamu Hiramoto; Sony Corporation, Japan

A Taguchi experiment with variables Gold thickness, Nickel thickness, Co-content in Gold, Pd-Ni thickness, Type of Ni, Sealing tries to find the optimum plating for contacts that have to withstand 10.000 cycles from for example bankcard insertions. The recommended solution is 0.03  $\mu\text{m}$  Au with 0.3% Co on 1.0  $\mu\text{m}$  Pd-Ni 80-20 over 3  $\mu\text{m}$  Ni with sealing a and Ni-plating b. No description is provided for the 3 Ni-types and the three sealing methods.

**8.5 Development of AgNi Contact Material.** Nobuhito Yanagihara, Osamu Sakaguchi, Toshiya Yamamoto; Tanaka Kikinzoku Kogyo K..K., Japan

For switching contacts Ag with Ni particles smaller than 1  $\mu\text{m}$  was compared to a conventional Ag-Ni alloy with 3-7  $\mu\text{m}$  particles, made with powder metallurgy. This improved the durability considerable, enough to present it as an alternative for AgCdO, which is being banned because of the Cadmium content.

**Extra to the presentations a poster session has been held with following papers of interest for connector technology:**

**P11 The Acceleration Test Method for Heat and Fire Phenomena of Electrical Terminal by Loose Contact.** Youichi Aoyama, Hisa Numa, Ryo Fujita; Kurume Natinal College of Technology, Japan

A vibration test has been developed to simulate the deterioration from loose contact in wall plug type applications. Unplated brass proves to deteriorate much quicker than unplated copper.

**P12 Change in Contact Resistance for Closed Contacts of Ag, Al, Au, Cu, Ni and Sn in Aging Tests without Mechanical Separation.** Eisuke Takano; Consultant, Japan

An enormous amount of experimental data basically confirming that Au, Silver and Tin contacts are best resistant to ageing, while non noble metals like Cu, Ni and Al show increase of resistance. Worn through gold plated contacts behave similar to the non-noble metals.

**P29 Electro-Mechanics Goes Lead-Free Re-qualification, Reliability and Field Report of a Connector Manufacturer.** Stefan Jorgens; Lumberg Connect GmbH & Co.KG, Germany

A report on the changes needed for direct and indirect connectors in order to comply with the ROHS-directive. Soldering is at higher temperatures but does not represent a big problem. Mentioned is the use of plastics with a higher temperature resistance, and in some cases redesigns. An example is presented where contact springs have been pre-loaded in order to enable the design of a more temperature resistant housing. The whisker problem is mentioned but not tested nor further discussed.

**P30 Press-fit Connector for Automobile ECUs.** Yoshiyuki Nomura, Yasushi Saitoh, Kingo Furukawa, Yoshinori Minami, Kanji Horiuchi, Yasuhiro Hattori; AutoNetworks Technologies, Ltd., Japan

This paper describes the developed from a compliant pin with a N-shaped cross-section for air-bag connection. Tin is (almost) completely converted into “hard Tin” (= tin intermetallic) to avoid sliver formation.

**P31 Crosstalk Control of High Speed LAN Connectors.** Seiichi Onoda, Keiichi Inoue; Watanabe Co., Ltd., Japan

A new simple measurement technique is proposed to grasp the complex crosstalk characteristics. Measurements of Cat 5 and Cat 6 LAN connectors are extensively discussed.

**P34 Physical and Chemical Changes under Thermal Cycling of an Extrinsic Conducting Polymer Electrical Contact.** Liza Lam; Osaka University, Singapore , John W. McBride, Jonathan Swingler; University of Southampton, UK

This work is related to elastomeric connectors with different conducting systems, The background is a European programme called AUTOCON, Tycoelectronics is among the participants and mr. Christian Koehler provided samples. The conclusion from the investigation is that elastomeric connectors, or in this paper more general named extrinsic conducting polymers, are not stable and reliable enough for automotive application. Nonetheless the AuNi plated samples show promising electrical stability.

Some changes have been decided upon in the composition of the advisory board of the ICEC conference:

- Ir. A Steinmetz ends his active membership representing the Netherlands and is appointed honorair member of the board.
- Dipl. Ing. Alexander Neuhaus is appointed to become a member of the board, representing Austria, filling the vacancy left by Prof. Dr. Werner Rieder who died in February 2006.
- The undersigned was appointed to become a member representing the Netherlands, filling the vacancy left by ir. A. Steinmetz.

Piet van Dijk  
Sint-Michielsgestel, 26 june 2006