Tutorial title:	**Reliability for System Integration**
Organizer:	Prof. Bernhard Wunderle, Fraunhofer IZM Berlin/ TU Chemnitz, Germany
Instructor(s) and Topics:	Prof. Ralph Schacht, Lausitz U of Applied Sciences, Senftenberg, Germany *Advanced thermal measurement techniques* Dr. Jürgen Keller, AMIC, Berlin, Germany *Failure Analysis in the micro and nano region* Dr. Olaf Wittler, Fraunhofer IZM, Berlin, Germany *Structural health monitoring and accelerated testing* Dr. Hermann Oppermann, Fraunhofer IZM, Berlin Germany *Advanced joining technology for system integration* Prof. Bernhard Wunderle, TU Chemnitz, Germany *Physics of Failure lifetime prediction*
Importance of topic:	Due to the rapid development of IC technology the traditional packaging concepts are making a transition into more complex system integration techniques in order to enable the constantly increasing demand for more functionality, performance, miniaturisation and lower cost. These new packaging concepts (as e.g. System in Package (SIP), 3D integration, MEMS-devices but also power) will have to combine smaller structures and layers made of new materials with even higher reliability. As these structures will more and more display nano-features, a coupled experimental and simulative approach has to account for this development to assure design for reliability in the future. A necessary combined approach as a scientific discipline has to encompass research on the properties and failure behaviour of materials and material interfaces under explicit consideration of their micro- and nano-structure and the effects hereby induced. It uses micro- and nano-analytical methods in simulation and experiment to consistently describe failure mechanisms over these length scales for more accurate and physically motivated lifetime prediction models. This tutorial deals with the technological development and the thermo-mechanical reliability of microelectronic components and systems and methods to analyse and predict it. Various methods are presented to enable lifetime prediction on system, component and material level, promoting an all in one approach for technology development for future packaging challenges in advanced electronics system integration.

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<tr><td>Aim of course:</td><td>

Communicate status and advancements on the field of lifetime prediction and reliability for system integration for various failure modes
Solder and via fatigue
Interface delamination
Die cracking
Under temperature, moisture and vibration loading
Present a system approach to reliable technology development
Material selection & characterisation
Technology and processes
Simulation and lifetime prediction
Experimental verification
Combined and accelerated testing
Health monitoring
Present novel concepts for interconnect technologies
Sintering
Nanosponge-bonding
Transient liquid phase bonding
Exemplify advanced thermal technology for
Flip-Chip
SIP
LED
Power Dies
Introduce new methods for failure analytics and characterisation on micro and nano-level
Greyscale correlation based methods
IR thermography-based methods
Integrated stress measurement chip
Deformation measurements at the nanoscale
Residual stress analysis by high resolution method fibDAC

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<tr><td>Who should attend:</td><td>
This course will benefit those who are interested in design, analysis and technology development for advanced electronic packages with respect to performance, cost and reliability.
Although examples are given from specific fields (SIP, flip-chip, micro-processors, power-electronics, LED), the tutorial provides insight into a more general methodology presenting advanced technological, experimental and numerical techniques.
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<tr><td>Outline:</td><td>

Accelerated and combined testing
Techniques for degradation monitoring (health monitoring)
Advanced packaging and joining technologies
Non-destructive advance failure analytical techniques
Physics of failure lifetime modelling for SIP, etc.
FE-Simulation
Deformation analysis for reliability characterisation

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About the instructors	Jürgen Keller studied Mechanical Engineering at the University of Kaiserslautern. 2005 he received Ph.D degree in a collaboration of the University of Cottbus and the Fraunhofer IZM, Berlin. He is working on micro- and nanomechanical deformation measurement techniques and Finite Element Analysis for microelectronics and nanotechnology applications. Since 2003 he is working as a development engineer for micro and nanomaterials for the AMIC Angewandte Micro-Messtechnik GmbH, Berlin. Since 2005 he is managing director of AMIC. Olaf Wittler studied physics Paderborn, Berlin and London. After working at Robert Bosch GmbH on crack growth in encapsulation materials from 1999 to 2002, he joined the TU Berlin to work in the field of thermo-mechanical reliability and simulation. Since January 2006 he is heading the group Materials Mechanics in Micro- and Nanoelectronics at Fraunhofer IZM Mirco Materials Center Berlin. Hermann Oppermann studied Materials Science & Technology and received the Doctor degree in Materials Science. At Fraunhofer IZM he leads the group "Interconnect Metallurgy and Processes". There he worked on power applications using approaches of fluxless die bond~~ing~~ soldering, thermocompression bonding and power enhanced flip chip solutions. Ralph Schacht studied telecommunications and electro techniques in Berlin/Germany and got his Ph.D. in 2002 in electronic engineering at TU-Berlin/Germany.Since 2006 he is a full professor at Hochschule Lausitz (FH) in Senftenberg/Germany for electronic circuit engineering. At Fraunhofer IZM, which he joined in 2001, he leads the Thermo-Electric-Testing Lab, specialising in IR-thermography as well as in thermal interface and system characterisation. Bernhard Wunderle received his diploma in theoretical physics from the University of Tübingen. From 1999 on he was with Robert Bosch Ltd, where he was concerned with reliability for electronic packages in automotive applications. After his Ph.D. in 2003 he joined Fraunhofer and currently leads a group in the field of material characterisation and reliability in experiment and simulation. He is responsible for the IZM thermal management program. Since 2009, he is a full professor for materials and reliability at the Technical University of Chemnitz, Germany.