Thermal Management in Photonics Packaging

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Dr.-Ing. Stefan Mohrdiek

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Stefan Mohrdiek is heading the packaging & optics activities at Swiss Center for Electronics and Microtechnology CSEM. The main focus of his work is on supervising programs and establishing new research platforms in microelectronics, enabling / targeting innovative packaging solutions and aligning the research strategy with industry needs and the company's existing research areas.

He received the master degree in electrical engineering with emphasis on communications engineering at the Technical University Darmstadt, Germany in 1990. The PhD in Optoelectronics he obtained working at the Deutsche Telekom Technology and Research Center in Darmstadt in 1995 within the department of opto-electronic components as guest from the Technical University Hamburg-Harburg. The PhD was followed by a fellowship granted by the European Union at the Technical University Tampere in Finland in the semiconductor laboratories, working on multinational programs in semiconductor physics and technology.
When moving to Switzerland in 1998 he joined the semiconductor industry, developing applications for packaged semiconductor lasers. After 15 years he started at CSEM SA in 2013 with an overall experience of more than 20 years in the field of optoelectronics and packaging, about 50 scientific publications and a number of patents. Stefan Mohrdiek is Head of the Swiss Photonic Packaging Laboratory SPPL.

Moderation, Welcome from CSEM SA and SPPL

Dr. Christian Bosshard

Manager Swissphotonics, Vice-President Center Muttenz, CSEM SA, 4132 Muttenz BL
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Dr. Christian Bosshard is Vice-President of the at Swiss Center for Electronics and Microtechnology CSEM Center in Muttenz. He received his degree in Physics (1986) and his doctorate (1991, Silver medal award) from ETH. Christian Bosshard is a Fellow of the Optical Society of America OSA, coordinator for CSEM in the Heterogeneous Technology Alliance HTA, Managing Director and board member of Swissphotonics NTN.

Welcome from Swissphotonicsb NTN

Dr. Joël Grognuz

Head of Engineering, CADFEM (Suisse) AG, 1020 Renens VD
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Joel Grognuz received his master in Physics at EPFL in 2003, his thesis work consisting of an experimental study of a novel plasma heating technique using microwaves in tokamaks both in Switzerland and UK. Later as a project responsible at CERN he delivered a non-standard cooling system with catastrophic failure occurrence decreased from *almost certain* to *highly improbable*. Since 2008 he works at CADFEM (Suisse) where today he is the leader of the Multiphysics team which works on virtual prototyping and robust design optimization in mechanics, electromagnetism, hydrodynamics, thermodynamics and systems engineering.

Multiphysics numerical simulation for photonics packaging
Lighting the way using state of the art tools for robust design optimization of photonics packaging. Multi-dimensional (0D, 1D, 2D, 3D), multi-physics and multi-timescale approaches allowing coupling between thermal, structural, humidity concentration and electro-magnetic fields to assess effects on shape and wave propagation.

Dr. Bruno Michel

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Bruno Michel received a PhD degree in biochemistry and computer engineering from the University of Zurich, subsequently joined IBM Research to work on scanning probe microscopy and later on the development of accurate large-area soft lithography. Dr. Michel started the Advanced Micro Integration group to improve thermal interfaces and miniaturized convective cooling for processors and concentrated photovoltaic systems. Main research topics of the Zurich group were microtechnology / microfluidics for nature-inspired miniaturized tree-like hierarchical supply networks, 3D packaging, and thermos-physics. Important breakthroughs were made in datacenter energy re-use for future green IT and 3D packaging with interlayer cooling and electrochemical chip power supply. Recent activities include integration of wearable and IoT systems to accelerate application of artificial intelligence in industry and healthcare.

Ultimately Dense and Efficient Future Computers
Liquid cooling enables an unprecedented density in future computers to a level similar to a human brain. This is mediated by a dense 3D architecture for interconnects, fluid cooling, and power delivery of energetic chemical compounds transported in the same fluid. Vertical integration improves memory proximity and electrochemical power delivery creating valuable space for communication. This strongly improves large system efficiency thereby allowing computers to grow beyond exa-scale. A dense and efficient µServer has been demonstrated as a first milestone along this roadmap. A concept is presented showing that volumetric density drives efficiency in information processing and can replace the currently slowing Moore's law. In this concept efficient optical and electrical data transport play an important role.

Dr. Antoine Müller

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Dr. Antoine Müller born in 1964 in Geneva is presently CEO of Alpes Lasers. Antoine studied Solid State Physics at the University of Geneva, he received a PhD in Physics in 1995 for his work in Quantum Cryptography with Professor Dr. Nicolas Gisin. In 1996 he continued work as post doctorate on the same subject at the University of Geneva. In 1997, he worked on single photon metrology at NIST in Gaithersburg, MD and in 1998 he joined Professor Faist's group of mesoscopic physics at the University of Neuchâtel to work on electrical tuning in QCLs. In 1998 he founded Alpes Lasers SA together with Professor Faist and Dr. Beck, he acts as CEO since foundation. He co-authored more than 30 peer reviewed papers or contributions to topical meetings and 7 granted patent & patent applications.

Thermal management of Packaged Quantum Cascade Lasers QCL
The issues related to the management of the heat extraction and temperature regulation for QCLs will be discussed. A brief review of the characteristics of the QCLs and their relation to the operation conditions will be given. Emphasis will be put on the challenges posed by the pure thermal wavelength tuning of these devices and the need for very tight emission specification required by optical spectroscopy. The reduction of heat production opportunities and the maximization of the heat extraction challenges will be discussed.

Dr. Johanna Wolf

R&D engineer high power diode laser bars, II-VI Laser Enterprise GmbH, 8045 Zurich
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Johanna Wolf joined II-VI Laser Enterprise in 2017. Her main focus is on semiconductor laser design and high power diode bar assembly. She received her master's degree in physics at ETH Zurich. The doctoral degree in the quantum optoelectronics group at ETH was completed in 2017.

Actively Cooled Diode Laser Bars: Requirements and Assembly Technology
The diode laser bar market is an active area with continuously increasing performance requests. The main focus is clearly on output power, but also on beam quality, power conversion efficiency and polarization. Laser Enterprise fulfills the requests of the markets by raising the power rating by roughly 20 W / year, with the current laser bar product being specified at 250 W and 68% power conversion efficiency. Subsequently new product generations have a higher thermal load, asking for improved cooling mechanisms. We will present the requirements of thermal management, the current Laser Enterprise micro channel cooler and future perspectives of high power laser bar cooling.

Prof. Dr.-Ing. habil. Jolanta Janczak-Rusch

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Jolanta Janczak-Rusch is leading the *Micro- and Nanojoining* group at Swiss Federal Laboratories for Materials Science & Technology Empa, Laboratory for Joining Technologies and Corrosion. Her main interests are new joining technologies and materials (in particular nanojoining materials and processes, joints of dissimilar materials, composite materials and interfaces in complex materials). She has an interdisciplinary background ranging from Technical and Biomedical Cybernetics (Master of Science at Technical University, Ilmenau, Germany in 1988), Materials Technology (PhD at the University of Dortmund in 1994) and Materials Engineering (Habilitation at Warsaw University of Technology in 2008). After a one-year Post-doc at EPFL, she joined Empa in 1994, first working on the development of in-situ interfacial testing methods for composite materials at Empa Thun. In 1999, she moved to Empa Dübendorf to support the joining technology research activities there.

Nanojoining technologies for miniaturized assemblies
Nanojoining is emerging as a novel scientific discipline and technology for the joining of heat-sensitive materials and components and for the assembly of micro-/nanoscale devices. The developed nanojoining concepts offer new opportunities for heat management in miniaturized assemblies by materials and process design. In this talk, an overview on the nanojoining processes, ranging from sintering with nanoparticle based pastes, diffusion bonding and soldering with nanomultilayers over reactive joining to selective joining approaches, will be given.

Dipl.-Ing. HTL Dietmar Bertsch

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Mr. Bertsch received his engineering diploma (HTL) from the Interstate University of Applied Sciences Buchs NTB after graduating as a systems engineer with a specialization in materials engineering. He completed his military service and then (2000) joined the Institute for Micro and Nanotchnology MNT, where he focused on applied research and development in the MNT field and its application in the industrial environment. He has specialized in the packaging of microsystems technology components, in particular joining techniques and materials research / analysis.

Cooling methods for high thermal load devices
I give an overview about various cooling concepts and their efficiency for high thermal load applications based on thermal measurements and simulations. Particularly, I will show (1) investigation on high power LED applications for automotive and (2) a cooling device for high-concentration photovoltaic thermal systems that was developed and manufactured by IBM and NTB.

Guido Spinola Durante

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Guido Spinola Durante was born in Luxembourg City, Grand Duchy of Luxembourg, in 1974. In 1999, he received the degree in nuclear engineering in Milan – Politecnico di Milano – Italy. In 2000, he joined ST Microelectronics MEMS R&D group in Italy. His R&D activities have concentrated on inertial MEMS numerical modeling, design and measurements and has filed a number of patents especially on MEMS gyroscope. In 2006, to broaden his professional skills, he joined CSEM in Alpnach Dorf, Central Switzerland. His current tasks and interests are in the field of packaging technologies applied to 0-level hermetic sealing of MEMS, adhesive bonding and solder reflow assembly processes of MEMS and optoelectronic components. He also is responsible for maintenance and purchase order of the packaging cleanroom in CSEM. He also keeps active in the FEM simulations area and he is performing simulations in the thermal management and microfluidic topics and also in other packaging multi-physics domains.

Thermal Management Solutions for Optoelectronics Packages
We present examples for the integration of devices into optoelectronic packages for stable and stress minimized operation at high powers. Thermo-mechanical simulations e.g. by the Multiphysics program Comsol are used in the design phase to optimize for lowest temperature operation to ensure longest system reliability and lifetime. A further emphasis is given on matched material solutions for assembly technologies with their corresponding bonding technologies.

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Discussion of topics, all presenters & moderator

Our next stops:

Image Processing, Augmented and Virtual Reality
Tuesday, 28. May 2019
10:00 – 17:00
HTW Chur

Photonic 4 intelligent processing
Wednesday, 19. June 2019
12:30 – 18:00
Palexpo Genève-Airport
EPHJ · EPMT · SMT

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Innosuisse – Schweizerische Agentur für Innovationsförderung