Final Remarks MAM 2016

Volker Saile

February 2, 2016

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MAM 2016, 7th Edition

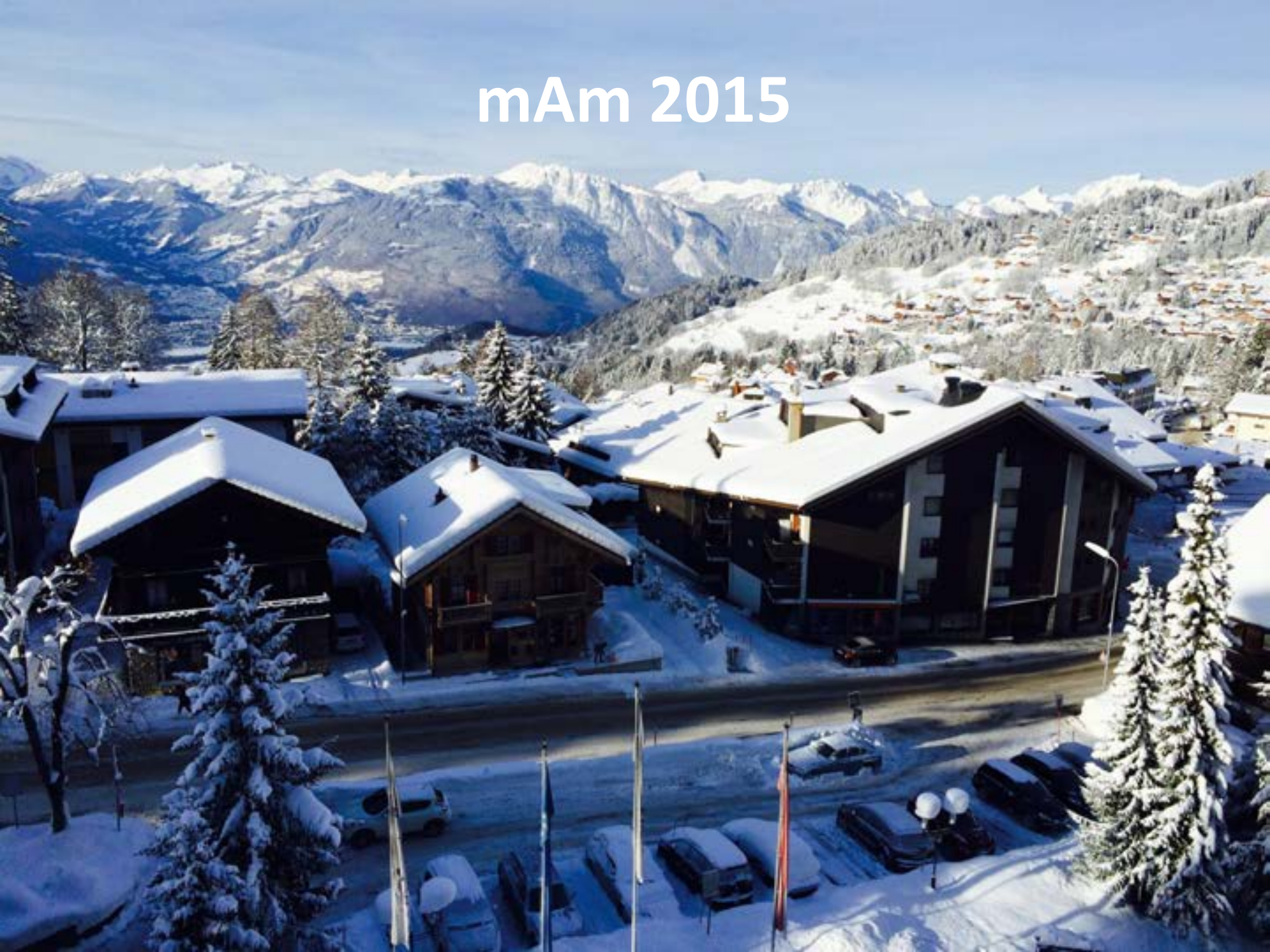
Same Concept, Same Venue, Same Quality

mAm 2010 – the first mAm


mAm 2010
Micronarc Alpine Meeting
Equipment for microproducts
MICRONARC
MANCEF
20-22 January 2010 Villars-sur-Ollon, Switzerland
SKI

mAm 2012

mAm 2015




mAm 2016

mAm 2016 – the days before in the webcam

http://villars.roundshot.com/bretaye/

Sunday, January 21, 2016

Its a workshop and not a skiing excursion!

mAm 2016 is organised by Micronarc, in collaboration with Mancef.

Organising Committee

- **Edward Byrne** – Micronarc; Project Manager FSRM
- **Prof. Dr. Volker Saile** – Chief Science Officer, Karlsruhe Institute of Technology; President, Mancef
- **David Tolfree** – Vice President Africa/Europe, Mancef
- **Danick Bionda**, Secretary General, Micronarc
- **Philippe Fischer** – Director, FSRM (Swiss Foundation for Research in Microtechnology); General Advisory Board Mancef Africa/Europe
- **Dr. Sikha Ray** – KIT, Programme management STN
- **Suzanne Schwendener** – Micronarc

The Concept

Background

Microsystems have now entered the age of **high volume production** for consumer applications, especially mobile phones, ICT and medical disposable devices. The issues associated with the production of these are of continued interest to **manufacturers**. These include **tooling in high volume fabrication** of **precision parts,** making highly **efficient and reliable automated assembly lines** and **test systems** for microproducts. There is a **fast growing market** for such components and products.

The Program

Monday 1 February 2016

9:00 - 09:30 **Welcome**

Danick Bionda, Secretary General, Micronarc

Prof. Dr. Volker Saile, Karlsruhe Institute of Technology, President, Mancef

David Tolfree, Vice President – Europe, Mancef

Christine Reiley, ASME / COMS 2016

Yvan Dénéréaz, Office for Economic Affairs, Canton of Vaud

09:30 - 10:00 **Invited Keynote on the Future of Micro-manufacturing I**

Chair: Prof. Volker Saile, Mancef; KIT

Prof. Richard Leach, Professor in Metrology, Faculty of Engineering, The University of Nottingham (UK)
Next generation optical micro-metrology: beating the current barriers

Why Nottingham?
Interests in Micromanufacturing and Additive Manufacturing
Surface measurements: spatial frequencies
Why optical and not contact? Optical instruments
Imaging compromises
Information rich metrologies (**IRM**)

Special problem: High slopes
Difference Engines

Current research:
Develop new all optical CMM platform
50 mm³ and sub-µm capability
Focus and interferometry variation
IRM principles
Self-calibration
It is never too late to start over!

10:30 - 12:15 **Micro-manufacturing Applications I – Watchmaking**

Chair: Philippe Fischer, FSRM

Keynote: Dr. Jens Kraus, VP, Systems, CSEM (Switzerland)
Enabling micro-technologies for smartwatches: low-power, embedded, connected

Smart watches
Connected watches

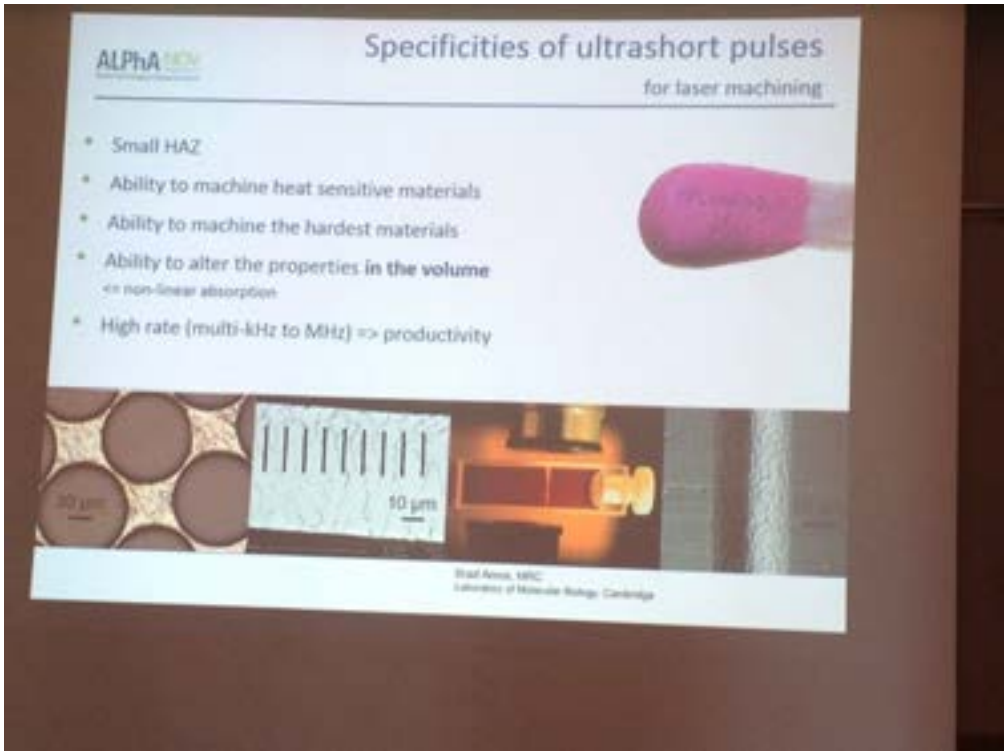
Market: 15-28 M/a

Enabling technologies @ CSEM:
MEMS, MOEMS
Ultra-low power
Photovoltaics
Human vital sign sensing and processing

Swiss smart watches
Energy consumption
Killer App?
Future thoughts

Dr. Rainer Kling, Business Unit Manager / Laser Micromachining, AlphaNov (France)

Femtosecond lasers for ultra-precision watchmaking applications



AlphaNov organization

fs-Lasers: advantages
Non-linear absorption

Sapphire: properties

Holes and deep engraving
Improving ablation quality
Bottom-up ablation

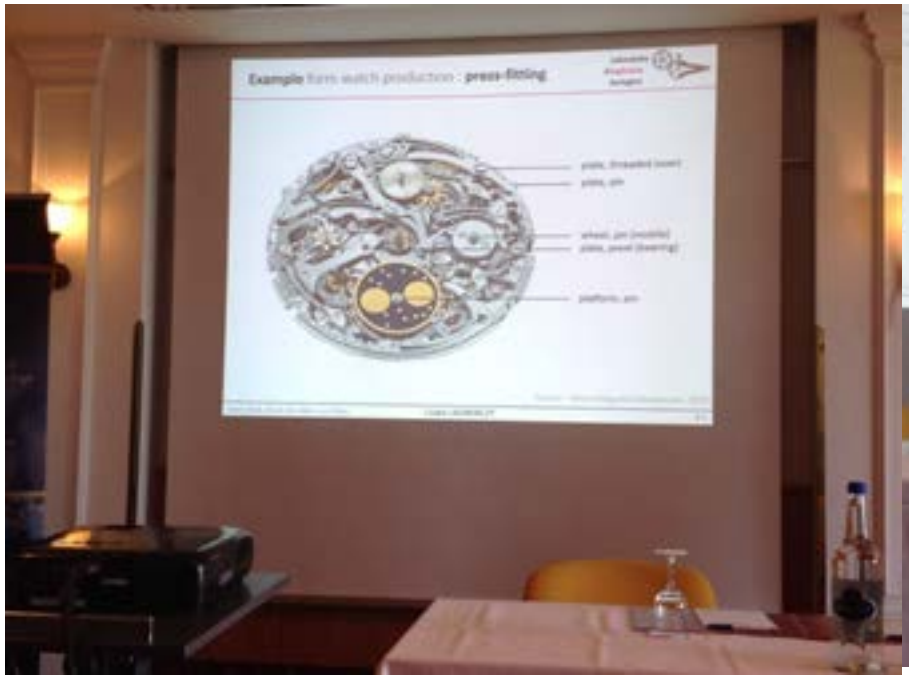
Process window: <2° taper

Laser-drilling strategies: Trepanning drilling, geometry control
High AR > 10

Decoration: holographic effects, hydrophobic surfaces, coin making

Dr. Csaba Laurenczy, Haute-École Arc, Lab. d'ingénierie horlogère (Switzerland)

Functionality and attribute driven process control and quality inspection for watch production



Press fittings: up to 80 per watch > production problems

Attribute driven process control: Client needs-functionality of assembly-
-set of process attributes-assembly functionality check-
-set of component attributes-component functionality check-
-client needs

Silvio Dalla Piazza, Vice President Research & Development, Micro Crystal AG [Swatch Group] (Switzerland)

Quartz Tuning Forks: A high-volume, low-cost, high-tech MEMS product

Quartz: Tuning forks = first MEMS
Today: miniaturized ceramic packaged quartz resonator
Photolithography-wet chemical etching
Frequency adjustment by laser trimming
Types of resonators, 32.768 kHz for watches and smartphones
New geometry with grooves (Q-factor!)
T-compensation and aging
Small: 1.6x1 mm, 2B pieces/a, critical parameter is market price (6 C/ piece !!!)

13:30 - 15:00 **Micro-manufacturing Applications II – Medtech**

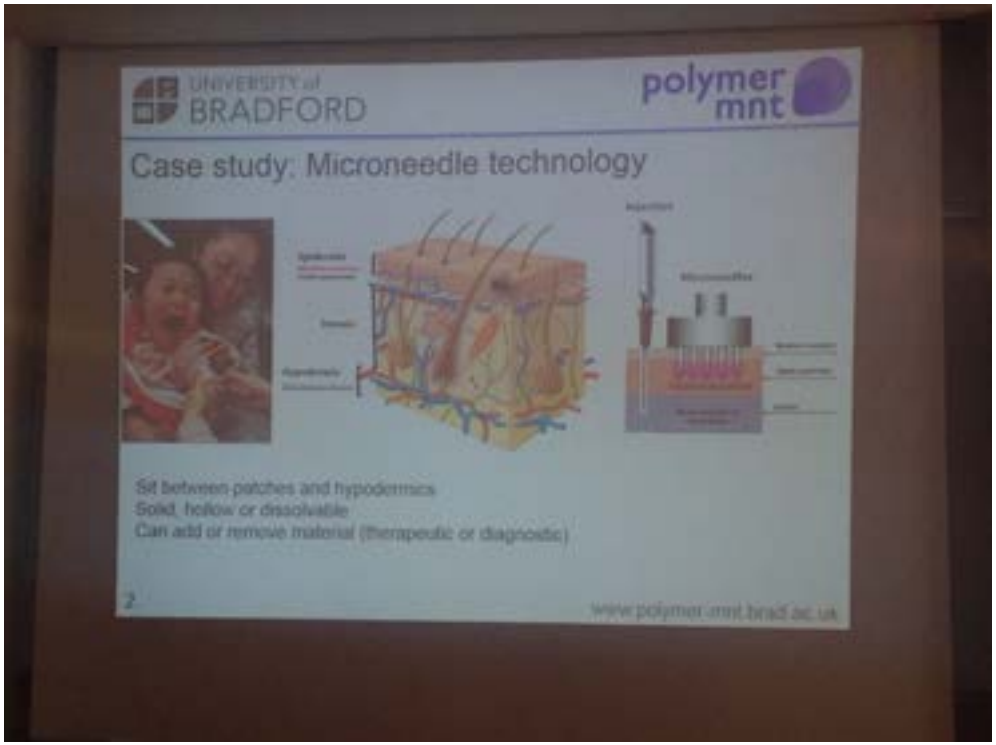
Chair: Pierre-André Grandchamp, FSRM

Keynote: Dr. John T. McDevitt, Chair, Department Biomaterials, New York University College of Dentistry, Bioengineering Institute (USA)
Development of the Programmable Bio-Nano-Chip: Bridging the Gaps in Micro-Manufacturing for A New Class of Medical Devices

Books, health market, missing link: biomarker information
Strategic focus: technical advantage, societal need, passion – flywheel effect
Senso DX: Platform to digitize biology, sensor that learns, empower people
Platform, barriers, pathway to analyzer, failure of current LOC for POC, **New content!**
Consumer cardiac ScoreCard, adaptive clinical trials
Soft product launch SensoDX in January 2016
Internet of Biomarkers (IoB)

Dr. Ben Whiteside, Director – RKT Centre for Polymer MNT, University of Bradford (United Kingdom)

Microinjection moulding for microneedle drug delivery devices



RKT Centre for polymer micro- and nano-technology

„Organizing Molecules“

Micro-needles case study

- High shear rheometry
- IR shear heating measurements
- Design and simulation
- Hollow micro-needles
- Process analytics

AFM, polymer morphology, analysis techniques, 3D confocal microscopy

Plasma treatment – contact angle

Dr. Vincent Dessenne, General Manager, Heraeus Materials SA (Switzerland)

Innovative cermet ceramic composites for miniaturized medical applications

Miniature feedthroughs for implants

Example pacemakers: downsizing 1958-2013

Current technology is very complex

CerMet ceramic and conductor
Network of conductive material (Pt)
Absence of macroscopic interface
Strength, conductivity, leak-tight

Improvement: Polishing, slow cooling

Stacking: 3D designs

Laser welding

Exhibitor elevator pitch (3 min) – **FEMTOprint**

Glass. Rapid prototyping w/o cleanroom

15:30 - 17:30 **MEMS**

Chair: Dr. Sebastian Gautsch, EPFL

Keynote: Benedetto Vigna, Executive Vice President, General Manager, Analog, MEMS & Sensors Group, ST Microelectronics (Italy/Switzerland)
Sensors and..... actuators

10 years of sensors at ST
Start: Nintendo and iPhone
10 B MEMS shipped
Erosion of price

Today: inflection point – IoT or actuators,
MEMS not anymore new, get out of smartphone

Power consumption
Image stabilization: Cameras and drones
Wearables, automotive is stable
Very small pressure sensors: accuracy – 10 Pa equiv. 80 cm
UV sensors, humidity sensors
Microphones: the only MEMS growing

Smart things for augmented life
Low power blue-tooth (IoT needs radio!)

Lowering the barriers for developers; STM32 open development environment

Sensing and actuating: gap in actuator development; Real Sense with INTEL
Sensors shrink – actuators don‘t. Piezo, thermal, electro-static, electro-magnetic

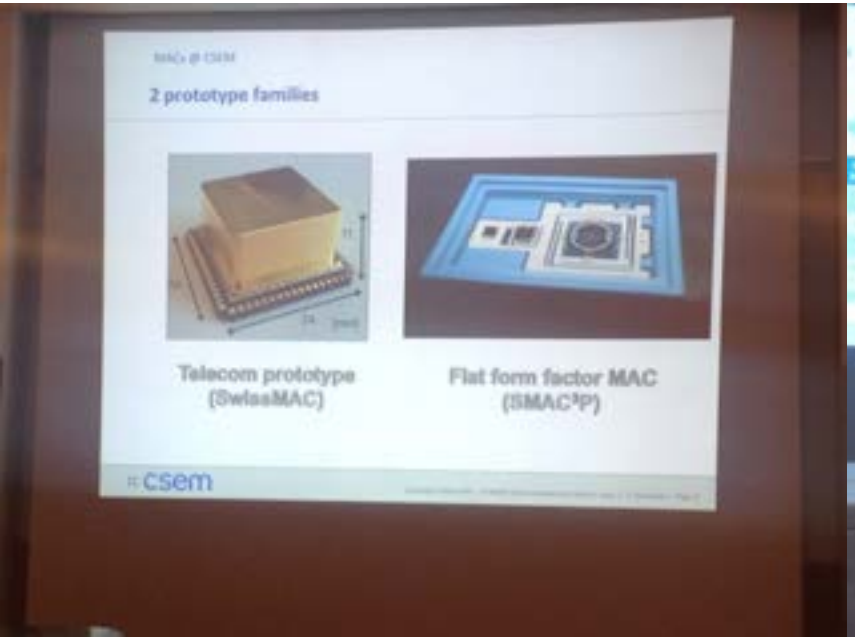
Micro-mirrors for scanning in notebooks (LENOVO YOGA15)

ST is the only company to offer the full range of actuators and IoT devices

Dr. Thomas Overstolz, Senior R&D Engineer, CSEM (Switzerland)
A MEMS-based miniaturized atomic clock

Applications: wireless base station, GPS, test&measurement….
Two prototypes
Basic principle: Swiss-MAC. CSEM. Complete system

Alkali vapor cell (Rb), integrated functionalities
Problems with Rb: quantity? In-situ Raman spectroscopy > Rb diffuses into glass
MVD coating solves problem
Lifetime is now 15 years



Dr. Christophe Gorecki, Directeur de Recherche CNRS, Institut FEMTO-ST (France)

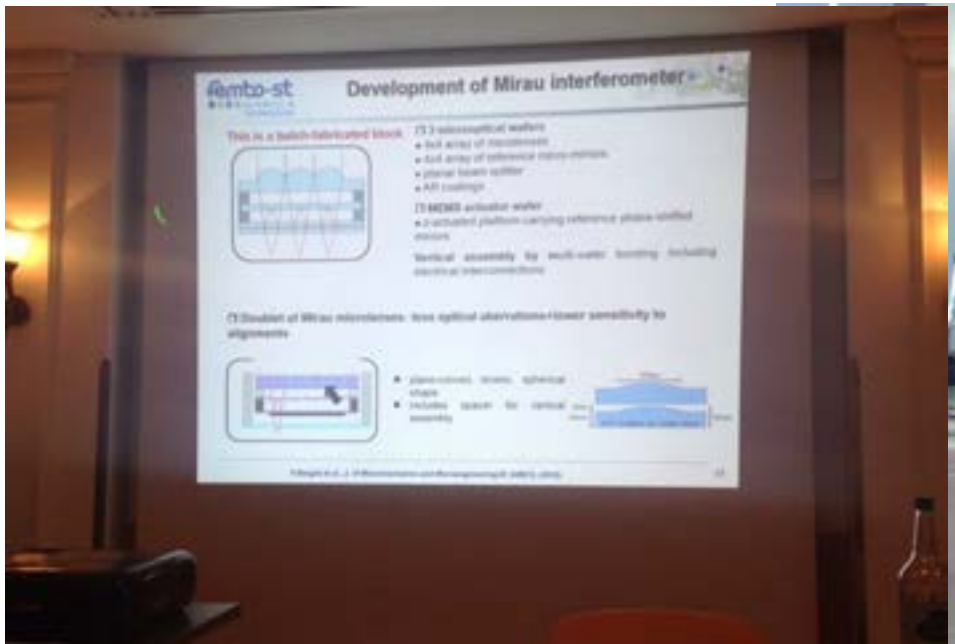
Miniature Mirau interferometry for swept-source OCT imaging with applications to cancer diagnosis

Miniature microscopes for auto-diagnosis
Optical coherence tomography (OCT)
Skin cancer

VIAMOS Consortium – 7 partners
MOEMS based instrument
Architecture

Demonstrators for building blocks
Doublet of 4x4 microlens arrays
Beamsplitter
Z-scanner

Assembly and characterization



Prof. Dr.-Ing. Helmut F. Schlaak, Technische Universität Darmstadt (Germany)

Micro Nano Integration - Iontrack Template Technology for Future MEMS

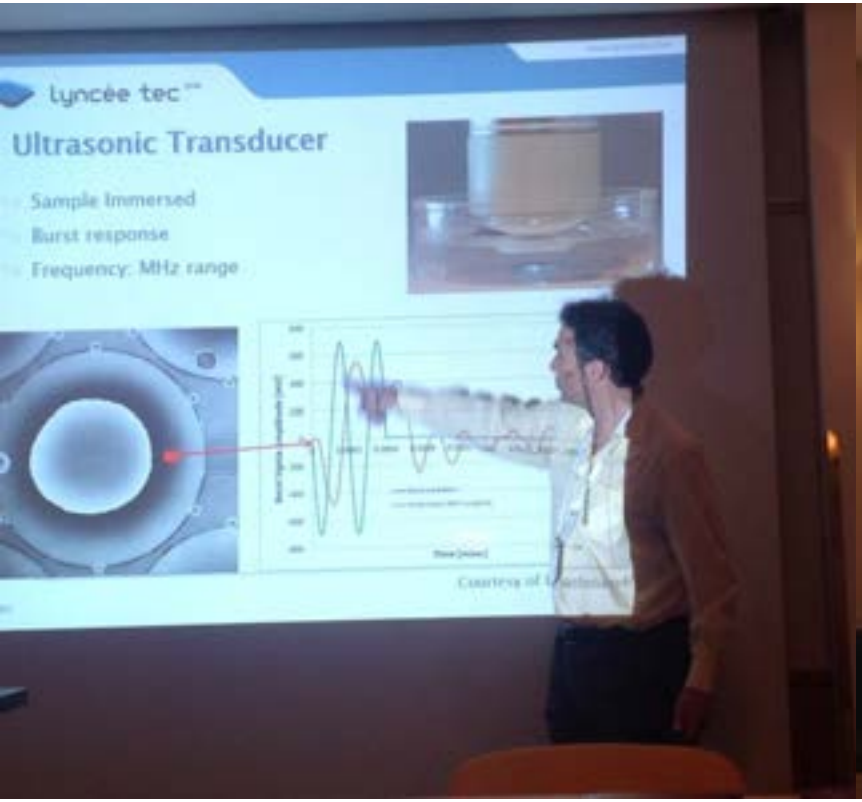
Nanowires, nanotubes, nanorods
Bottom-up fabrication
Ion-track etching
Prefabricated foils, no expensive equipment
Laminate ion-etched foils, adhesive layer
Solvent-enhanced lamination
Electroplating

Properties: 100 nm to 1.5 µm, 100µm long
Electrical connections
Applications: many (see photo)

Tayloring of the needles

Upscaling and commercialization

Exhibitor elevator pitch (3 min) – **Lyncée Tec**



SAW, US-transducer in liquid, EPFL ROLEX Center - Evaporation of the building replica

Venue and Conference Dinner

Excellent!!!


TISSOT

Microtechnologies are fine, but…

…sometimes not the best solution

Tuesday 2 February 2016

08:30-10:00 **Novel Manufacturing I - Energy Harvesting**

Chair: Dr. Christine Neuy, microTEC Südwest

Keynote: Prof. Adrian Ionescu, EPFL / NANOLAB (Switzerland)
Energy harvesting and storage for smart autonomous systems

Wearables and IoT
Energy scavenging: Light, vibration, motion
Energy storage

Nano Era, size of transistors,
3D, 14 nm transistors

Trillions of sensors? Abundance
EU Zero-Power technology
Autonomous smart systems

Energy for elementary functions

Wearable technology

Key enabling technologies

Si technology: a 3D migration to the future. Self powered chips?

Solar, thermal, vibration, RF for harvesting
Mechanisms for energy harvesting
Micropower energy harvesting: Solid-State Electronics 53(2009), 684-693

Scenario 1: harvesting
Scenario 2: harvesting and storage combined

Energy: majority goes into radio
Scavenging: system level problem

Light: low efficiency at low lux – solutions such as photon recycling
Vibrations: mass!
Human energy: activities. Where to tap the power? Shoes?
Piezoelectric conversion/harvesting: PVDF on wafer, low T
Thermoelectric (TEG): nanomaterials, performance factors, SEIKO watch, on foil harvester
material, package, system
Hot ICs

Storage: Li-ion battery, supercapacitors – advantages/disadvantages, Graphene

Roadmap

Prof. Dr. Uli Lemmer, KIT / Light Technology Institute (LTI) and Institute of Microstructure technology (IMT), (Germany)
Fully printed thermoelectric generators

OTEGO

Basics of TE-modules
Materials: high el. cond. and low thermal con.
Figure of merit
Conventional vs. non-conventional materials

Conventional materials: expensive, toxic
Organic: printing, PEDOT, commercially available
Efficiency development: impressive
Controlled doping PEDOT:TOS

Market, business: mW/cm²
Smart home applications
Trillion of sensors in industry
Large area heat recovery

InnovationLab: Roll-to-Roll printing
Screen printing: PDOT:PSS/Ag-Paste
Folding and wrapping thick TEGs

Dr. Simone Marasso, Chilab, Materials and Microsystems Laboratory, Department of Applied Science and Technology (DISAT), Politecnico di Torino (Italy)

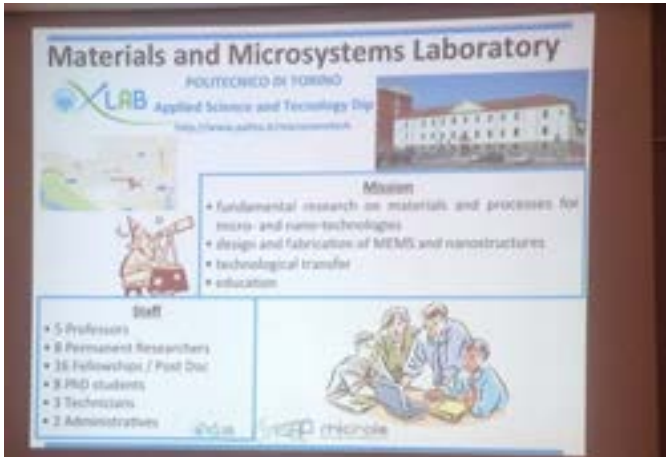
3D flexible micro-supercapacitors

Supercapacitors: bursts of energy, low energy density
Comparison with battery
Technological challenges

Graphene based material
MEMS
Polymer substrate

Graphene properties
Solution: graphene oxide
Then reduction of GO
Loading with metal oxide particles
Very high surface area

Fabrication: LIGA-like, high AR
Silicon master
3D flexible µsupercapacitors
Loading of µstructure
Characterization 10mF/cm²



Exhibitor elevator pitch (3 min) - **IcoFlex**

2016: Metrology machine for watchmakers. GyroTracker. Micro-movements of metallic parts

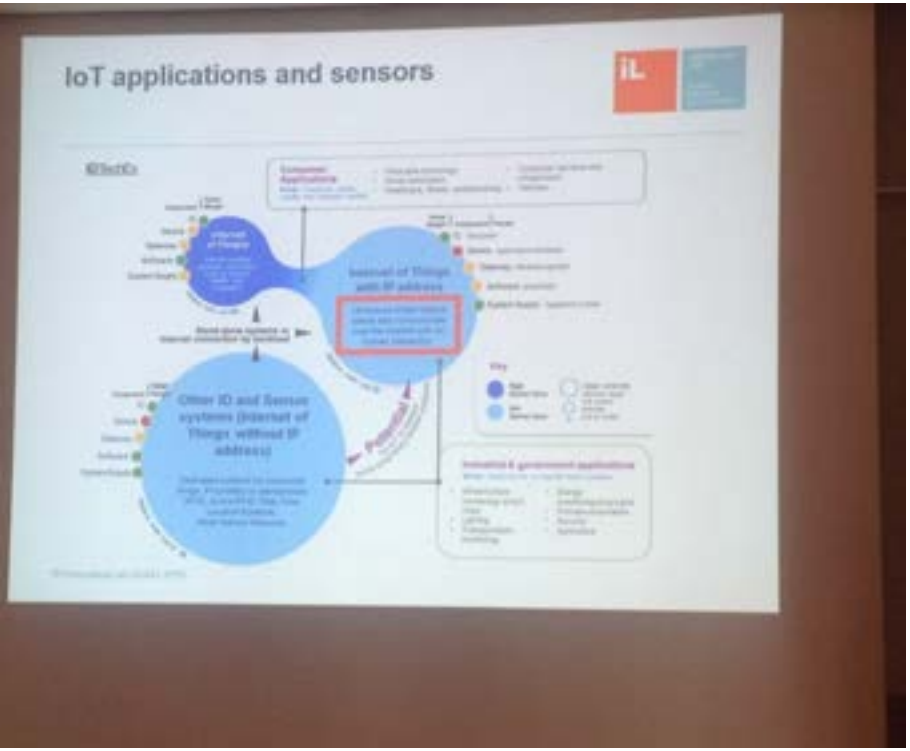
10:30 - 12:00 **Novel Manufacturing II - Printing Technologies**

Chair: David Tolfree, Mancef

Keynote: Dr. Martin Raditsch, Managing Director Business of InnovationLab GmbH (Germany)
Printed sensors for the IoT

Internet device forecast: mostly wrong
But…smart TV, wearables (?)
Smart world – INTEL
IoT Hypecycle (Gartner 2014)
Autonomous cars

IoT applications and sensors
From OLED and OPV to Sensors
Consumer and industrial applications



Smart homes: will come
Bio-degradable electronics (KIT-Forbes, 9-2015)
Hybrid wireless sensor node – printing/Si

INNOVATONLab: Printed organic electronics
Sensors!
Mass production, labels…
CHEAP

Printing stages 1, 2 and 3 –
Examples:
TEG
Replace ITO – Touch screen applications
Printed force sensor – piezoresistive – medical
LOC printed, diapers-sensors: delivery!
Disposable pressure sensor: Decubitus

Dr. Giovanni Nisato, Business and technology development senior manager CSEM Basel (Switzerland)

CSEM submicron printable technologies

Macro trends: additive manufacturing
ITC/life sciences…

Printable electronics 5-500 k$/m² to <1 $/m²
Complementary to Silicon
Feature sizes – dimensions

CSEM: Surface engineering, PV
Hybrid int., design, modelling, testing, PV

Device examples, R&D flows
Gravure printing: mature industry,
fixed pattern, >10 µm

Workflow toward design kit
Gravure printed diode-connected inverter

Sub-micron: re-tooling from optics
CSEM submicron OTFT building blocks
Submicron OTFT –simulations at CSEM

Gravure 30 microns pitch

USP: value for basic functions

Towards submicron

Dr. Dario Mager, Institute of Microstructure Technology (IMT), KIT, (Germany)

Printed MEMS – getting micro manufacturing out of the cleanroom

History of ink jet printing

No cleanrooms, not high volume

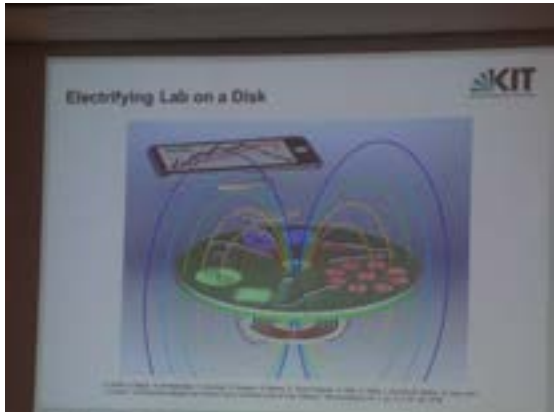
Electroplated structures: thin – receiver coils
Thickness limited

Self-rolled structures in a tube
PDMS µ-tubes
Diameters: wide range

µ-NMR receivers: rolling on glass tube
Fancy structures inside tubes

Broke man‘s LIGA
Electroplate inside trench
Printed Track used as shadow mask
Wafer scale

Electrifying Lab on a Disk
Prototypes
Putting detection and intelligence on disk
Energy supply



Exhibitor elevator pitch (3 min) - **microTEC Südwest**

380 members – special interest groups: printing, smart health, industry 4.0…

13:30 - 15:00 **Novel Manufacturing III - Assembly and Laser Methods**

Chair: Danick Bionda, Micronarc

Keynote: Prof. Yves Bellouard, Galatea Lab, Richemont Chair in Micromanufacturing, EPFL (Switzerland)
Femtosecond laser processing of dielectrics: a micro-manufacturing platform for single-material multifunctional microsystems

Microcity
One material – one function
How about 3-D structures?
Increasing number of functionalities

Monolithic integration: example optical bench, one piece of glass, micro-gripper
Modify material properties locally at will:
Non-linear absorption – pulsed lasers

Applications with fused Silica

Local increase of refractive index
Waveguides, gratings…

Waveguides+channels, optomechanics, 3D, flexures in glass, waveguides+flexures, Transparent actuators, dielectrophoresis devices,
cantilevers for laser- matter interactions, polarization and stress (Gpa!)

Mechanical properties of glass

Packaging of optics: positioning by laser

Laser morphing: surface tension (spheres)

Prof. Dr. Klaus-Dieter Lang, Director, Fraunhofer Institute for Reliability and Microintegration IZM (Germany)

Advanced Assembly and Integration Technologies for Miniaturized Electronic Systems

Wafer level –panel level integration
System integration-driving forces
Design, Technology, Reliability

ASTROSE – wireless sensor node
Power line - capacitive harvester
Sensor systems and electronics
Requirements on integration

Every application requires…

Interface to digital world, human-machine interface

Device integration:

Example - Apple A5 processor
Interconnect resolution trend

Fan out, embedded die, thru silicon via

Wafer level – Panel level: Size!

Interconnects: size scaling
3d-integration: cleanroom conditions

Panel level – PCB technology

Combine wafer level and PCB

Example: Camera – Who makes Decisions?

Prof. Dr. Boris N. Chichkov, Leibniz Universität Hannover and Laser Zentrum Hannover e.V. Head of the Nanotechnology Department (Germany)

3D laser nanoengineering and printing of nanoparticles

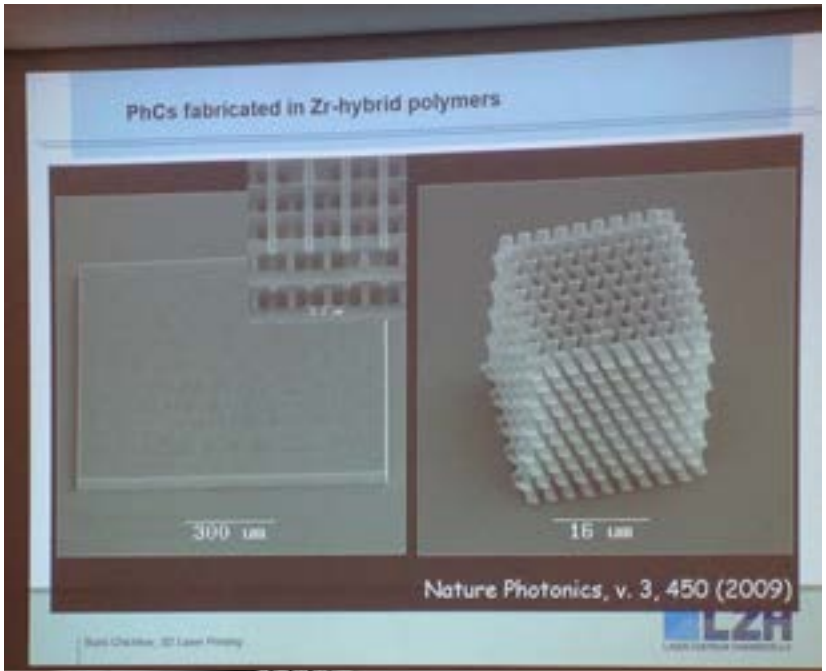
Generation of nanoparticles: Au (ablation)
Electrophoretic coatings

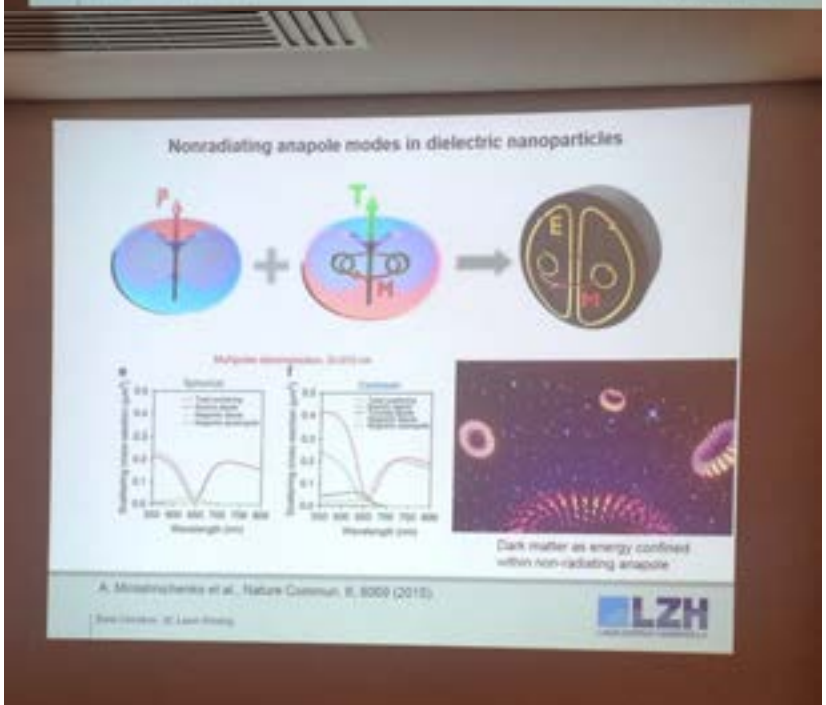
Two photon absorption
Photonic crystals, interconnects, super-strong materials
Tissue engineering: scaffolds, also from fibrin
3D conductive polymers
Splitting of beams

Laser printing of nanoparticles (Au), catch droplets, also as antennae

Huge arrays of nanoparticles

Printing of Si particles
Mie theory
Amorphous phase – unstable
Non-radiating particles
Optics with nanoparticles





Additive manufacturing:
Laser-melting: 100 µm to 1 µm
Print on top on each other AR = 40

Stem cells can be differentiated within the printed pattern

15:30 - 16:15 **Invited Keynote on the Future of Micro-manufacturing II**

Prof. Dr. Andreas Manz, Head of Research, KIST Europe Forschungsgesellschaft mbH (Germany)

» European Inventor Award 2015 for lifetime achievement

Beyond Microfluidics, biomimetics or self-assembly?

LOC achievements
No killer apps yet

Early devices
3D manifold
Older videos

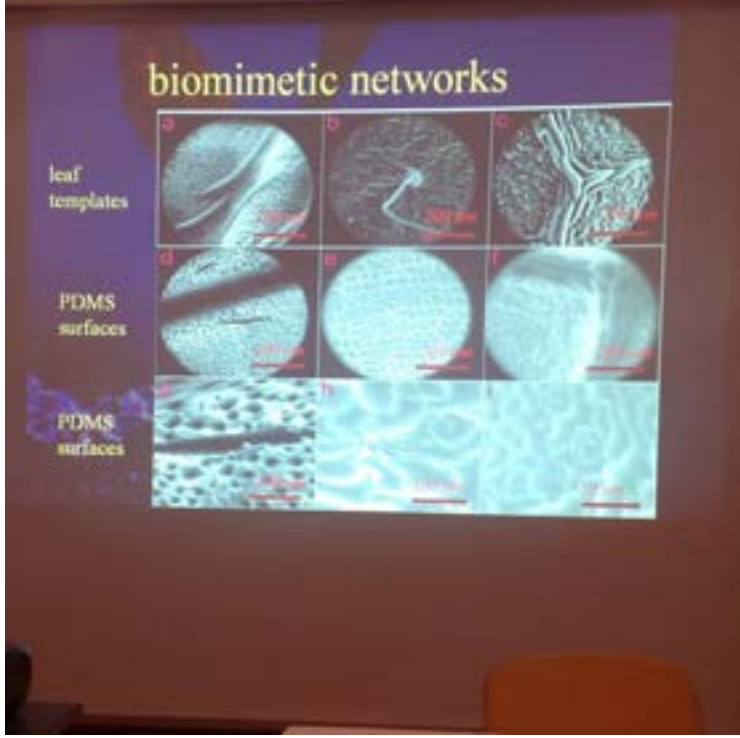
Substrates mostly glass to glass
Integrated features mostly nothing
Topology of channels
Interfacing: **It is a chip in a lab**
Application areas
Commercialization
Best commercial case: Caliper
New horizons?

- more of the same?
- early patents expired
- new materials? Paper!
- new fields? Stem cell biology, organ on a chip, wearables
- technologies? Droplets in oil! Droplets on surface!
- Large scale int. of valves?
- Nano scale? Single molecules?

Capillary forces and phase gates
Feed cells by phase gates (MIMETAS company)
3d liver cells – metabolism – chip is the best
Canaliculi formation – chip is the best

Microfluidic networks: biological channels:
no constant cross section, not smooth
Biomimetic networks: leaf > copy in PDMS > glass
Microfluidics: filling the structure
No straight lines. Put cells into it. Melanoma cells

Self assembly
Flies are self-assembled! Mechanical structures?
Si-cubes in paramagnetic fluid and magnetic field
Diffusion and Brownian motion, combinatorial problem
Externally propelled, self propelled
Magnetotactic bacteria:
Self propelled with external steering
Capillary forces: logic, four parts of self assembly
Fabricated SU-8 tripods > Project cancelled
Soap bubbles – helices from soap, ion track channels



16:15 - 16:30 **Final Remarks**

Prof. Dr. Volker Saile, Karlsruhe Institute of Technology (Germany), President, Mancef

Danick Bionda, Secretary General, Micronarc

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Exhibitors

Thanks

See you at COMS2016 in Houston, TX

ASME

COMS
Commercialization of Micro, Nano, and Emerging Technologies

JW Marriott Houston, Houston, TX, USA

CONFERENCE
August 28 – 31, 2016
EXHIBITION
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TRANSFORM lives.

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VILLAR-SUR-OLLON

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