Welcome to the Chemnitzer Seminar “System Integration Technologies”
Smart Systems Campus Chemnitz

A – Institute of Physics and Center for Microtechnologies at the CUT
B – Fraunhofer ENAS
C – Start-up-building
D – Lightweight Structures Engineering
E – 3D-Micromac AG
F – Microflex Center Chemnitz (3D-Micromac AG, Fraunhofer ENAS)

G – MAIN
H – EDC Electronic Design Chemnitz GmbH
I – Competence Center IT and Catering
Fraunhofer Institute for Electronic Nano Systems

Director: Prof. Dr. T. Gessner
Deputy Directors: Prof. T. Otto and Prof. S. Schulz

Rep. Office Manaus Brazil
Multi Device Integration (OE 610)
Prof. Otto

Rep. Office Shanghai China
Printed Functionality (OE 630)
Prof. Baumann

Rep. Office Tokyo/Sendai Japan
System Packaging (OE 650)
Dr. Wiemer

Administration
Mr. Höppner

Micro Materials Center (OE 620)
Prof. Rzepka

Back-End of Line (OE 640)
Prof. Schulz

Advanced System Engineering (OE 660)
Dr. Hedayat
Main working fields

International Offices of Fraunhofer ENAS:

Since 2001/2005 Tokyo/Sendai, Japan
Since 2012 Project-Center in Sendai
Since 2002 Shanghai, China
Since 2007 Manaus, Brazil

Systems integration by using of micro and nano technologies

- MEMS/NEMS design
- Development of MEMS/NEMS
- MEMS/NEMS test
- System packaging/waferbonding
- Back-end of Line technologies for micro and nano electronics
- Process and equipment simulation
- Micro and nano reliability
- Printed functionalities
- Advanced system engineering
2014 - Kernkompetenzen der Abteilung 500

**System Packaging**

- Competence extension
  - Ionic Liquids
  - New materials
  - Packaging for bio MEMS
  - MEMS for acoustic applications
  - Nano effects

**Waferbonding**

- Bonding with nano effects
- Temporarily bonding
- Low temperature bonding
- Characterisation for bonding

**Integration technologies**

- Printing for bonding and contacting
- 3D Integration (chip- and wafer level)
- Harsh environment MEMS

**Service**

- Dicing
- Wire bonding
- Wafer bonding
- Technology consulting and transfer
Materials & Technologies
(Group Leader: F. Roscher)

Topics
- Aerosol-Jet deposition
- Screen printing (Contacting, Bonding)
- Bonding by Nano effects (ionic liquids)
- Bond characterization

Integration technologies
(Group Leader: M. Baum)

Topics
- Temporarily and permanent bonding
- MEMS Packaging (medical and acoustic applications, harsh environment)
- Integration technologies (3D MEMS+ electronics)
- Nanoimprinting

Operators:
- Kinner, Uhlig, Lesner

Service:
- wafer dicing, wire bonding, analytics, sample preparation

Scientists:
- Roscher, Seifert, Saeidi, Vogel, Hertel, Reich

Scientist:
- Baum, Frömel, Wünsch, Haubold, Gabler, Hofmann, Wang

Printed Interconnect for industrial automation

MEMS Packaging for medical devices
Mean processes for temporary waferbonding

- Preparation of device wafer
- Preparation of carrier wafer
- Adhesive waferbonding
- Wafer de-bonding

Temporary waferbonding – key technology for 3D-Integration
Temporary waferbonding – key technology for 3D-Integration

TEMPORARY BOND WITH THERMOPLASTIC ADHESIVE

- Device Wafer
- Spin Coat Thermoplastic Adhesive
- Cure Adhesive
- Flip Wafer
- Mechanical Debond at Room Temperature
- Clean Device Wafer on Frame

TEMPORARY BOND WITH THERMOPLASTIC ADHESIVE

- Device Wafer
- Spin Coat Thermoplastic Adhesive
- Cure Adhesive
- Flip Wafer
- Thermocompression Bond (Temperature / Force)

ROOM TEMPERATURE PEEL-OFF DEBOND

- Thinned Device Wafer
- ZoneBOND™ Carrier
- Attach to Dicing Frame
- Mechanical Debond at Room Temperature
- Clean Device Wafer on Frame

ROOM TEMPERATURE PEEL-OFF DEBOND

- Carrier Wafer
- Spin Coat Release Layer
- Soft Bake Release Layer
- Bond (Temperature / Force)
- Clean Carrier

Fig.: Process flow of Zone-Bond de-bonding process (Zone-Bond)

- Mechanical room temperature over peel-off process
- Two Zone carrier needed
- Edge release needed

Fig.: Process flow of new temporary zoneless de-bonding process (Brewer-Bond)

- Mechanical room temperature over peel-off process
- One Zone carrier
- Edge release not needed
Temporary waferbonding – key technology for 3D-Integration

Different Methods established with different requirements regarding thermal, chemical and mechanical stress

Traditionally Methods:
- Thermal slide, Laser release

New Trend:
- Mechanical room temperature over peel-off process
- **Zone-Bond de-bonding process (Zone-Bond); New: zone-less de-bonding process (BrewerBond)**

ENAS-focus:
- Zone-less de-bonding process from Brewer Science with temporary waferbonding over an adhesive
- Reason → room temperature de-bonding technology
Temporay waferbonding – key technology for 3D-Integration

- ENAS method → adhesive temporary waferbonding
- Complete process flow to fabricate thin wafer (up to 50µm) → ZoneBond process established
- Research focus: from Zone-Bond to zone-less de-bonding techniques to reduce process time and costs
- Critical: cracks on wafer edge after wafer thinning

Fig.: Puddle-dispense cleaning of thin device wafer on tape frame

Abb.: De-bonding (SÜSS-DB 12T) and Coater system (SÜSS RCD 8)

Abb.: waferbonding system (SÜSS-SB 8e)
Technology Screen Printing

DEK Horizon 03iX

- Screen frame: 736 x 736mm (29" x 29") standard
- Printable Area (510mm x 508.5mm)
- Modul for Via Filling
- Modul for Dispensing
- Vector Guard stencil printing
- Machine Alignment >2 Cpk @ +/- 12.5µm, 6 Sigma
- Process Alignment >2 Cpk @ +/- 25µm, 6 Sigma #

Strukturmorphologie: Lateral 50 µm - 150 mm; Vertikal 10 µm - 1 mm

Source: SMTnet
IV. Technology

DEK – Via Filling Technology Pro Flow

Filled through glass vias by stencil printing
<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Company</th>
<th>Titel</th>
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</thead>
<tbody>
<tr>
<td>13:00</td>
<td>M. Wiemer</td>
<td>Fraunhofer ENAS</td>
<td>Welcome note, Packaging of MEMS devices – An overview</td>
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<tr>
<td>13:20</td>
<td>Jörg Siegert</td>
<td>ams AG</td>
<td>Open TSV technology for 3D sensor applications</td>
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<tr>
<td>13:55</td>
<td>Dr. Peter O’Brien</td>
<td>University College Cork</td>
<td>Packaging of integrated photonic devices; applications, user foundry</td>
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<tr>
<td>14:20</td>
<td>Thomas Krebs</td>
<td>Heraeus Deutschland GmbH &amp; Co. KG</td>
<td>Silver sinter interconnects in diversified applications</td>
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<tr>
<td>14:45</td>
<td>Toru Kondo</td>
<td>Olympus</td>
<td>16Mpixel 3D stacked CMOS image sensor</td>
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<tr>
<td>15:10</td>
<td>Coffee break</td>
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<tr>
<td>15:40</td>
<td>Felix Gabler</td>
<td>Fraunhofer ENAS</td>
<td>Towards MEMS loudspeaker fabrication by using metallic glass thin films</td>
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<tr>
<td>16:05</td>
<td>Margarete Zoberbier</td>
<td>SUSS MicroTec Lithography GmbH</td>
<td>MEMS packaging – Infinite variety of bonding applications</td>
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<tr>
<td>16:30</td>
<td>Reinhard Jurisch</td>
<td>Microsensys</td>
<td>Passive RFID sensor solutions</td>
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<tr>
<td>16:55</td>
<td>Dr. Dieter Rammlmair</td>
<td>Federal Institute for Geosciences and Natural Resourcesa</td>
<td>Geology needs MEMS and sensors</td>
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<tr>
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<td>09:00</td>
<td>09:10</td>
<td>M. Wiemer</td>
<td>Welcome</td>
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<tr>
<td>09:10</td>
<td>09:35</td>
<td>Sven Bochmann</td>
<td>MEMS-based industry 4.0 applications</td>
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<tr>
<td>09:35</td>
<td>10:00</td>
<td>Dr. Ursula Palfinger</td>
<td>Large-area patterning by roller-based nanoimprint lithography</td>
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<tr>
<td>10:00</td>
<td>10:25</td>
<td>Steffi Proschwitz</td>
<td>Applications of thermal nano imprint lithography</td>
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<td>10:25</td>
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<td>Coffee break</td>
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<td>10:55</td>
<td>11:20</td>
<td>Dr. Martin Eibelhuber</td>
<td>Oxide free direct wafer bonding</td>
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<td>11:20</td>
<td>11:45</td>
<td>Dr. Axel Müller</td>
<td>Telecardiology – Technical innovations and challenges in clinical practice</td>
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<td>11:45</td>
<td>12:10</td>
<td>Marco Haubold</td>
<td>Packaging and fabrication opportunities enabled by the room temperature deposition of Parylene</td>
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<td>12:10</td>
<td>12:35</td>
<td>Prof. Dr. Richard Funk</td>
<td>MEMS and biological cells – advances in designing sensors, actuators and biocompatible surfaces for medical use</td>
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<td>12:35</td>
<td>13:00</td>
<td>Michel Brizoux</td>
<td>Thales vision and need in advanced packaging for high end applications</td>
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Second Day – Wednesday June 24, 2015