Recent developments regarding Optical MEMS and their applications

Dr. Michael Scholles
Director “Business Development & Strategy”

Fraunhofer Institute for Photonic Microsystems
Maria-Reiche-Strasse 2
01109 Dresden / Germany

www.ipms.fraunhofer.de
scholles@ipms.fraunhofer.de
HISTORY
Fraunhofer IPMS

1992  Fraunhofer IPMS started as branch of the Fraunhofer Institute of Microelectronic Circuits and Systems

2003  Fraunhofer Institute for Photonic Microsystems (Fraunhofer IPMS) became an independent institute in Dresden

2005  Fraunhofer Center Nanoelectronic Technologies (Fraunhofer CNT) founded as Public Private Partnership with AMD & Infineon

2007  Modernization of the institute and opening of a new MEMS clean room

2013  Fraunhofer CNT became a department of Fraunhofer IPMS as business field IPMS-CNT
Fraunhofer IPMS clean rooms

- 1500 m², class 10
- 150 mm (6”) Wafer line
- 3 shift preparation for R&D and pilot fabrication
- Technological parameter supervising system
- PPS based planning and documentation
- ISO 9001 certification

- 800 m² clean room, class 1000 & 200 m² laboratory area
- 40 Tools for Wafer Processing, Patterning, Metrology & Analytics
- Qualification of processes & materials on 300 mm industrial standard equipment
- Sub-nm characterization and verification
- Full integration into customer process flow in 28 nm technology and beyond
Fraunhofer IPMS Location in the „Silicon Saxony“

Sources: Google / Bing / Infineon / Globalfoundries
Spatial Light Modulators

16 μm pitch
2048 x 512 pixel
(1Mega-Pixel)
2 kHz frame rate
Operating wavelength 248nm
Custom-built SLM by Fraunhofer IPMS: Applications

Laser Direct Imaging

Microscopy

Mask Writing

Adaptive Optics
MICRONIC MYDATA’s SIGMA 7700 Mask Writer

Application

- Quick turn-around and cost-effective production of reticles.
- Prints entire mask set at the 90nm technology node, and non-critical photomasks down to the 22nm node
- 3h per reticle (4-pass writing), ~1.5h (2-pass-writing)
- Ideal solution for 2nd layer patterning of advanced PSM and well-suited for advanced image sensors

Status: Several systems in field

Custom-built SLM by Fraunhofer IPMS: Applications

- Laser Direct Imaging
- Mask Writing
- Microscopy
- Adaptive Optics
Introduction: Laser direct imaging in substrate industry

- In semiconductor packages, interposers and substrates interface chips to the outside world. Advanced packages require a LS resolution down to 10 μm.
- Cost-effective substrates are produced from organic (plastic film) material. They are processed in form of large panels (e.g. 51cm x 51.5cm).

Source: Micronic Mydata annual report 2011
http://www.micronic-mydata.com
Introduction: Laser direct imaging in substrate industry

- Micronic Mydata’s new LDI5sp system accounts for shape changes: high resolution and pattern overlay without loss of productivity.
- Fraunhofer IPMS contributed spatial light modulator (SLM) to the system.
**SLM features**

<table>
<thead>
<tr>
<th>LDI SLM Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chip dimensions [mm]</td>
<td>15 x 88</td>
</tr>
<tr>
<td>Dimensions of pixel area [mm]</td>
<td>4 x 82</td>
</tr>
<tr>
<td>Fill grade of active area [%]</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>Number of optical pixels</td>
<td>8192</td>
</tr>
<tr>
<td>Mirrors per optical pixel</td>
<td>268</td>
</tr>
<tr>
<td>Mirror material</td>
<td>Al-alloy</td>
</tr>
<tr>
<td>Operating wavelength [nm]</td>
<td>355</td>
</tr>
<tr>
<td>Mirror reflectance at 355nm [%]</td>
<td>&gt; 85</td>
</tr>
<tr>
<td>Pixel resonance frequency [MHz]</td>
<td>&gt; 1.3</td>
</tr>
<tr>
<td>Achieved contrast</td>
<td>Up to 1000</td>
</tr>
</tbody>
</table>
Assembly of SLM chip

- SLM electrodes are hard wired to external data path.
- This enables a high-rate parallel update of all pixels.
SLM performance in exposure system: Exposure results

- 15 um DFR on Cu seed layer, patterned with a micro-VIA interconnect test pattern. Minimum line/space feature size is 6 um.
Micro Scanning Mirrors

- Technology
  - Bulk micromachining
  - 1D-Scanner
  - Frequency: 250 Hz
  - Diameter: 1.5 mm
  - Deflection angle: up to +/- 34°
    (136° optical scan range)
Micro Scanning Mirror Variants and Applications

1D rot.

Grating

Linear Scan

2D rot.

translatory

Your Device
Application: Biometry

MARS: Mobile Authentication by Retina Scanning
Application: 3D Camera
Application: Biomedical Imaging

ZEISS light sheet fluorescence microscope system Lightsheet Z.1
## Technology Toolset at Fraunhofer IPMS

### MEMS/ MOEMS

**Bulk MEMS**
- 3-dim. Structures in Silicon
- Applications:
  - MEMS Scanner
  - Pressure Sensor

**Surface MEMS**
- Thin film surface MEMS
- Applications:
  - Spatial Light Modulator
  - CMUTs

### CMOS & „active“ Silicon
- High Voltage CMOS
- Photodiodes
- pH- Sensor
Barcode reading systems based on micro scanning mirrors

PIN-Diodes for high precision optical measurement and positioning

Piezo resistive pressure sensors for automotive applications
THANK YOU FOR YOUR ATTENTION!

Michael Scholles; phone: +49-351-8823-201; email: scholles@ipms.fraunhofer.de