

Micro and Nano systems (Alain Bosseboeuf)

[3D Integrated MOEMS]

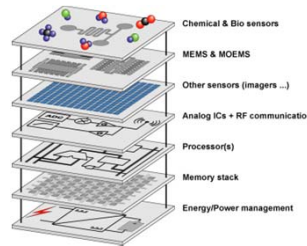
生産技術研究所 マイクロナノメカトロニクス国際研究センター
Centre for International Research on MicroNano Mechatronics

<http://www.cirmm.iis.u-tokyo.ac.jp>

Fundamental Microsystem Engineering

Objectives

Development of technology and characterization techniques for 3D Integrated Micro Opto Electro Mechanical Systems and application to microsensors and microinstruments



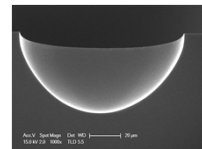
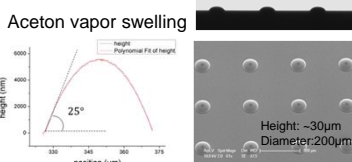
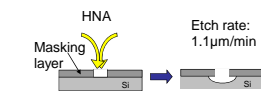
Benefits of 3D Integration

- Smaller footprint
- Easier heterogenous integration:
 - Light sources and detectors
 - Electronics & Packaging
 - III-V, glass, Si, polymer devices
- Mapping and imaging capabilities

Micro-optics for MOEMS

Fabrication processes of large size refractive microlenses (Zhou Yifan, S. Edmond, Nguyen Phuoc Trung Hoa, A. Bosseboeuf)

- 1) UV Lithography of a cylindrical pattern
- 2) Pattern swelling by heating or by acetone vapor exposure
- 3) Transfer into Si by RIE etching

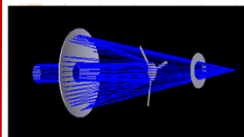


3D integrated MOEMS

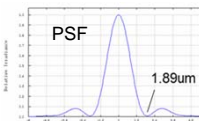
Array of tunable Fabry Perot filters for a spectral imaging camera (Thesis Hervé Bertin, Coll. Institut d'Optique, SAGEM)

3D Integrated Swarzschild achromatic micro-objective (Thesis Zhou Yifan)

Principle



Optical simulations (Ray tracing), (Pupil=1mm, λ=550 nm)



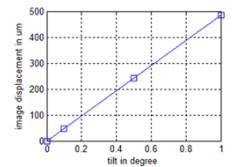
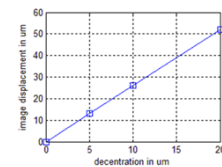
After optimization (ideal case)

Spherical aberration = $4 \times 10^{-4} \lambda$.
Coma & astigmatism perfectly corrected

3D Integration (3 wafers)



Effect of imperfections (ex: misalignments)

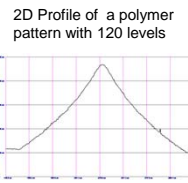
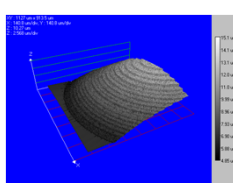


Multilevel (diffractive) optical elements by 3D lithography (V. Mathet, X. Leroux, A. Bosseboeuf)

3D e-beam lithography
In electrosensitive glass



3D laser beam lithography



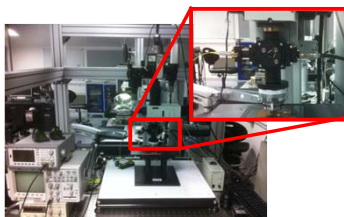
New characterization techniques

MEMSCAN **FOGALE nanotech**
OCT system with NIR Imagong



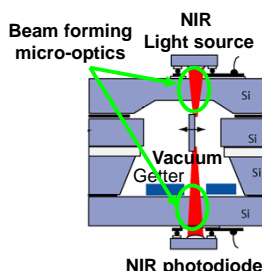
- Deep Via etching depths
- Wafer TTV & bow
- Stacks: thicknesses & gaps
- Wafer bonding defects

Laser Doppler & knife-edge vibrometer



- Simultaneous out-of-plane and in-plane vibrations measurements
- Optical actuation of Si resonators with NIR beam (No heating)

All optical resonant sensor (P. Coste, P. Fabbri, F. Parrain, G. Raynaud, A. Bosseboeuf, Coll. ONERA-ESIEE)



Samples fabrication in progress

- Optical actuation by radiation pressure and/or optical field gradient
- Motion detection by knife-edge or deflection techniques
- Tuning fork resonator with Si/Vacuum Bragg mirror
- Vacuum packaging with getter