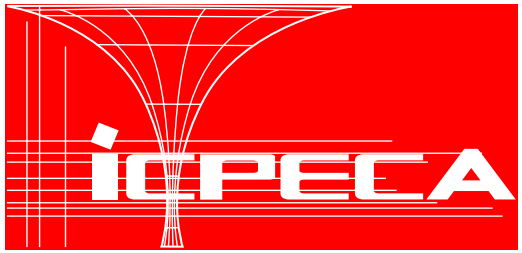

NATIONAL INSTITUTE OF RESEARCH & DEVELOPMENT FOR ELECTRICAL ENGINEERING - INCDIE ICPE-CA

Micro and nano-structure processing, using LIGA technology

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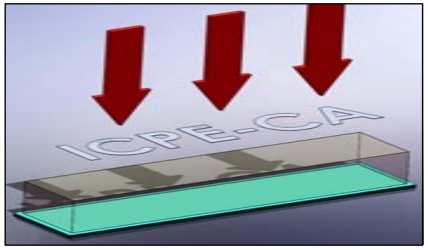
LIGA technology - last step to integrate the research results in the real industry

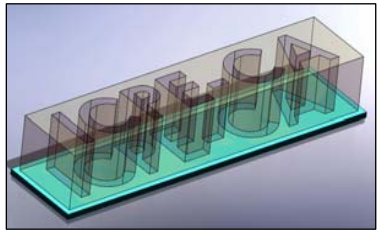
- **INCDIE ICPE-CA develops research projects in the field of nanotechnology :**
  - **New materials : - multifunctional metalic materials;**
    - micro and nanostructured magnetic materials;
    - advanced carbonic materials
- **INCDIE ICPE-CA puts in a good use the research results und integrate the new materials in:**
  - **Micro and nano-electromechanical systems (MEMS & NEMS);**
  - **Micro and nano-actuators;**
  - **Micro and nano-sensors;**
  - **New sources of energy (micro fuel cells and hot pipes);**
- **How ? – using LIGA technology to process small and high precision mechanical parts and create MEMS & NEMS;**

LIGA technology

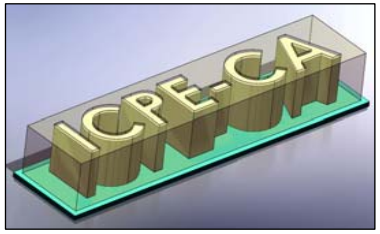
1. Exposure



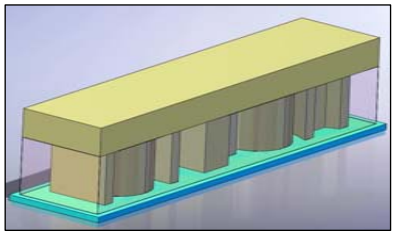
2. Developing



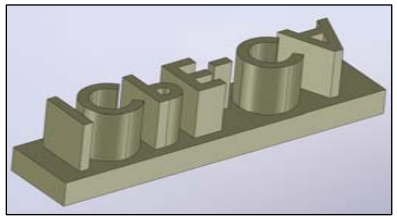
3. Electroplating



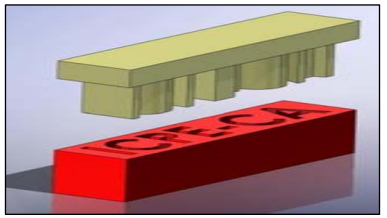
4. Mould processing



5. Metal mould

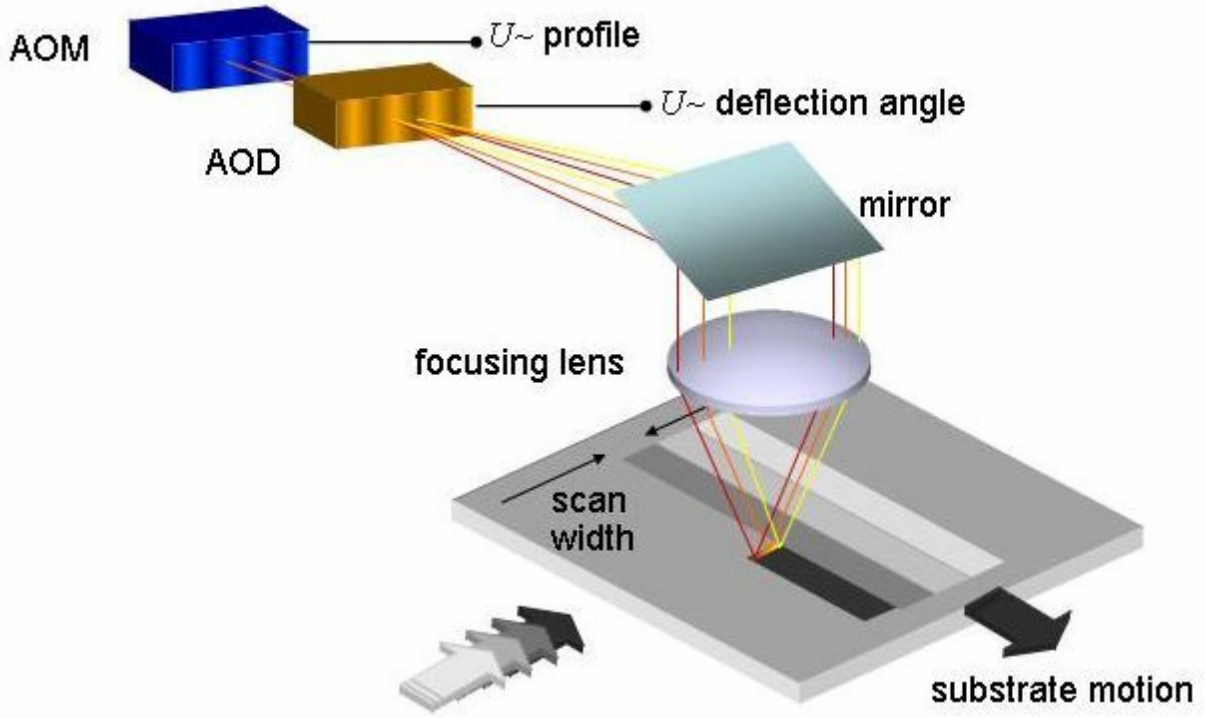


6. Hot embosing



- Laser litography system
- Stripping tool for SU8 resist

LIGA – direct laser writing



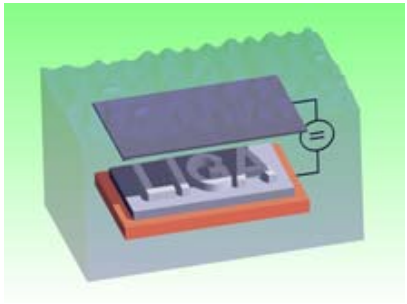
AOM - Acusto-optical modulator, AOD - Acusto-optical deflector

Laser lithography system (laser wavelenght :365 nm)

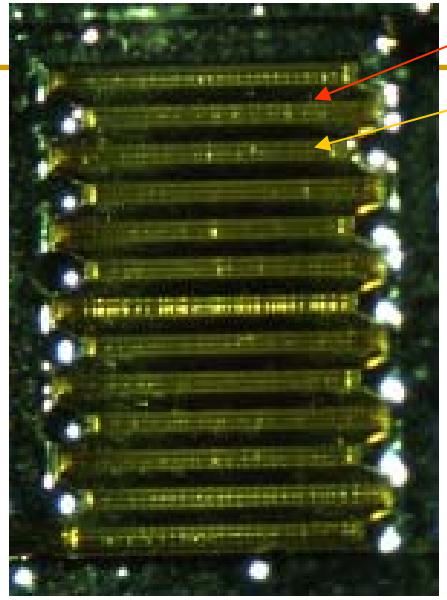
- minimum structure size : 0.6 µm
- accuracy : 200 nm

ELECTROPLATING of WAFERS with Ni

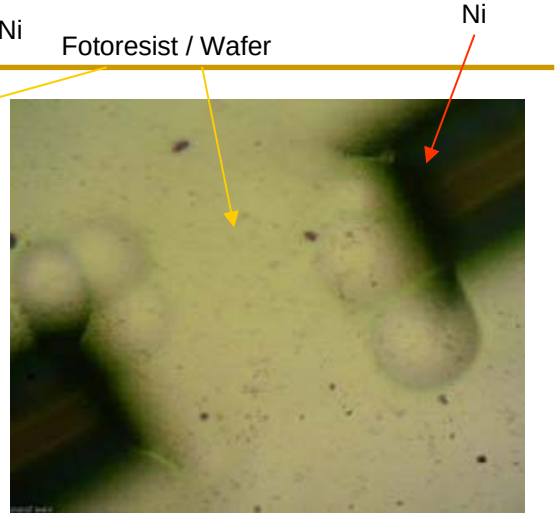
Aim of electroplating



Transform the resist structures into metallic structures



Optical image for electrodeposited Ni onto a wafer substrate



Optical micrography for electrodeposited Ni onto a wafer substrate at 12.5X magnification

Sulfamate bath composition:

Ni(II) sulfamate:	280- 300 g/l
$NiCl_2 \cdot 6\ H2O$:	25- 30 g/l
H_3BO_3:	30 g/l
Naftalen trisulfonic acid	7. 5 g/l
Levelling agent	0.02- 0.05 g/l

Working parameters:

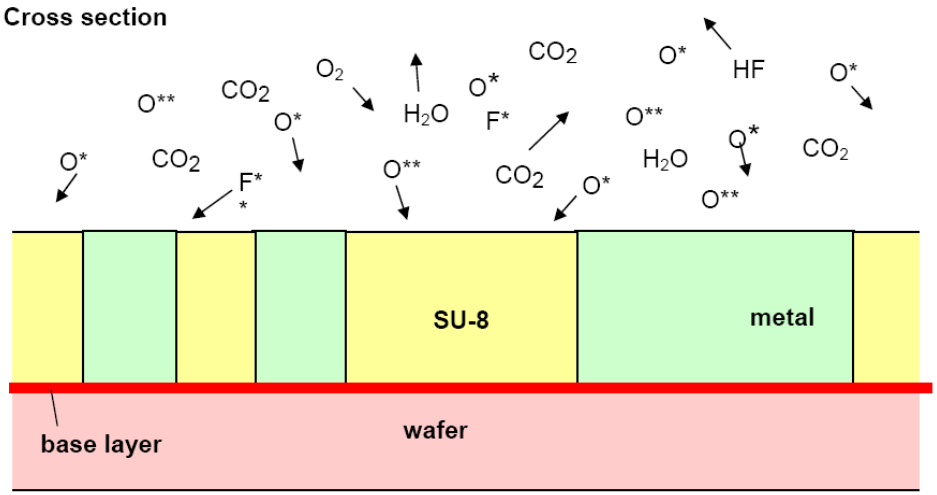
- pH = 3.5 – 4. 2;
- T^0 = 40 – 60^{0}C;
- d = 3 – 15 A/ dm^2
- Magnetic stirring
- Electrolyte filtering

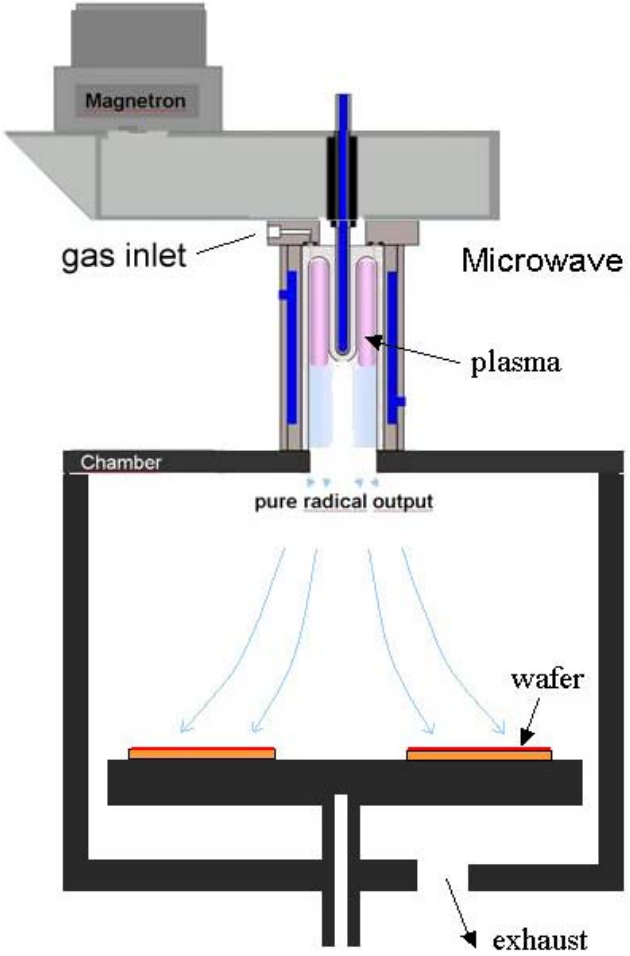
Advantages:

- the most robust process in LIGA electroplating;
- layers from pure electrolyte shows 230Hv;
- layers from electrolyte with additives >600Hv;
- high deposition rate: 40-60μm/h;
- high throwing power;
- very low internal strength

LIGA – stripping tool for SU8

- Plasma tool with 3 gas channels : O_2 , CF_4 , N_2
- Optimized for the removal of thick photo resist layers like SU8
- Only the radicals O^* and F^* react with SU8
- The metals don't react with these radicals and are therefore not attacked.

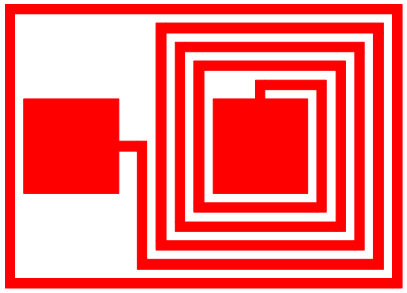
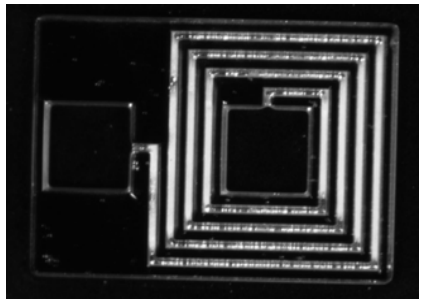
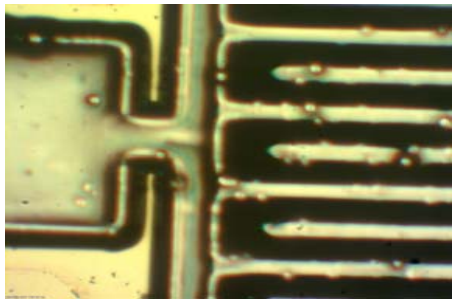
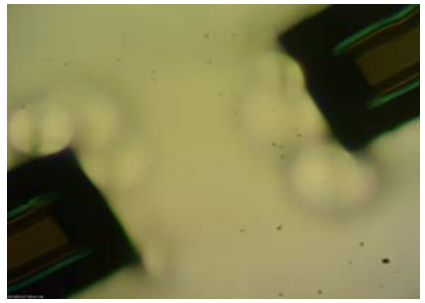


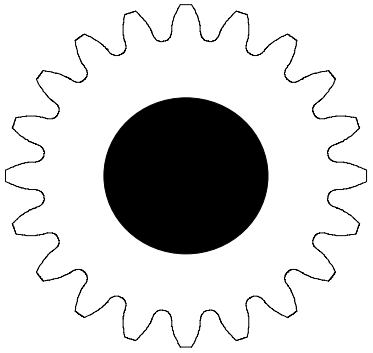
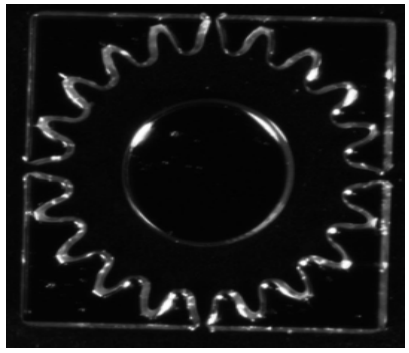
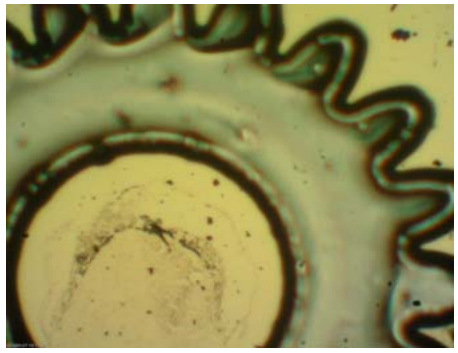
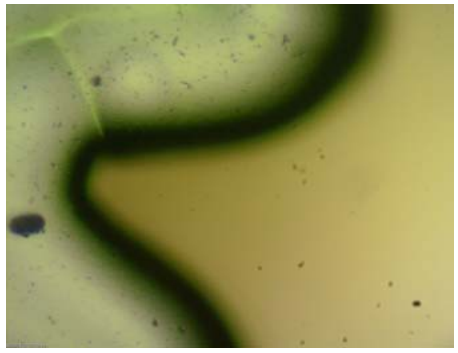


LIGA – main steps and process parameters for SU8 wafers

- Wafer 4 inch Si (100), doping n-type, 0.5 to 1µm termal SiO_2, one side coated with Cr/Au layer, SU8 resist on top of Cr/Au, 100 µm.
- **1.Transfer the drawing** of the part from CAD format in the LIC data format with a conversion program (Xconvert). MAP data format fix the drawing on the 4 inch wafer. JOB data format contain the working parameter.
- **2. Exposure** – optimized for i-line (375 nm) ; the process parameter are very sensitive (energy and defoc).
- **3. Post exposure bake –** minimize stress, wafer bowing and resist kracking; perform on a hot plate which adjust the temperature and the time.
- **4. Developing –** optimized for a special chemical developer (mr-Dev 600); strong agitation;
- **5. Rinse and Dry –** with isopropyl alcohol ; dry with a gentle stream of air.
- **6. Electroplating –** a multi-parameter problem for any electrolyte.
- **7. Stripping of SU8 resist** – a special plasma machine which can separate ions from neutral radicals; only the radicals O* and F* react with SU8
- **8. Remove the structure from the wafer**

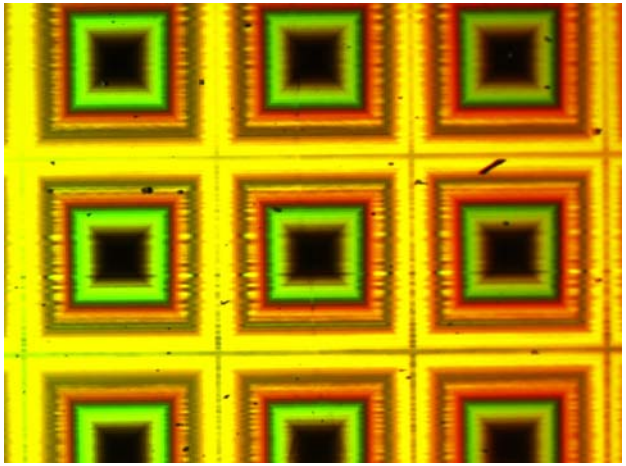
LIGA - aplications

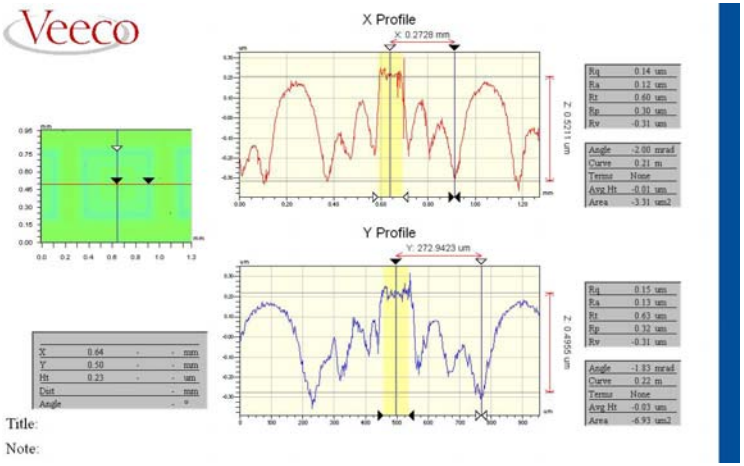





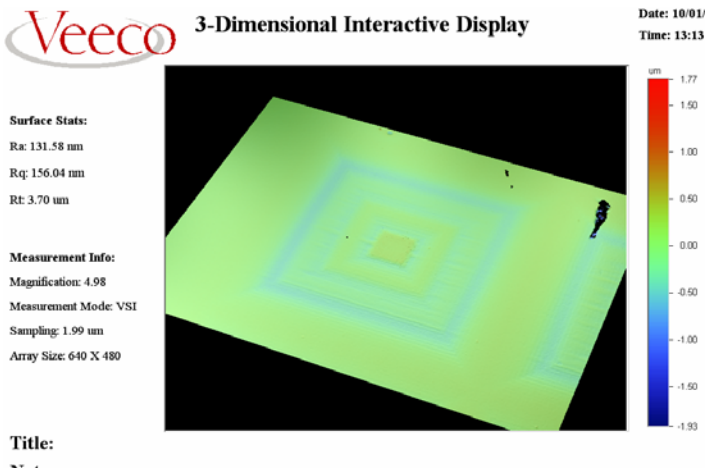





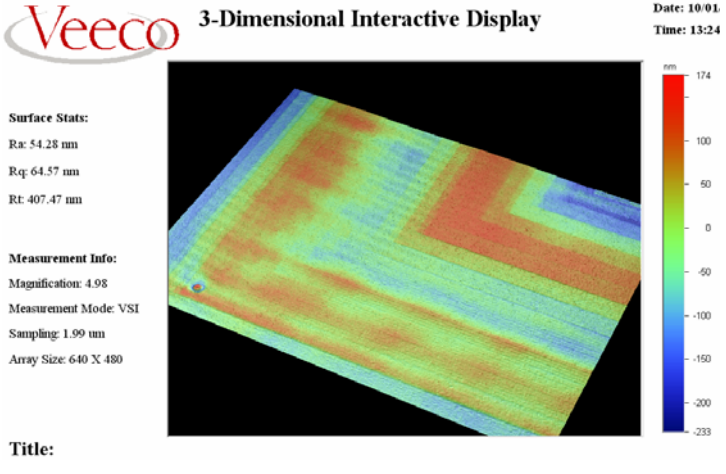
Drawing | Parts after developing | Parts after SU8 stripping | Detail

LIGA – metrology equipment









Interferometer Microscope Veeco NT-1100

Vertical resolution: 0.1 nm

Repeatability: < 0.01 nm

LIGA – metrology equipment

•Scanning Probe Microscope (SPM) Veeco Instruments

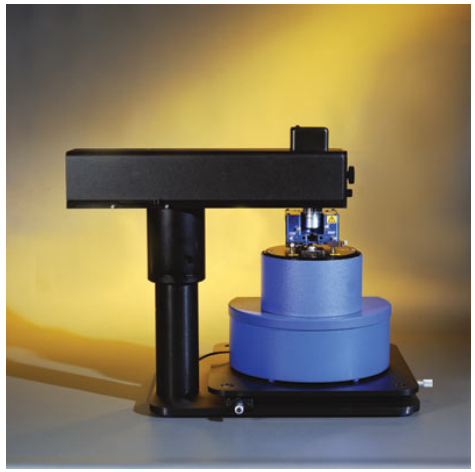
SPECIFICATIONS AND PERFORMANCE

System Configurations

Probe Head : Operates in C-AFM, NC-AFM, IC-AFM, LFM,STM, MFM, Nanolithography and conducting AFM modes.

Measurement Performance

Scanner : Large Area(~90µm) piezoelectric scanner.
Scan Range : Maximum lateral scan range: ~90µm.
Maximum vertical scan range: 7.5µm.
Control Resolution : Maximum DAC lateral resolution: 0.25A°.
Maximum DAC vertical resolution: 0.025A°.



•FESEM- FIB(Field Emission Scanning Electron Microscope Focus Ion Beam)

Essential specification:

- Resolution: GEMINI® column 1.0 nm at 15 kV and 1.9 nm at 1 kV
- Magnification : SEM 12 X -1.000.000 X
  FIB 300 X- 500.000 X
- MonoGIS –Platinum precursor
  Micromanipulator Kleindiek
-

Thank you very much!

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