MEMS: Training in Microsystems: Fabrication, Simulation and Characterization of Various MEMs and MOS Devices on a Chip

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For this practical training, we have chosen to illustrate the specificities of MEMs technologies through the elaboration of volume and surface micromachined devices such as pressure sensors, cantilevers, bridges, thermal deflectors, capacitive mirrors, etc. The pedagogic objective is to give the participants a practical example of the main technological steps commonly used in IC processing and available in clean room facilities such as Minatec clean rooms (CIME-Nanotech / PTA): wafer cleaning, photolithography, etching (wet/RIE), ion implantation, metal and polysilicon deposition (sputtering/CVD), annealing (RTP), … The process flow also includes specific MEMs techniques such as double face lithography, surface and volume micromachining.

We take benefit of the process to realize basic microelectronics devices: diodes, MOS capacitors and transistors. This implementation of IC and MEMs on the same chip helps in highlighting both the possibility and difficulty to integrate electronic functionalities together with sensing availability on a single chip.

Figure 1. ESONN students operating double side photolithography and in clean room (top pictures). Realized MEMS and MOS devices on 4” wafer (bottom picture).

The realization is completed with electro-mechanical, technological and electrical simulations using commercial simulators, to help giving an insight at the physical and electrical phenomena involved. The influence of different technological or device parameters is also revealed.

Different techniques for device and material characterization are used during the process: microscopy, profilometry, ellipsometry, four points probe … We emphasize on the necessity of these controls at various stages of the process. Numerous parameters are extracted: material thicknesses and resistivity, refractive index …

Microscopy (SEM, optical, interferometer) is used to image and measure the sensors and devices. We also take a look at other MEMs developed in research (micro-engines, finger print detectors, micro-mirrors array …) to give the participants a glance at more sophisticated MEMs. Finally, the devices are characterized: the thickness is determined with the profilometer and optically. An IR camera is used to check the gauge position relative to the membrane edge. Finally the devices are electrically characterized with a semiconductor parameter analyzer and specific 3D interferometer microscope.

More info: http://www.master-nanotech.com/old/Labs/introduction.htm