NANOFABRICATION LABORATORY SYNOPSIS

Introduction to Micro/Nano device design and fabrication

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The Advanced Materials Engineering Research Institute (AMERI) at Florida International University is a 10,000 sqft open access advanced research facility specializing in sensor and materials development from front end to back end with materials formulation and analysis, and device testing capabilities. The facility houses the Motorola Nanofabrication Facility (MNRF), which is a 4" to 8" Silicon/Silicon Carbide wafer fab, a full materials analysis and characterization laboratory containing SEMs/FIB/TEM, an advanced ceramics formulation and packaging laboratory, as well as a multi-material 3D printing/prototyping laboratory.

The **Motorola Nanofabrication Facility (MNRF)** is a 2,000 sqft (ISO 5-7) cleanroom specifically designed for MEMS and Nanotechnology device research and development to small device batch processing. All front end device processes are done in house, from design through wafer dicing. Our capabilities include mask writing for contact lithography or direct wafer writing with 0.9 micron resolution, nano imprint lithography, mask alignment to 1.0 micron precision, and full photolithography processing. Our ebeam nanolithography system is capable of 20 nm line widths over a 4" writable area, mainly for nanophotonics research. Metallization processes include ebeam evaporation and sputtering systems with multiple guns/targets. The MNRF also has a myriad of thermal processes for oxidation/diffusion/nanowire/CNT growth, full wet and dry etching facilities, metrology, and wafer probe testing stations. Polymer processing includes PDMS and parylene processing for microfluidics, flex cable, and bio-electrode research. The MNRF also has a DRIE capable of processing 4" to 8" Si, SiC, SiO2 wafers and BCB films. This capability extends our microfabrication design and material set to enable more complex devices, high temperature device development, as well as wafer level packaging. Finally the MNRF has an FEI Phenom SEM for fast process inspection up to 26kx, well beyond optical microscopy, as well as standard SEM analysis capabilities.

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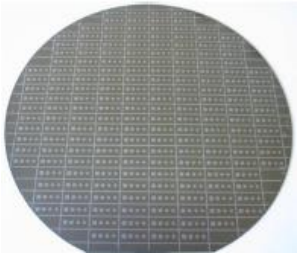
The objective of this laboratory is to provide an introduction to cleanrooms, wafer processing, and the sensor development capabilities of the AMERI via a summary of the micro/nanofabrication processes involved in building a MEMS pressure sensor.

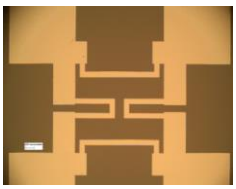
The following topics and process steps will be discussed:

- MNRF introduction: Cleanrooms enable micro/nanotechnology
- Semiconductor processing: CMOS vs MEMS/Nanotechnology
- Pressure sensors…….. what for and how they work……old and new
- Wafer and device processing and device testing

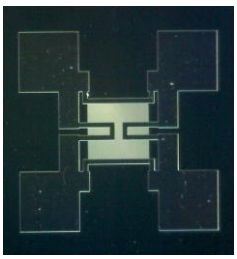
The MEMS Pressure Sensor



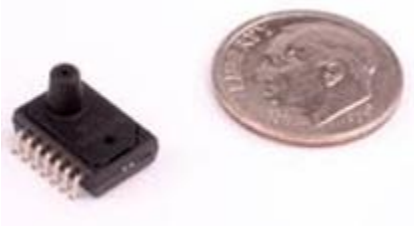
1) Silicon – Why?
2) Silicon Nitride Deposition – 1um membrane, Si_3N_4 vs Si or SiO_2
3) Frontside Photolithography – Patterning of device layers
   a. Coat – (Photoresist) Types and why?
   b. Expose
   c. Develop



4) Metal Deposition – The device electronics, what metals and why?
5) Metal Lift off – Creating the electrodes
6) LOR Strip (Lift Off Resist)
7) Frontside metrology and protection
8) Backside Photolithography/etching/membrane release
   a. Coat
   b. Align/expose
   c. Develop



9) RIE (Reactive Ion Etch)
10) Backside Photoresist Strip
11) KOH Etch (Potassium Hydroxide)
12) Probe station electrical testing – Determining yield and device performance
13) Dicing and Packaging



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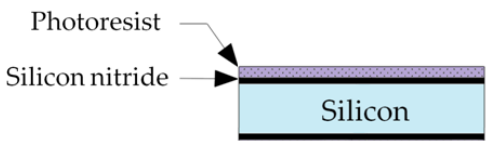
Process Flow – Silicon Nitride MEMS pressure sensor

Backside processing

Backside processing

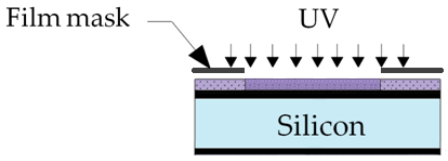
- **Etching the backside**

1. Wafer Preparation



DSP Wafer

2. Pattern Transfer



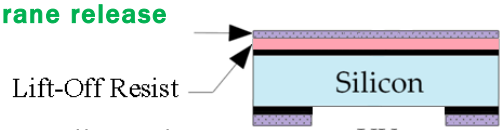
3. Photoresist Development

4. Nitride Removal **RIE Plasma etch**

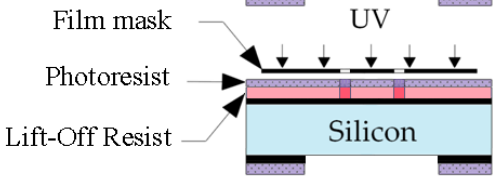
Frontside processing – Metalization and membrane release

Frontside processing

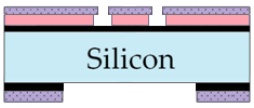
5. Photoresists Deposition



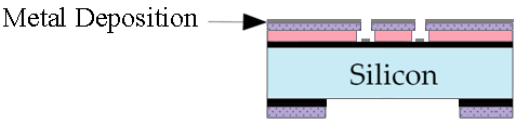
6. Pattern Transfer



7. Photoresists Development



8. Metal Deposition



9. Lift Off

10. KOH Etch

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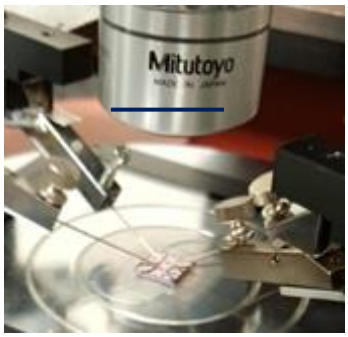
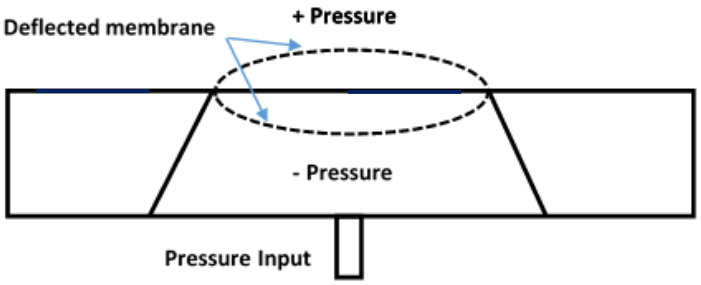
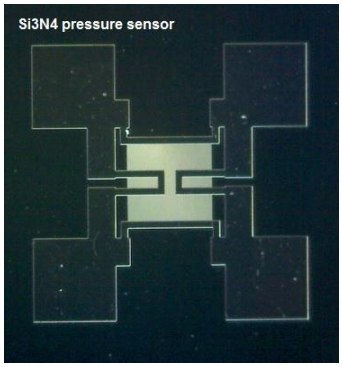
Device Testing – Pressure sensor operation







Wheatstone Bridge