

May 21-25, 2012

2nd Annual MEMS/NEMS Nanotechnology Cleanroom Workshop

The second annual Micro/Nano-Electro-Mechanical Systems (MEMS/NEMS) workshop was held during the week of May 21 to 25, 2012. The workshop covers five full days of lectures and hands-on experience in the MEMS Research Laboratory's cleanroom, located at the University of Texas at San Antonio's (UTSA) west campus. The MEMS Research Laboratory is part of UTSA's Department of Physics & Astronomy, and its mission is to train graduate and undergraduate engineering and physical science students in micro- and nanotechnology processing methods used in scientific laboratories and commercial production facilities. This year 12 students from Northwest Vista College (NVC) spent the week participating in the workshop. All participants received a CD containing approximately 700 PowerPoint slides, the Material Safety Data Sheets (MSDS) for the chemicals used in the workshop, and the operating procedures for the cleanroom's processing equipment.

Prior to the workshop, all participants were required to take two online UTSA training courses and pass their proficiency tests with scores of at least 80%. All of the NVC participants provided Certificates of Achievement for the *Hazardous Waste Generator Training* and the *Hazard Communications & Laboratory Safety* courses in order to perform cleanroom activities. Each day of the MEMS workshop started with lectures by the Director of the MEMS Research Laboratory, Professor Arturo Ayon. The lectures were very comprehensive and thoroughly covered the underlying theory and practical considerations of all topics related to MEMS technology, including the materials science related to micro- and nanofabrication, micro- and nanosensors (mechanical, optical, and thermal), and specific issues dealing with nanoscale

devices. Professor Ayon's experiences with commercial fabrication allowed him to interject practical large-scale production issues along with theoretical considerations and the single-product research focus.

During the MEMS/NEMS workshop, students were able to learn through three projects:

- 1) Wet chemical fabrication of gold nanorods and its characterization
- 2) Formation of silicon nanowires using nanosphere lithography on a silicon wafer chip
- 3) Formation of nanopores in a silicon wafer chip by selective etching under dispersed gold nanoparticles

By rotating projects, NVC students learn the techniques used in all three projects and gain hands-on experience with the instruments used for fabrication and characterization. The wet-bench techniques included reactant preparation, product isolation, centrifugation, multi-step silicon wafer cleaning, and silicon etching. Equipment used included a sonicator, a sputter coater for gold nanofilm deposition, an oxygen plasma etcher, an atomic force microscope (AFM), and a scanning electron microscope (SEM) with EDX capability. All activities except for the SEM characterization were performed in the MEMS Research Laboratory's cleanroom, meaning that all participants had to suit up with booties, gown, cap, and gloves in the lab's changing room. In addition, face shields, and chemical-resistant gloves and aprons were available inside the cleanroom for handling hazardous chemicals. The SEM characterization was performed at UTSA's Chemistry Department, so chemistry professor Carlos Garcia provided a lecture on his research in microfluidic devices and electrochemical detection methods. He also encouraged the

NVC students to apply for fully-funded eight-week summer internships held annually in São Carlos, Brazil, which he described as one of the most beautiful places on earth.

It was obvious at the end of the workshop on Friday afternoon that the effort was successful. All of the NVC participants commented on how much they learned during the week and how interesting the topics and hands-on activities were. They were also happy that plenty of snacks were provided throughout the week to give them the energy to complete the full-day activities. In addition to the CD containing all of the lecture material, all participants received a Certificate of Completion of the MEMS/NEMS workshop, digital copies of all of the SEM images from the three projects (gold nanorods, silicon nanowires, and dispersed gold nanoparticles on silicon), a UTSA Roadrunners bandanna, and a UTSA College of Sciences lanyard. Everyone felt that the MEMS/NEMS workshop is a worthwhile experience for all students interested in the field of nanotechnology, whether the interest is pure nanoscience or applied nanofabrication.

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