**Facilities, Equipment, and Other Resources**

**I. UCI SAMUELI SCHOOL OF ENGINEERING SHARED FACILITIES**

**Integrated Nanosystems Research Facilities (INRF)**

The INRF is a 9,600 square foot class 100/1,000/10,000 cleanroom devoted to research and development for integrated systems at nano and micro scales equipped with all the major equipment for micro- and nanofabrication for thin films and processing of nanowires, carbon nanotubes, quantum dots, microfabrication of electronics with nanomaterials, and materials characterization. The INRF maintains a comprehensive array of equipment for photolithography, thin film deposition, material growth, dry etching, wet etching, annealing, packaging, device integration, sample preparation for characterization, and a variety of analytical capabilities including SEM and ellipsometry. In addition, INRF offers the capability to incorporate non-standard processes and materials, pushing the boundaries of new fabrication techniques and integration at ultra-small scales. It operates in a multi-user recharge mode and utilizes the Forged System that allows users and staff to have real time status on equipment, lab environment, user usage, maintenance needs, billing/procurement, education, programs, foundry, inventory, safety and lab community. There is also a service ticket functionality that will give users transparency into the repair or maintenance process with rapid response timing and accurate progress status. It is an online management system for everything cleanroom related for both staff, PI and users. All training, maintenance, and common supplies for all equipment is provided by the INRF. INRF equipment includes the following major instruments:

*NanoCT - Xradia VersaXR 410:* The Xradia VersaXR 410 is the latest generation of three-dimensional (3-D) X-ray microscopy (XRM) solutions optimized for non-destructive micro tomography for heterogeneous materials. The VersaXRM 410 advances industry and science with a versatile combination of world-leading resolution and contrast, sample flexibility and the large working distance required to address emerging research challenges. The system's source technology and high-resolution detector provide unmatched sub-micron resolution (800nm), even for large samples.

*Deposition:* CHA Mark 50 evaporator; Temescal CV-8 e-beam evaporator; Temescal CV-14 e-beam evaporator; CHA SEC-600-RAP thermal evaporator; PE 4400 sputterer; PE 2400 sputterer; PE 2400 sputterer; electric plating hood for Au and Ni; Cambridge Savannah Atomic Layer Deposition (ALD) with 6 heated lines for Al2O3, HfO2, ZnO, TiO2, and SnO2.

*CVD Systems:* First Nano EasyTube 3000, a customizable CVD/annealing tool for nanomaterials synthesis (carbon nanotubes, graphene, and nanowires of Si, Ge, ZnO, GaN, and BN), thin film depositions, and annealing; PlasmaTherm PECVD Model 780 performs reactive ion etching (Si3N4, SiO2, and GaAs) and plasma enhanced chemical vapor deposition (SiO2 and Si3N4); BMR Low Temp PECVD for dielectric films such as SiO2 and Si3N4; Anicon LTO CVD 150 mm is used for deposition of low temperature and low pressure silicon dioxide, polysilicon, and amorphous silicon.

*Lithography:* Canon i4 4000 Wafer Stepper; Hitachi 4700 e-beam writer (20 nm resolution); Karl Suss MA6 Mask Aligner; Karl Suss MJB-3 Mask Aligner; Kasper 3001 Mask Aligner; Quintel Mask Aligner; UV flood exposure system; Solitec 5110-CT spinner; Solitec 5110-ND spinner; Solitec 5110-C-TD spinner; three Laurell spinners; two headway spinners.

*Characterization:* Hitachi 4700 SEM/EDAX; HS200 confocal microscope/profiler; Dektak profilometer; Dektak 3 profilometer; DektakXT; Tencor FLX-2320A stress measurement tool; Nanospec 200 AFT thickness measurement system; Gardner ellipsometer; Tousimis 815C critical point dryer.

*Dry Etching:* STS System DRIE; PlasmaTherm RIE Model 780; Trion ICP/RIE; Ion Milling; XeF2 Pulsing Etcher (INRF built).

*Plasma-Ashing:* Gasonics Downstream Plasma Ashing; Technics II 500; Plasma line asher.

*Diffusion Furnaces:* 6-inch dry and wet oxidation tube; 4-inch dry oxidation tube; 4-inch long anneal tube; 4-inch sintering tube; 4-inch boron tube; 2-inch Nano Furnace tube; 6-inch Mini-Brute Thermal Bonding tube; 4-inch Mini-Brute tube; Heatpulse 610 RTA; 4-inch anodic bonding furnace (INRF built).

*Back-End Processing:* K&S 780 Dicing Saw; K&S Wedge Bonder; K&S Gold Ball Bonder; Hybrid Ball Bonder; Cincinnati Sub-Zero Environmental Chamber; Tenney Environmental Chamber; Inert Environment Blue M oven; vacuum oven.

**Bio-Organic Nanofabrication Facility (BiON)**

The BiON is a 4,000 square foot class 1000 cleanroom facility dedicated to developing technologies for environmental, life science and medical applications. In addition to two tissue culture hoods and supporting facilities for growing tissue culture, the BiON cleanroom contains unique lithographic tools, embossing tools, deposition tools, nano-imprinting, surface coating, and laser etching tools for performing micro- and nanofabrication of materials such as polymers, hydrogels, collagens, proteins and even living tissue. These materials have traditionally been difficult or impossible to nanomachine since they require special care or unusual process conditions. Many of the manufacturing techniques used in BiON have been developed as experimental processes by researchers in smaller laboratories at UCI and elsewhere; these are now available to the BiON community at large. By its very nature, BiON specializes in incorporating non-standard processes and materials for fabrication of nano- and micro-scale materials and devices. BiON staff are experienced in working with internal and external users to carry out nonstandard processes and perform one-off experiments. The facility supports ongoing work in the areas of bio-nanotechnology, advanced materials, BioMEMS, environmental sensors, medical devices and biological research. The BiON is operated by the INRF and shares its staff, and policies, procedures.

BiON equipment includes the following major instruments:

*Deposition:* Temescal SR-10 E-beam Evaporator; MRC Model 8667 Sputtering System.

*CVD Systems:* Tylan PVD-100 for SiO2 deposition; Applied MST MVD 100 for FDTS (perfluorodecyltrichlorosilane) deposition.

*Lithography:* Karl Suss MA56 Mask Aligner; Quintel Mask Aligner; AB&M UV Flood Exposure System; Laurell spinners.

*Dry Etching:* SPTS DRIE Etcher; Resonetics Rapid X 250 Laser Ablation System

*Plasma-Ashing:* Anatech LTD Model SP100 Plasma System; Technics II 500 Mercator Control Plasma System; Plasma line Asher; Harrick Plasma Cleaner.

*Hot Embossing:* Jenoptik HEX03 Nano Imprinter; Rey Embosser; Scientific Technology Embosser; Digital Combo Embosser.

*Characterization:* Dektak 3 Profilometer.

*Back-End Processing:* CO2 Water Jacketed Incubator Series II; Class II Biohazard Safety Hoods; Rapid Temp 1800 Series Furnace.

There are eight full-time staff members for the INRF and BiON. They consist of the Facility Administrator, Cleanroom Manager, Senior Process Engineers, IT Technician, and Purchasing Coordinators.