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# Integrated Materials Growth System

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## Personnel

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## Sponsorship

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Vacuum growth of organic materials can generate atomically flat thin films of high purity, facilitating fabrication of complex multi-layer devices with excellent uniformity and sharp interfaces between adjacent layers. Such vacuum grown devices are highly reproducible from run to run, and can have complex structures containing thin layers of precisely controlled composition. Increased control over the growth parameter is essential for the better performance devices. Additionally, flexibility of van der Waal bonds in the organic thin films facilitate their integration with both conventional technologies and less conventional materials such as flexible, self-assembled, or conformable substrates.

We are in the process of developing a versatile materials growth system (see Figure 1) that combines conventional materials growth techniques with novel deposition methods developed in our laboratories. The completed growth system will integrate the method for physical and vapor phase deposition of hybrid organic/inorganic thin-films with a low-pressure RF/DC sputtering chamber, an evaporative growth chamber, and a chemical vapor deposition chamber. The completed vacuum system will be capable of depositing molecular organics, polymers, metals, metal oxides, inorganic nanodots, and colloids in a controlled layer-by-layer fashion. An *in-situ* shadow masking sys-

tem will enable fabrication of complex patterned structures inside a vacuum environment, while the integrated N<sub>2</sub>-filled, dry glove box will facilitate handling, measuring, and packaging of organic thin film samples that are susceptible to reactions with atmospheric oxygen and water vapor. Completed samples will be *in-situ* tested in the analysis chamber by contacting them with an electrical probe attached to an X-Y-Z manipulator. Optical ports on the chamber allow for a telescopic view of the devices and facilitate optical excitation of probed samples. Optoelectronic properties of the hybrid materials and structures will be investigated at a range of temperatures from 5 K to 600 K, generated by the liquid helium cryostat and the boron-nitride heater situated behind the sample stage. The modularly attached AFM/STM chamber will facilitate *in-situ* atomic scale microscopy for evaluating morphology and electronic properties of hybrid materials.

All chambers are connected to the central transfer system that has linear degrees of freedom. Maximum substrate size is 10 cm with a 5% variation in the thickness and composition of deposited films over the substrate area. The integrated growth system is the centerpiece of our materials growth effort, as in its completed form it will accommodate solvent-free deposition and co-deposition of polymers, colloids, and molecular organic materials in vacuum.

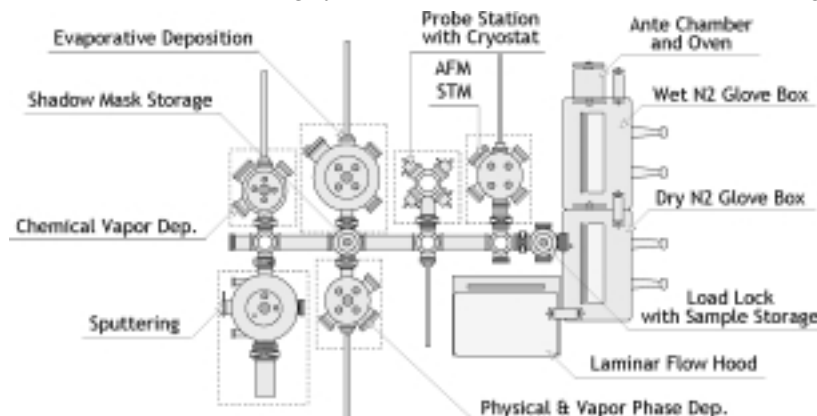


Fig. 1: Integrated materials and devices growth system consisting of the materials growth chambers based on physical and vapor phase deposition, sputtering, chemical vapor deposition, and evaporative deposition with *in-situ* shadow masking. Samples are analyzed in the analytical and AFM/STM chambers, and all connected to the central transfer line with load lock and an integrated, nitrogen-filled glove box.

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