MEng Project:

Construction and characterization of a high-throughput screening tool for the development of next generation atomic layer processing technologies

James R. Engstrom

The objective of this project is to construct and characterize a new experimental system that will enable rapid screening of chemistries and processes used in atomic layer deposition (ALD) and etching. In this work we will complete construction of and make use of a custom designed system that employs a quartz crystal microbalance (QCM) to characterize adsorption/desorption behavior of candidate molecules and the ALD process itself. One focus will be on developing processes for area-selective ALD, achieving growth on some features, and avoiding growth on others. This process has been identified by industrial experts as key to enabling the next several generations of single-digit nm technologies used in high volume manufacturing of microelectronic devices. This issue is extremely important for future devices where patterning will become problematic, and selective growth may help eliminate some steps in a fabrication sequence involving lithography. In this project we will employ two custom-designed experimental systems to investigate novel approaches to area selective ALD (AS-ALD). As a primary screen we will employ the new experimental system that makes use of a quartz crystal microbalance (QCM) as an analytical probe of the deposition process. This system will be able to quickly identify promising chemistries for AS-ALD. In addition to the QCM system, for these promising systems we will employ our custom designed ALD micro-reactor that is coupled to an ultrahigh vacuum chamber for surface analysis for more detailed, direct studies of the surface chemistry. These analyses will include the use of X-ray photoelectron spectroscopy, low-energy ion scattering spectroscopy, and other UHV surface analysis techniques. This research will improve our understanding of the fundamental mechanisms involved in selective deposition for emerging the film/substrate combinations.