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Advanced Electron Microscopy Characterization of Semiconductor Surface and Interface Processes

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The successful development of many semiconductor surface and interface processes depends on a detailed understanding of the key kinetic and thermodynamic parameters. *In-situ* electron microscopy methods allow for the direct observation of such processes with high spatial and temporal resolution. Electron microscopy methods routinely combine both imaging and diffraction capabilities, giving rise to a wide and powerful variety of imaging and contrast methods. In this talk I will review results obtained with Low Energy Electron Microscopy (LEEM), Photo Electron Emission Microscopy (PEEM), as well as Transmission Electron Microscopy applied both in ultrahigh vacuum and liquid environments. The materials systems studied with these techniques include strain-induced roughening during SiGe alloy growth, Ge and SiGe quantum dot growth and shape transitions of such quantum dots, growth of thin films of the organic semiconductor pentacene on both Si and SiO_2 surfaces, and the electroplating of Cu from a Cu-sulfate solution. The direct information obtained on these systems enables a detailed and quantitative analysis of the key process parameters, yielding new and important insights not easily obtainable with other methods. With the advent of new aberration-corrected electron microscopy techniques we are at the threshold of a revolution that will enable us to apply electron microscopy techniques to a even broader range of materials and processing problems.