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PLASMA SURFACE INTERACTIONS IN MATERIAL PROCESSING

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Abstract. As the dimensions of semiconductor devices diminish, surface irregularities in less-than a nanometer scale have increasingly higher chances to affect the performance of such devices. Therefore, in plasma processing used for semiconductor fabrication, etching and deposition processes that are less damaging to the surface are now in high demand. Probably the single most important cause for surface damages in plasma etching processes is the kinetic energies of ions that bombard the surface. Especially in a process that contains hydrogen, hydrogen ions that have relatively low energies can still penetrate deeply into the surface and damage or modify the surface structures (for example, the crystalline structure of silicon at the gate channel). In the semiconductor industry, such damages are now carefully studied mostly with the use of plasma processing tools that are actually in use in the manufacturing lines. However, if one wishes to understand better the atomic processes on or near the surface during processing, more carefully controlled studies on surface processing are needed. In this presentation, after briefly reviewing the current status of plasma processing research for semiconductor, I will discuss studies on plasma surface interaction based on mass and energy controlled ion beams that are expected to simulate a plasma exposure to a surface experimentally. Numerical simulations on plasma-surface interactions based on molecular dynamics (MD) simulations are also a powerful tool to analyze such processes and, indeed, can be compared rather directly with the beam experiments mentioned above. Therefore, using some examples of etching processes for silicon gates, low-*k* (i.e., low dielectric constant) insulators, polymers, and metals, as well as deposition processes of SiO_2 and diamond-like carbon (DLC), I will show how the beam experiments and MD simulations can be used to effectively analyze plasma surface interactions.