135a Control of Defect Concentrations in Silicon through Surface Chemistry

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Point defects govern many aspects of the behavior of crystalline solids, especially for semiconductors. We show through self-diffusion measurements that defect concentrations deep in the semiconductor bulk can be varied controllably over several orders of magnitude through submonolayer-level adsorption at the surface. For example, less than 0.01 monolayer of nitrogen adsorbed on silicon (100) that is undersaturated in defects lowers their concentration and inhibits diffusion, with the effects extending at least 0.5 μm into the bulk. The measurements have been made using a new method for determining key diffusion parameters via the short-time decay of an initial step concentration profile in an isotopic heterostructure. This method takes advantage of the relative ease with which step concentration profiles can be fabricated by thin film deposition, and in the limit of very short times provides particularly simple analytical means for obtaining parameters connected to diffusion length and defect formation. The adsorption phenomena discovered here open the possibility of precise defect engineering for numerous applications.