Nanostructured surfaces

Nanomechanical properties of silicon irradiated by deuterium

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Silicon is the most common material of modern electronics. Implantation of hydrogen into the silicon and subsequent annealing are applied (Smart-cut technology) to create microelectronic devices [1]. Improving the characteristics of the resulting structures was achieved by implantation of deuterium instead of hydrogen [2]. Nanomechanical properties of silicon studied in detail [3], but the depth profile of mechanical properties modified by ion-beam irradiation was rarely reported. In this work, the mechanical properties were investigated on crystalline silicon (111) samples irradiated by D_2^+ ion beam (energy of 24 keV, fluences from 1×10^{16} to 1×10^{18} D/cm^2 at temperature 293 K).

Nanoindentation performed on Nano Indenter G200 device using CSM option which controls the hardness and elastic modulus of the depth of indentation during the loading segment.

Nanohardness of initial silicon is at 11.8 GPa, the presence of implanted deuterium at doses up to 1×10^{17} D/cm^2 results in increased nanohardness to 14.2 GPa, but dose $\geq 5\times10^{17}$ D/cm^2 leads to a drastic decrease of silicon nanohardness to 3.6 GPa. Reasons for these changes are discussed in the work.

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