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Application of cluster ion beam smoothing to crystal surfaces.

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The advantages of using cluster-ion beams for smoothing of rough surfaces, and its ability to produce surface height variations of less than nanometer-sized dimensions, has been previously demonstrated[a]. Results of smoothing several materials will be reported using an Epion cluster beam system, which is capable of generating ion clusters of greater than 2000 atoms/cluster with cluster energies to 30 keV. Of particular interest in this study was the morphological instabilities in ion-implanted Ge. Regularly spaced columnar voids of 20-40 nm in diameter extending 180 nm from the surface into the amorphous layer are formed during heavy ion bombardment[b]. An 25 keV, Ar^+ cluster beam at a dose of 5×10^{15} clusters /cm^2 will be shown to displace 60 nm of the surface leaving a planar amorphous layer of <3 nm roughness at the surface. Thermal annealing removes this amorphous layer by solid-phase-epitaxial growth (SPEG) leaving a smooth crystalline layer at the surface that is doped with the implanted specie. Since ion implantation is an integral part of the manufacturing process for integrated circuits, the ion-induced roughening of the surface may lead to reliability and performance problems. Not only can cluster beams be used to re-establish the original surface smoothness after the ion implantation, but also may be used to smooth localized regions. In addition to the Ge results, work related to smoothing of SiC will be discussed.

a) (Smoothing of YBCO films by cluster beam bombardment), W.K. Chu, et al. Appl. Phys. Lett. (1997)
b) (Morphological Instabilities and Ion Beam Mixing in Ge), B.R. Appleton, et al. Nucl. Inst. and Methods in Phys. Res. B7/8, (1985) 639-644.

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