Poster Presentation

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X-ray n-beam diffraction to study nanodefects of Xe+ implantation in Si(001)

G. Calligaris[1], A. de Menezes[2], R. Lang[3], A. dos Santos[4], J. Bettini[5], L. Cardoso[1]

[1]*Institute of Physics Gleb Wataghin, UNICAMP, Campinas, SP, Brazil,* [2]*Department of Physics CCET, UFMA, São Luís, MA, Brazil,* [3]*ICT, UNIFESP, São José dos Campos, SP, Brazil,* [4]*CCSST, UFMA, Imperatriz, MA, Brazil,* [5]*Laboratório Nacional de Luz Síncrotron, LNLS, CP 6192, Campinas, Brazil*

Investigations about the nanocavities/bubbles formation by inert gas ion implantation in Si matrix and its properties have constituted an ongoing challenge in material science. Dislocation/extended defects (likely the {113} defects) are produced by post-implant annealing, which affect directly the nanocavities/bubbles structural evolution. In this work, the formation of defects induced by Xenon gas ion implantation in a Si sample (#Si-pristine) was studied by high-resolution reciprocal space mappings (RSM) and non-conventional X-ray Multiple Diffraction (XRMD) using synchrotron radiation. For this, Xe+ ions (80 keV; 5x1015 cm-2) were implanted in Si(001) at room temperature. Subsequently, the as-implanted samples were thermally annealed in air atmosphere at 600, 700 and 800 ºC for 30 min in order to nucleate Xe nanobubbles that were detected in annealed samples by TEM images. Differences in the diffracted intensity pattern, along the crystal truncation rod, were detected in the Si (113) asymmetrical RSM for as-implanted and annealed samples, in comparison to pristine Si, indicating defect contribution along in-plane an out-of-plane directions. The ω(incident):φ(azimuthal) coupled scans of two XRMD cases: 3-beam Bragg-Surface-Diffraction (BSD) (000)(002)(1-11) and the 4-beam (000)(002)(1-1-1)(1-13) have shown expected broader peaks (as-implanted sample) in comparison to the pristine sample, besides the ω-axis intensity asymmetry (c-axis strain induced). Furthermore, the analysis of all BSD mappings has provided: i) the annealing effect of reducing the lattice strain (600 and 700 ºC samples), and ii) a huge surface effect through the diffuse scattering (800 ºC-sample). As to the 4-beam case, a strong streak (diffraction condition trace) was observed for annealed sample patterns. This remarkable effect can be associated to the {113} defects, which are in the same direction of the secondary/coupling diffracting planes (XRMD phenomenon). It is believed that these defects break the spatial coherence, increasing the streak intensity. On the other hand, the streak is suppressed by the primary extinction effect in the pristine-Si and as-implanted samples. Financial support by Brazilian Synchrotron Light Laboratory (LNLS), CAPES, CNPq and FAPEMA.

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