Stress influence on the orientation of planar defects in Silicon

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Abstract

The Smart Cut process© developed for the silicon industry is based on the formation and on the propagation of cracks. The improvement of this process and of the quality of Si thin film needs to precisely control the formation of crack precursors. Initially the Smart Cut process© was performed by implanting a high dose of hydrogen. Hydrogen forms in silicon planar defects named H-platelets leading to cracks after a subsequent annealing. Several studies show that the orientation of these defects depends on the experimental procedure. The use of a plasma hydrogenation induces platelets lying in the {111} planes. On the contrary the implantation leads to other families of H-platelets depending of the crystalline orientation. For example, for {001} samples, H-platelets are mainly formed in planes parallel to the surface in the highly damaged band and in {111} planes at the edges. More recently Reboh et al. [1] have experimentally showed the possibility of modifying locally the orientation of H-platelets by adding in first time another stress field source. Both cases show the stress significance during the formation step of H-platelets.
We have developed to form cracks. This procedure consists in using planar defects of helium as precursor. These defects named He-plates present a similar shape to H-platelets. However mechanisms which take place in their formation are completely different than those for H-platelet formation and are still largely unknown. Few studies have been carried out on the effect of stress and of the crystalline orientation on He-plate formation.

In this perspective, the understanding of the effect of the stress on the formation of planar defects is primordial for the development of the Smart-Cut process or of more complex nanoscale structures. In a first part we studied by transmission electron microscopy (TEM) the orientation of He-plates as a function of the crystalline orientation i.e. the in-plane stress. In a second part, a 3D program based on elastic interaction was developed in order to calculate the energy density variation (component which depends on the total stress field) of platelets under the influence of a stress field and consequently study the interaction between the in-plane stress (implantation) and an additional stress produced by a spherical precipitate. The study of the interaction between both stress fields enables us to determine favourable planes of platelet formation.
S. Reboh et al., Appl. Phys. Lett. **96**, 031907 (2010).

Keywords: Stress, He implantation, H, platelet, formation energy

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