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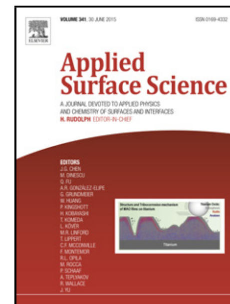

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Investigation of focused ion beam induced damage in single crystal diamond tools

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Abstract

In this work, transmission electron microscope (TEM) measurements and molecular dynamics (MD) simulations were carried out to characterise the focused ion beam (FIB) induced damage layer in a single crystal diamond tool under different FIB processing voltages. The results obtained from the experiments and the simulations are in good agreement. The results indicate that during FIB processing cutting tools made of natural single crystal diamond, the energetic Ga^+ collision will create an impulse-dependent damage layer at the irradiated surface. For the tested beam voltages in a typical FIB system (from 8 kV to 30 kV), the thicknesses of the damaged layers formed on a diamond tool surface increased from 11.5 nm to 27.6 nm. The dynamic damage process of FIB irradiation and ion-solid interactions physics leading to processing defects in FIB milling were emulated by MD simulations. The research findings from this study provide the in-depth understanding of the wear of nanoscale multi-tip diamond tools considering the FIB irradiation induced doping and defects during the tool fabrication process.

(Some figures in this article are in colour only in the electronic version)

Keywords: molecular dynamics; focused ion beam; irradiation damage; amorphization; diamond tool.

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