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MS-9-P-5715 HRTEM and EELS study of C+ implanted and annealed diamond

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The transformation of diamond to graphite by ion implantation and annealing has been reported by several authors [1,2]. Previous studies done on the carbon implantation of diamond using the Cold Implant Rapid Anneal technique have indicated that if the critical dose of about 5.2 × 1015 carbon ions is exceeded, diamond transforms to graphite [2]. Below the critical dose, recrystallization of the implanted layer into the original diamond structure is seen [3]. This paper present results of a high resolution transmission electron microscopy (HRTEM) and electron energy loss spectroscopy (EELS) investigation of room temperature, single energy (150 keV) C implanted diamond (synthetic type IIa, <100>) using a dose (1,5x1016 C+/cm2) exceeded the critical dose as defined above. The implanted layer was studied by cutting the diamond into several pieces and annealing each piece at different temperatures of up to a 1000 oC. HRTEM specimens were prepared by using a Helios Nanolab 650 FIB/SEM and investigated in a double Cs-corrected JEOL JEM-ARM200F HRTEM equipped with a Quantum Gatan Image Filter.

Fig. 1 is a bright-field scanning TEM (STEM) image of carbon implanted and annealed diamond, showing the implanted region extending from the diamond surface to the interface between the damage layer and diamond substrate. Inserted is a selected area diffraction pattern obtained from the layer showing amorphous rings. Fig. 2 shows an EEL spectrum of the C k-edge obtained from the implanted layer. Although the π* peak is an indication of the sp2 character of the carbon layer, the overall EEL spectrum in Fig. 2 is characteristic of highly disordered or amorphous carbon [4]. Further results of the structural evolution of the implanted layer with annealing will be presented.

This investigation illustrates the value of HRTEM and EELS to determine the nature of defects generated by ion implantation in diamond and the micro- and nanostructure of the implanted layer. These techniques are also very useful for the determination of the critical implantation and annealing conditions for the transformation of diamond to graphite.

References

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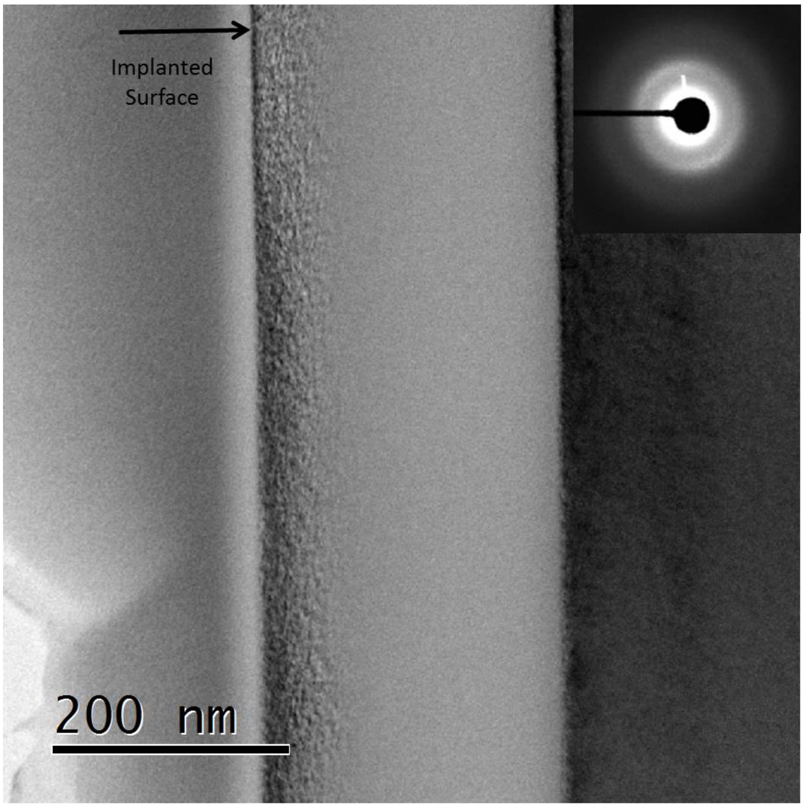

Fig. 1: Bright STEM image of the implanted layer after implantation. Inserted is a selected area diffraction pattern of the implanted layer

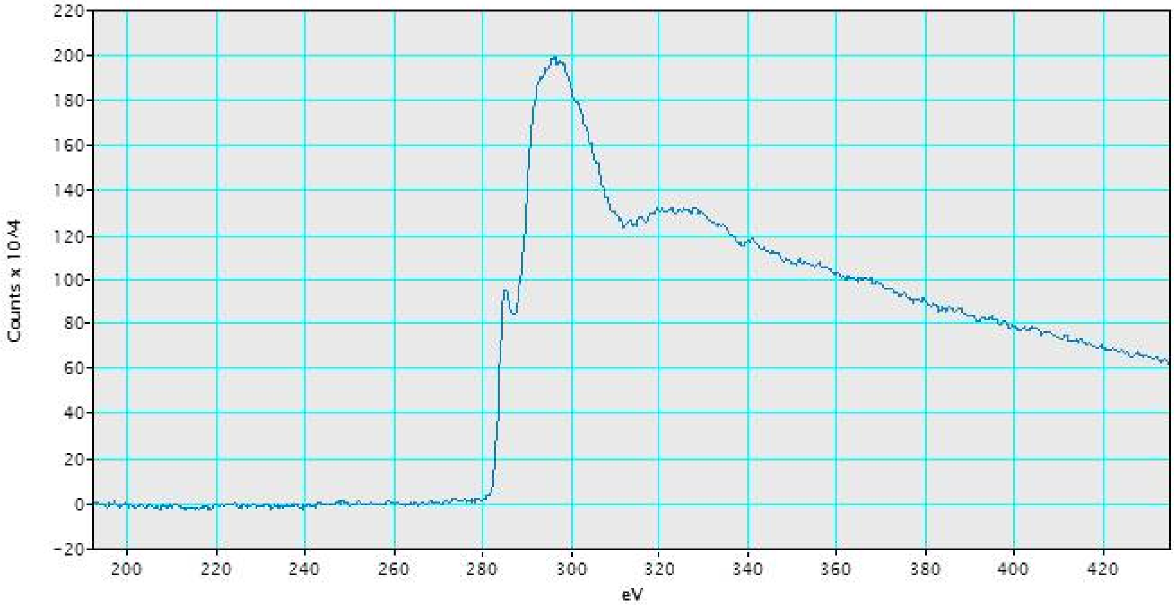

Fig. 2: EEL spectrum of the implanted layer showing an amorphous carbon character