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Low Dose Radiation damage in diamond

Radiation damage is of great interest in diamond. Diamond is so-called radiation hard and is a candidate for passive and active electronics in high radiation environments. Further, it is possible to treat diamond by radiation and annealing stages, so as to change its color or introduce a favoured colour. The studies of radiation damage is therefore well advanced in diamond. More recently, so called “quantum diamond” is engineered by a low dose damage and ion implantation process. Our own interest in the matter of radiation damage in diamond arises from natural diamond recovery using the MinPET technique. This has a high energy photon irradiation stage to produce internal Positron Emission Tomography (PET) emitters, whose subsequent transient PET radiation yields 3D quantitative local carbon density distributions within kimberlite rock. We have therefore made a study of radiation damage in diamond in the limit of very low dose derived from a high energy mixed radiation field of photons and electrons. The process has also been modelled using Geant4. The major mechanism for displacement of carbon atoms is ballistic collisions derived from the primary and secondary electrons. One must also consider the damage due to the secondary carbon recoils. Then there is the various nuclear reactions and the secondary consequences of these. The primary damage creation is the single neutral vacancy (GR1 defect). There is also the primary interstitials which can be the single dumbell interstitial on cubic face centre (R2 defect) or the self-trapped pair of these (R1 defect). Finally there can be aggregates of these defects with each other as well as with pre-existing defects in the diamond (if there were present not too far from the radiation induced defect). As most of these defects are optically active, measurements were performed using UV-VIS absorption spectroscopy, IR absorption spectroscopy very sensitive photoluminescence (PL) spectroscopy at 77K. The results will be presented and discussed.

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yes

Level for award
 (Hons, MSc,
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PhD

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