Spectroscopic and imaging studies of defect distributions in natural and synthetic diamond.

In this PhD the student will focus on (but not be restricted to) the use of diffraction limited photoluminescence (PL) defect imaging studies in natural and HPHT-treated natural diamond, and lab grown HPHT diamond from non-metallic solvents (available through collaboration with Novosibirsk). The confocal system (x-y resolution 250 nm; z resolution 800 nm in diamond) at Warwick has multiple-channel detection for simultaneous imaging of different luminescent defects. PL spectra can be recorded at any point in the image (with polarised excitation and detection), single defects (confirmed using correlated photon detection) can be imaged and identified in only less than a second and optically detected magnetic resonance of NV^- is possible to determine the orientation and environment of this detect. NV^- can itself be used to interrogate nearby defects.

The objective of this project is to provide an insight into natural diamond growth mechanisms, post growth defect evolution/production (including the role played by plastic deformation) and ultimately provides new knowledge for the differentiation of natural and lab grown diamond. The work will focus on low fluorescence natural type IIa and IIb diamond. In the former obvious targets include the H3, H4 and N3 defects since the presence and distribution trace nitrogen aggregates could readily differentiate natural from synthetic high purity diamond and provide information on the growth history of the diamond that could be linked to other data. We also have the opportunity to investigate defect distributions found in close proximity to inclusions, which for example could at one time have been radioactive, and produces radiation damage defects in the vicinity of the inclusion. In the case of type IIb diamond we are interested in characterising the properties and the spatial distribution of relative few PL defects that are observed in this material. We have the opportunity to carry out confocal PL imaging on samples that can also be studied by transmission electron microscopy. This provides the opportunity to study the PL emission from individual dislocations/dislocation bundles and investigate the potential decoration of dislocations with colour centres. This work will be contrasted with studies on synthetic diamond, and is expected to contribute to the development of new knowledge of colour centres in diamond, which may be exploitable in photonic and quantum technologies.

The project is part funded by the Gemological Institute of America (GIA), and there will be an opportunity to work in the GIA laboratories in the USA.

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