Controlling Surface Properties of Diamond for Electronics and Quantum Technology

Subtle changes in the composition and morphology of diamond surfaces can strongly influence the feasibility of diamond devices. For example, inhomogeneous termination and deviation from crystalline perfection in single-crystal surfaces can lead to large differences in properties such as work function, surface conductivity and spin. O-termination is process dependent and changes with temperature up to 600°C in vacuum. H-termination is stable up to 900°C and above this temperature, the diamond surface in vacuum is adsorbate free. These surfaces cover a very wide range of electron affinity, varying from -1 eV for H to +2 eV for O and there are also differences in surface band bending for different orientation and termination. All of these can severely affect the performance of electronic and sensing devices. Surface defects play a key role in these applications and they can also lead to localized spin centres that can interfere with sub-surface NV centres. This project will apply a range of complementary experimental and theoretical probes to understand the source of such effects. At Aberystwyth, the student will use a dedicated vacuum spectrometer where diamond surfaces can be treated with O* and H* plasmas and annealed to high temperature and, in the same environment, characterised by UPS, XPS, LEED and Raman spectroscopy. Annealing experiments can be carried out in real-time with each technique. There will also be scope to apply soft x-ray synchrotron radiation methods to access higher surface sensitivity and to probe unoccupied as well as occupied states.

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