University of Warwick Department of Physics

An ultrafast shakedown of defects in diamond using intense infrared pulses

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Atomic-scale defects contained within crystals of diamond provide fascinating opportunities for fundamental and applied physics, including emerging use in quantum technologies and magnetometry. These defects are often a combination of missing carbon atoms, and extra nitrogen and hydrogen atoms. While the unique electronic and vibrational states of defects in diamond can be probed via optical spectroscopy techniques, often only the time-averaged response is accessed.

In this project the PhD candidate will use intense pulses of infared light to promote defects into their vibrationally excited states. The subsequent "shakedown" – the transient vibrational response of the defect – contains information about the vibrational energy levels, cross-coupled vibrational modes and energy relaxation rates. This information is crucial in order to better understand the fundamental physics of defects in diamond. The student will make use of the Warwick Centre for Ultrafast Spectroscopy (go.warwick.ac.uk/WCUS), a joint collaboration between the Physics and Chemistry Departments at Warwick that provides ultrafast spectroscopy experiments covering the ultraviolet, visible, infrared and terahertz ranges. This massive spectral coverage will let the student further examine the dynamics of electrons and their coupling to vibrational modes. Additional material characterisation will be undertaken using Warwick's suites of modern spectroscopy (UV-visible, Raman, FTIR, ESR), and microscopy (SEM, TEM) equipment.

This project suits an enthusiastic and motivated student keen to work with advanced experimental methods to further our understanding of the physics of novel materials. Funding is available for exceptional UK and EU candidates for 4 years at standard research council rates (stipend plus fees). The student will be part of the Diamond Centre for Doctoral Training (go.warwick.ac.uk/DST). The studentship is offered with the support of an industrial partner, the de Beers Group.

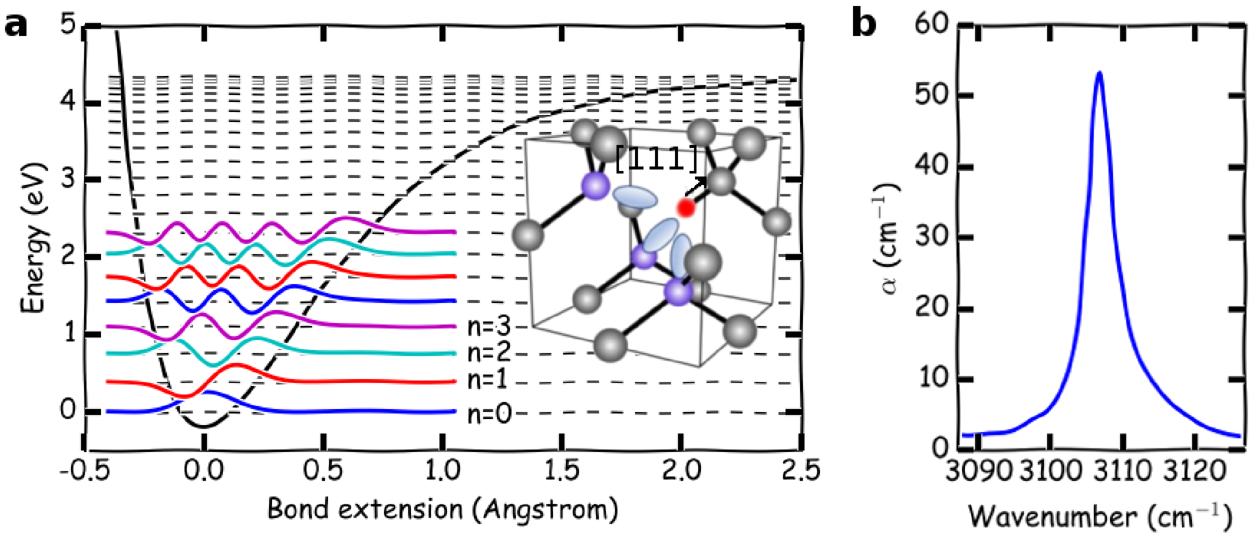

Figure: **a**. The potential energy of the C-H stretch, along the [111] crystal direction, as pictured in the inset, for a particular defect complex. The shape of the potential energy was deduced by combining results from steady-state and ultrafast infrared spectroscopy. **b.** The strong infrared absorption associated with the C-H stretch.

* Please feel free to contact me on j.lloyd-hughes@warwick.ac.uk if you have any questions regarding this project.