

New Electrochemical Based Polishing Methods for Processing Diamond Surfaces

Supervisor: Prof Julie V. Macpherson (Warwick Chemistry)
Second supervisor: Dr Matthew Markham (Element Six)
Funding: Fully funded PhD studentship (48 months)
Start date: September/October 2022.
Application deadline: Ongoing

Diamond is a material that has many extreme properties which has enabled technology and performance advances in many fields, including increased laser and microwave power densities in industrial cutting / fusion, quantum information processing and communication, magnetic and electric field sensing, radiation-hard particle detectors and electrochemical sensing and waste water clean-up. Key to optimizing performance in many of these applications is preparation of a defect /damage free surface and near surface region. This is incredibly challenging as diamond is unlike materials such as silicon or metals, where procedures are known for preparing high quality surfaces. The most common method for reducing surface roughness in diamond is to mechanically polish. However, this in itself is well-known for introducing polishing lines and sub-surface damage. The overall aim of this project is to develop new chemical and electrochemical based methods of removing material from the diamond surface to significantly reduce surface roughness, remove polishing lines and minimize surface defects and sub- surface defect formation, while maintain high levels of flatness and smoothness. The material will be tested in different electrochemical and optical applications.

The project will involve but is not limited to:

- Investigate electrochemical methods of producing diamond etchant species capable of removing diamond in a controlled and defect free manner, initially working with boron doped material
- Development of a combined UV-electrochemical system for work with undoped diamond, where the UV acts to significantly increase the charge carrier concentration in diamond
- Proving the technology works with >100's microns thick as well as < 50 μm thick diamond
- Exploration of combined electro(chemical)-mechanical polishing methods
- Training in electrochemical and surface science characterisation techniques
- Investigation of prepared surfaces in different applications, comparison against state-of – the-art mechanically polished and plasma etched surfaces

The research will be carried out in the Chemistry Department at the University of Warwick in close collaboration with our industrial partner Element Six. This project is supported by the recently funded UKRI/EPSC Engineered Diamond Technologies Prosperity Partnership grant – which aims to advance and solidify the UK's world-leading role in diamond technologies to develop solutions where no other material is capable – and the Warwick Centre for Doctoral Training in Diamond Science and Technology. The project will exploit the world-leading diamond synthesis capabilities of Element Six and Warwick's pioneering expertise in electrochemistry and material characterisation/application of diamond. The student will join the Prosperity Partnership team (which consists of 5 academic research groups spread across Warwick Chemistry, Physics and Engineering) and benefit from interactions well as over 40 researchers in the wider diamond community at Warwick.

ENGINEERED DIAMOND TECHNOLOGIES PROSPERITY PARTNERSHIP

Applicants must have (or expect to obtain) at least the equivalent of a UK first or upper second-class degree in Chemistry, Physics or Chemical Engineering (or related subjects). The studentship will commence in October 2022 (although an earlier start is possible based on your availability) and for UK students will provide funding for tuition fees and a maintenance grant at the standard UKRI rate, currently £15,609 for the 2022/23 academic year. Funding may be available on a competitive basis to exceptional students of any citizenship. Applications are welcome to those able to support themselves or with funding already arranged. Such applications will go through the same level of academic assessment. For further details please contact Prof Julie Macpherson (j.macpherson@warwick.ac.uk) and DST.Admin@warwick.ac.uk, and provide a CV.

Further information about the research of Prof. Macpherson can be found at: <https://warwick.ac.uk/fac/sci/chemistry/staff/juliemacpherson/>. The Warwick Electrochemistry and Interfaces Group are internationally renowned, offering an excellent research environment with world class facilities dedicated to electrochemical and interfacial research, see: <https://warwick.ac.uk/fac/sci/chemistry/research/unwin/electrochemistry/>