**Applications of Boron Doped Diamond Electrodes in High-Pressure High-Temperature Electrochemistry (Profs Julie Macpherson, Pat Unwin and Mark Newton, Dr. Josh Tully)**

While not often studied due to the difficulties of cell construction and operation, electrochemical reactions under temperatures which are usually incompatible with aqueous solutions can be studied using a high-pressure apparatus. These high-temperature high-pressure conditions can allow powerful insights into redox processes under non-classical conditions, as well as accessing kinetics much faster than those usually seen at lower temperatures and pressures. Boron doped diamond (BDD) is an electrode material uniquely suited for investigations in these conditions, due to its high mechanical and chemical stability.

As well as fundamental studies using the BDD electrodes e.g. effect of using lower doped BDD electrodes in high temperature environments, there are also a number of industrial electrochemical processes that may benefit from being run in high-pressure high-temperature conditions. One such highly topical process is advanced oxidation of persistent organic contaminants such as perfluoro-octane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) which account for the majority of environmental PFC contamination.[1] PFCs are utilised in a number of industries, including metal plating, semiconductors, household goods, and firefighting foams.[1,2] The stability of the carbon-fluorine bond results in these PFCs being extremely resistant to thermal or biological breakdown.[1] The absence of natural methods of environmental breakdown has resulted in the PFCs released into the environment accumulating to levels where they can pose a risk for human health.[1–3] To date electrochemical advanced oxidation (on BDD electrodes) is the only advanced oxidation process that has shown promise in destroying these compounds.[2] However, the low PFOS concentration and solution conductivity of these solutions makes economical treatment of these species difficult. Operating under high-pressure high-temperature conditions has the possibility of improving process economics by increasing reaction kinetics, reactors designed to operate in these conditions would also require less power, as no chiller would need to be used to counteract the joule heating of the electrochemical oxidation.

This project would involve the design and build of a high-pressure high-temperature electrochemical vessel, with challenges such as reference electrode stability to be overcome. Once the cell is commissioned a number of fundamental and applied electrochemical systems could be studied. Material characterisation studies, including TEM, XPS, Raman and SEM would also be carried out to probe the effect of the high temperature / pressure advanced oxidation environment on the BDD electrodes.

Applicants must have (or expect to obtain) an honours degree (at least 2.i or equivalent) in Chemistry, Physics or Chemical Engineering (or a related subject)

The student will join a team of over 40 researchers in the diamond community at Warwick (academic research groups spread in Warwick Chemistry, Physics and Engineering) and benefit from a wide range of interactions. The studentship will commence in October 2023 (although an earlier start is possible based on your availability) and will provide a maintenance grant and tuition fees at the standard UK rate, currently set at £18,200 for the 2023/24 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.

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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/

References:

1 P. Zareitalabad, J. Siemens, M. Hamer and W. Amelung, *Chemosphere*, 2013, **91**, 725–732.

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3 J. M. Conder, R. A. Hoke, W. De Wolf, M. H. Russell and R. C. Buck, *Environ Sci Technol*, 2008, **42**, 995–1003.