Supporting Diamond Sensors in Extreme Environments

The ability to interrogate diamond sensors placed in extreme environments, such as those found in submarines, aerospace, the nuclear island and volcanic monitoring opens up a wide range of opportunities for UK industry. This includes the long term monitoring of nuclear installations, both civilian and defence, as well as closed circuit combustion control in automotive and aerospace applications. The diamond sensors required to achieve these tasks have been developed previously (for example diamond electrochemistry cells at Warwick and radiation detectors at a number of groups across the world) however, the electronics required to support these sensors in hostile environments is still outstanding.

The PhD will focus on the development of bespoke amplifier and signal conditioning circuits that can be integrated with diamond electrochemistry sensors and radiation detectors to form a hybrid module capable of deployment in an extreme environment. Here we describe an extreme environment as one in which conventional, silicon based electronics cannot function.

The initial stages will concentrate on the development of simulation models to describe the sensor and the circuit. Once these are complete, the next stage is to build a hybrid module (discrete devices mounted onto a high temperature circuit board). This will require knowledge of the surface treatment of diamond to ensure good adhesion and low resistance electrical contacts between the sensor and the module. The transistors and passive devices will be fabricated using silicon carbide devices, based on existing structures within the research group and made available through industrial collaboration. The testing of these circuits will initially be at room temperature, before being tested in a range of extreme environments within the University facilities and at collaborators facilities. The final stage of the project will be to assess the possibility of directly integrating the diamond sensors with monolithically integrated silicon carbide circuits to realise single die solutions.

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