Nanodiamond as an Optically Robust Fluorophore for Targeted Imaging of Neural Structures

One of the key scientific challenges of the 21st century is to better understand the principles that allow a collection of neural cells to work as a fully functioning brain. The complexity of neurobiology, along with the range of possible parameters to be investigated means that new techniques are embraced and quickly incorporated.

Nanodiamond (ND) offers many advantages as a fluorescent label for biological applications. Its biocompatibility, potential sensitivity to electric and magnetic fields, lack of photobleaching and the possibility of targetting specific neural structures are all of particular interest to researchers in neurophysiology. This PhD project aims to develop a comprehensive suite of tools and techniques that will enable superresolution imaging of NDs in brain tissue. By utilising Stimulated Emission Depletion (STED) microscopy, in conjunction with adaptive optics, it will be possible to image ND tens of microns into tissue with a resolution of 50nm. Achieving this resolution will allow imaging of synapic sites, the anatomical features where signals are passed from one neuron to another, thereby allowing a better understanding of the propagation of information through the brain. It follows that a key goal for the student will be to obtain a better understanding of how best to functionalise and bind ND to sites of interest, such as synapses, within brain, and other, tissue.

In order to allow both superresolution imaging, and the later extension to electric and magnetic field sensing, it will also be important to understand how nitrogen-vacancy (NV) centres in the ND are affected by the surface chemistry required for functionalisation, as this may influence the optical activity of the NV centres. Furthermore, intrinsic strain fields in the ND can influence both the formation and optical activity of NV centres within a ND and will also require investigation during the course of the studentship.

In the context of biological imaging, the effects of strain can also be beneficial. Strain also leads to a splitting in the optically detected magnetic resonance of NV centres that could be used as a fingerprint for individual centres. This would allow initial, high-resolution imaging, localisation and characterisation using STED followed by longer term, less damaging imaging using conventional methods such as confocal or wide-field imaging.

For further details please contact Dr Brian Patton:

brian.patton@strath.ac.uk