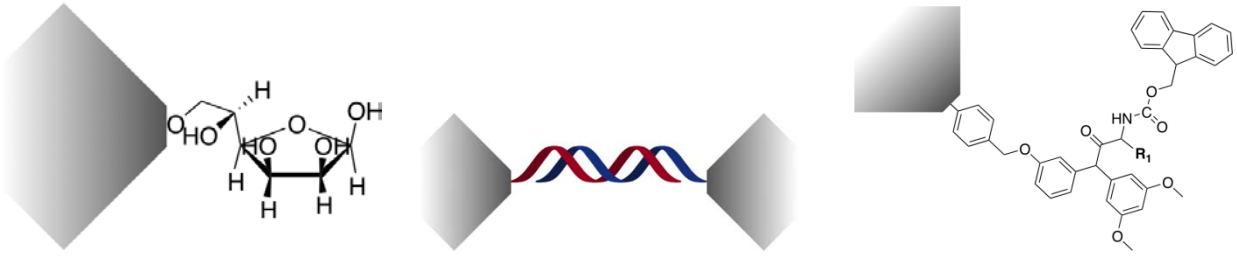
“GrapheneBioApps: Graphene bioconjugates for biotechnology applications”

4 year studentship funded by the BBSRC

Graphene is a material of superlatives. This single layer of carbon atoms forms the thinnest, strongest, stiffest and most stretchable material known. However, the full potential of graphene in biotechnology has yet to be realised. Its physical and chemical properties make it a potential vehicle for nanoscale diagnostic tools and sensors; support for heterogeneous and coupled biocatalytic reactions; vector for delivery of pharmaceuticals or genes; and foundation for solid-phase and combinatorial synthesis of biomolecules. The goal of this project is to provide the missing link between graphene and biological systems by designing and characterising their interface.

The project will begin by establishing chemical coupling routes to establish a library of graphene bioconjugates. These include both smaller molecules such as sugars, peptides and oligonucleotides as well as larger molecules such as antibodies and enzymes. Rigorous characterisation of the bioconjugates is essential to the success of the project. The disparity in size, chemistry, electronic and optical properties between the graphene and the biomolecule means that existing analysis and imaging techniques must be adapted to the biographene system.



From graphene modified by a single type of molecule, we expect to develop techniques for asymmetric modification of graphene. These polyfunctional materials could host multistage chemical and biocatalytic reactions on a single particle that then could be used in applications such as novel thin, tough, flexible wound dressing with built-in complex biofunctionality; as biosensors incorporating electrochemically driven transformations; and as platforms for synthetic biology inside and outside cellular environments. This project will fashion the tools to integrate graphene with the biological world.

Project roles

Prof. Sabine Flitsch will provide training in biological chemistry and is an expert in bioconjugation to surfaces. The project will be able to benefit from a current FP7 grant (2011–2016) on gold array technology. Prof. Flitsch’s experience in industrial biocatalysis (and her involvement with CoEBio3) will guide the choice of enzymes to match the requirements of industry and to predict where future commercial applications may exist.
Dr Christopher Blanford is an expert in the specific and directed attachment of metal-containing enzymes to conductive materials including carbon. This project will be strengthened by the methods and findings from his current EPSRC project on energy production through enzyme catalysis. He will provide training in graphene modification and enzyme attachment.
Dr Sarah Haigh is a member of the University of Manchester’s graphene working group, led by Nobel laureate Prof. Andre Geim. She is an expert in analytical electron microscopy and will lead the training on the imaging of graphene and the graphene–protein composite products and the development of new imaging methods. Dr Haigh will provide guidance on graphene production and ensure the project work is informed by the latest developments in the graphene research. Drs Haigh and Blanford will lead the development of the tools to analyse graphene and its bioconjugates.

References

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