PhD Studentship with the EPSRC Centre for Doctoral Training in the Science and Applications of Plastic Electronics

Project Title: Polymer Photonic Structures for Control of Terahertz Light

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CDT Collaborators: Dr Paul Stavrinou and Prof Natalie Stingelin, Imperial College London
Funding: 4-year fully funded studentship (bursary and home tuition fees)
Start date: October 2015

The Centre for Doctoral Training in the Science and Applications of Plastic Electronics was established in 2009 to train PhD students in the area of plastic electronics, which encompasses the materials science, chemistry and physics of molecular electronic materials and the application of such materials to displays, lighting, flexible thin film electronics, solar energy conversion, sensors, communications, smart textiles, and biomedicine. The field is a growth area, with the emerging industries in organic photovoltaics and lighting having enormous potential in the context of environmentally friendly low-carbon electricity and energy efficiency. The subject is inherently interdisciplinary, encompassing basic physics, optoelectronics, physical and materials chemistry, device engineering and modelling, as well as the design, synthesis and processing of molecular electronic materials. To train PhD students successfully across these fields, the CDT academic cohort comprises over 30 academics, from the Physics, Chemistry, Materials and Chemical Engineering Departments of Imperial College London, the University of Oxford, and Queen Mary University of London. Students accepted into the CDT program will register for their first year with Imperial College London, who will award an MRes degree upon successful completion of a course that includes both formally taught elements and a 9-month research project. For acceptance into the course based on the project listed below, the student will spend his/her 9-month project with the indicated supervisors at the University of Oxford. Subject to successful completion of the MRes, the student will then be enrolled for a DPhil (Phd) program at the University of Oxford for a further three years, during which they will carry out the research project described below. Successful completion of this part of the CDT program will result in the award of a DPhil (PhD) degree in Physics from the University of Oxford.

Project Description:

The THz region of the electromagnetic spectrum (0.1THz -10THz) has to date been relatively unexploited region owing to a lack of suitable sources, optical components and detectors. THz radiation is showing great promise for applications in areas such as communications, security screening, pharmaceutical quality control, semiconductor device development and non-destructive testing. Over the past decade there has been tremendous progress in the development of THz emitters and detectors [1], with commercial free-space imaging and spectroscopy systems now available from a range of companies. However to develop the next generation of THz based technologies we need to be able to control and funnel the THz light [2]. In this project you will use polymeric photonic materials to develop active and passive THz components such as waveguides, polarizers and modulators. Plastic-based materials are ideal as they show low loss in the THz region and can be patterned on a length scale suitable for manipulating the flow of THz photons. Furthermore they are flexible and cost-effective to manufacture.

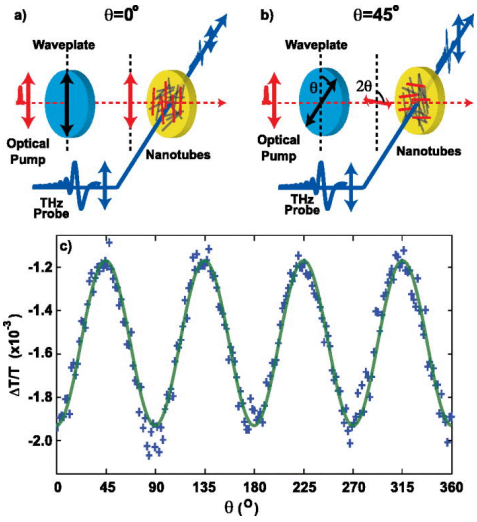

Figure 1 An active THz polariser based on carbon nanotubes embedded in a polymer (see Ref [3] for details)

Polymeric molecular semiconductors allow a large parameter space for flexible design and fabrication of photonic materials. Such photonic structures can confine the propagation of light or induce diffractive or reflective elements that can be combined to create a range of optoelectronic applications. For THz applications the development of novel organic-inorganic hybrid materials is particularly exciting. By including inorganic nanocrystals and nanowires within polymers it is now possible to create new class of artificial metamaterials that have many of the advantages of polymers such as flexibility and processability combined with the outstanding optoelectronic performance and high refractive indices of advanced inorganic semiconductors such as GaAs. The properties of these materials can be finely tuned based on nanowire/nanoparticle dimension, density, and orientation. In this project we will development high performance active components such as amplifiers, modulators and controllable polarizers. Using this technology we hope to integrate all these components into waveguides similar to optical fibres.

In this project, polymeric and hybrid photonic materials will be developed and fabricated at Imperial College with THz device deign, fabrication and testing being performed at the University of Oxford. This project will allow for fundamental insights to be gained in materials and device design.

[1] *Nature Photonics* **7**, 665 (2013)
[2] *Nature Photonics* **7**, 724–731 (2013)
[3] *J. Appl. Phys.* **115**, 203108 (2014)

See also:
Johnston Group Website: https://www-thz.physics.ox.ac.uk/people.html
Herz Group Website: https://www-herz.physics.ox.ac.uk/people.html
CDT for Plastic Electronics Webpages: http://www3.imperial.ac.uk/plasticelectronics/pecdt

How to apply for this studentship:
You must formally apply through Imperial College London for a "Postgraduate Masters - to be followed by Research" in the Physics department – see: http://apply.embark.com/grad/imperial/grad/
Please use the course code **F3U8B**. The decision on admissions is made by a CDT committee involving both IC and Oxford University academics. If you are admitted to the course based on this studentship, you will be accepted both into the MRes programme at IC for 2015, and the DPhil programme at Oxford from 2016 (subject to successful completion of the MRes).