Formation and Characterisation of Surface Self Assembled Functionalised Graphene Nanoribbons

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Scientific Background / Current Research
Graphene has exceptional properties but one specific drawback – no band-gap. Many strategies have been explored to produce band gaps in graphene and laterally confined graphene nanoribbons are promising, but sizable bandgaps require very narrow ribbons (<10nm) with the gap inversely proportional to the width. Production of these using top down approaches presents a serious challenge for conventional processing technologies. However, approaches such as that of surface self-assembly can produce atomically precise graphene nanoribbons (GNR) of very narrow width and thus with large bandgaps as has been demonstrated by Cai et al [1]. Such a surface self assembly uses metal crystal surfaces upon which halogenated precursor molecules are deposited; a thermally activated dehalogenation and the subsequent coupling of these precursor molecules into polyphenylenes occurs; further increasing the temperature a subsequent cyclodehydrogenation results in atomically precise GNRs (see figure: a-c)

Project: This project addresses the band-gap issue in graphene by exploring further this bottom-up molecular approach. Using novel precursors and other molecules we will synthesise new inherently functionalised graphene nanoribbons. These newly functionally-integrated graphene nanoribbons (fGNRs) will exhibit significantly different electronic, transport and optical properties and should be of intense interest. The formation of these fGNRs after organic molecular beam deposition of precursors in ultra high vacuum on single crystal metal surfaces will be studied by surface probe microscopies (STM & AFM); by x-ray and ultraviolet photoemission spectroscopies (XPS & UPS); through in-situ optical and Raman spectroscopies; and by advanced x-ray spectroscopic techniques such as x-ray absorption (XAS), x-ray emission (XES), angle resolved photoemission (ARPES), available at international synchrotron radiation facilities in the EU and US. Theoretical calculations to accompany experimental investigations. This will be a joint project with Tony Cafolla of DCU as well as chemists here in TCD, DCU, Groningen, physicists in Lund and theorists in TCD.

Funding:
Applicants should discuss funding with the Research Supervisor. They should apply for funding from the following sources: Irish Research Council (deadline 1 February, 2015), TCD PG Scholarship and School of Physics Studentship schemes.

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More information / References
A detailed project description available upon request (inclusive of sensitive details).
For broader background see http://www.tcd.ie/nanostructure/assets/documents/freshman-tutorials/GrapheneNanoribbons_tutorial/ if within TCD.