DEPARTMENT OF PHYSICS

Invites you to attend a Zoom presentation by:

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Low-Dimensional Nanomaterials
Department of Chemistry

Surface-confined synthesis of molecular-based low-dimensional nanomaterials

The growing interest in low-dimensional nanomaterials stems from their remarkable properties, such as high electrical conductivity, heat transfer, mechanical and chemical stability, arising from dimension reduction. These exceptional properties have made graphene, the only 2D material in nature, the focus of significant academic research over the past two decades. However, the lack of an electronic bandgap limits its use in some electronic applications. This limitation has inspired the emergence of novel nanomaterials, such as self-assembled molecular networks, 2D polymers and covalent organic frameworks, towards constituting several prominent classes of organic analogues of graphene. [1] The chemical and electronic properties of these low-dimensional nanomaterials are determined by their morphology, dimension, size, building blocks, π-electron delocalization, and the chemical nature of the bonds held them together.

My research focuses on the on-surface synthesis of nanomaterials whose chemical and electronic properties can be tailored by their chemical structure. Surfaces are used as a platform to design and fabricate 'bottom-up' materials made of organic molecules. [2] The molecules' functional groups and the reactivity of the substrates control the molecule-molecule and molecule-substrate interactions. These factors, together with the surface planes, temperature, deposition rate, and coverage, steer surface chemical reactions; hence, control the design of the obtained molecular structures. I have adapted various surface reactions for the synthesis of molecular imprints, 1D and 2D polymers, metal-organic networks, and organometallic structures. [3-10] To identify their morphology and chemical nature, we employ scanning tunnelling microscopy and non-contact atomic force microscopy with atomic scale resolution, and other surface characterization techniques, such as X-ray photoelectron spectroscopy, complemented with density functional theory calculations.

The chemical, thermal, and mechanical stability, and structural design of these molecular-based low-dimensional nanomaterials make them promising candidates for various applications, from the adsorption of greenhouse gases for environmental applications, to harvesting energy and light. Their unique tunable electronic properties, ranging from semiconducting to insulating behaviour, give rise to their integration in organic electronic devices used in displays, smartphones, and sensors. In summary, the molecular level understanding of the surface phenomena offers the pathway for the rational design of molecular networks and low-dimensional nanoarchitectures with tunable properties.

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