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(I) Formation of 1D and 2D carbon-based nanomaterials on surfaces

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The growing interest in nanostructured materials stems from their remarkable properties, such as high conductivity, heat transfer, mechanical and chemical stability, and emerging quantum properties, arising from reduced dimensionality. 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 electronic applications. This limitation has motivated interdisciplinary research at the intersection of condensed-matter physics, physical chemistry, and materials science to identify ways to design and create candidate nanomaterials with engineered bandgap and electron-spin sites for quantum processors.

Our research focuses on the surface-confined reactions to design molecular-based low-dimensional nanomaterials whose electronic properties can be tailored by their structural design, morphology, dimension, size, building blocks, and the chemical nature of the bonds which hold them together. We present various surface reactions for creating 1D and 2D polymers, metal-organic networks, and organometallic structures on noble metal single crystal surfaces. To identify their morphology and chemical nature, we employ scanning tunnelling microscopy and non-contact atomic force microscopy, and other surface characterization techniques, such as X-ray photoelectron spectroscopy, complemented with density functional theory calculations.

Our research benefits from an interdisciplinary approach for the rational design of electronic structures, known as **band-structure engineering**. The electronic properties of 1D and 2D nanomaterials can be tailored for smaller and faster transistors, or for quantum processors in carbon-based nanoelectronics.

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