Atomic-Scale Engineering of Complex Organic Nanomaterials via On-Surface Synthesis

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Materials science at the nanoscale has become a tangible reality across a wide range of applications, including integrated circuits, sensors, catalysts, pharmaceuticals, and data storage devices [1]. We now possess not only the ability to understand materials at the atomic level but also to precisely tailor their properties through advanced synthesis and growth techniques. Over the past few decades, substantial efforts have been devoted to developing innovative methodologies for the fabrication, characterization, and manipulation of materials within complex nanoarchitectures, achieving atomic precision and enabling the emergence of novel chemical, electronic, photonic, magnetic, and structural properties.

On-surface synthesis has emerged as a powerful bottom-up approach for constructing nanostructures using organic and organometallic precursors as molecular building blocks [1]. In this presentation, I will outline several strategies we have employed to fabricate planar carbon-based nanostructures, such as porous nanoribbons and nanomembranes [2–5].

To achieve a comprehensive understanding of the atomic and electronic properties of these materials, we integrate scanning tunneling microscopy and spectroscopy (STM/STS), X-ray photoelectron spectroscopy (XPS), and numerical simulations based on density functional theory (DFT) calculations.

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