Bottom-up fabrication of atomically precise molecular nanostructures through on-surface synthesis

The interest in molecular nanostructures on surfaces emerges from their prospective applications in nanoscale electronics, solar cells, energy storage devices, and other fields. Non-covalent intermolecular interactions in molecular self-assemblies facilitate the formation of long-range ordered patterns by usage of molecular recognition. In contrast, the stability and intermolecular charge transport are improved in covalently coupled molecular structures fabricated by on-surface synthesis, however, often at the expense of structural control owing to the irreversible nature of the newly formed covalent bonds.

In my presentation, I focus on recent high-resolution scanning probe microscopy experiments about the bottom-up fabrication and electronic properties of atomically precise one- and two-dimensional molecular nanostructures on metals. I will outline how nanoporous carbon ribbons and 2D covalent networks can be fabricated through on-surface synthesis by use of debromination coupling reactions. We observed a narrowing of the band gap from the single molecule to the 2D triphenylamine-based materials due to the extension of the π-system. Moreover, we found also delocalized electronic states in surface-supported organometallic networks assembled by Ag-bis-acetylide bonds.

A major challenge in realizing single molecular electronic devices is to mechanically stabilize and electronically decouple molecules at and from a surface. Hence, I will conclude with a comparison on the structure formation of molecular self-assemblies on bulk insulator and metal surfaces.