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Atomically Precise Graphene Nanoribbon Heterojunctions from a Single Molecular Precursor

Graphene nanoribbons (GNRs) are one-dimensional strips of graphene that exhibit novel electronic and magnetic properties. Due to quantum confinement, GNRs exhibit a finite band gap, promising future nano-device applications. Bottom-up synthesis via self-assembly of molecular precursors permits atomic-scale structural control of GNRs, allowing precise tuning of properties such as bandgap, edge chirality, and heteroatom doping. We report the bottom-up fabrication of GNR heterojunctions using a single molecular precursor. Atomically precise functionalized graphene nanoribbons are formed through surface-assisted polymerization of molecular precursors via thermal annealing. Subsequent thermal annealing of GNRs allows reconfiguration of GNR edge functional groups and the formation of atomically precise type II heterojunctions. The chemical structure of these GNR heterojunctions is revealed by bond resolved scanning tunneling microscopy (STM) and noncontact atomic force microscopy[1-3]. STM spectroscopy shows that GNR segments on either side of atomically precise heterojunction interfaces exhibit a band alignment consistent with type II heterojunction behavior. Experimental band edge energies and wave function distributions compare favorably with first principle theoretical simulations for this bottom-up heterojunction system.

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