19p-B3-11

Bottom-Up Graphene-Nanoribbon Fabrication Reveals Chiral Edges and Enantioselectivity

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To harness graphene's electronic and magnetic properties, one must first control the fabrication of graphene nanoribbons (GNRs) of desired widths and edge configurations. However, the required degree of precision excludes conventional top-down fabrication processes, which inevitably introduce defects. Bottom-up methods such as surface-assisted molecular assembly (SAMA) can produce defect-free armchair-edge GNRs of different widths,¹ but because current strategies rely entirely on precursor molecular structures to direct the assembly, to date, no one has synthesized a precursor that can yield different edge configurations. Here we fabricate precise chiral-edge GNRs using SAMA that, besides molecular design, invoke a combination of distinct substrate properties to direct assembly. Specifically, we show that a precursor molecule—known to form armchair GNRs on inert surfaces via the Ullmann coupling reaction¹—can be directed by a Cu{111} surface to undergo intermolecular cyclodehydrogenation instead.² Further, the particular combination of Cu surface properties enantioselectively distributes product GNRs along distinct azimuthal directions (**Fig. 1**); a phenomenon that enables asymmetric production of adsorbed chiral GNRs. We show that individual substrate properties can combine to override and/or to complement precursor molecular design, introducing new reaction pathways.



Figure 1. (A) STM image showing graphene nanoribbons fabricated on Cu(111). (B) Growth-direction measurement of the nanoribbons imaged in (A). Blue and yellow highlight opposite GNR adsorption chiralities.

References

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- 2. Treier, M. et al., Nat. Chem. 3 (1), 61-67 (2011).