Recent progress in the bottom-up fabrication of graphene nanoribbons: From armchair to zigzag and beyond

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Graphene nanoribbons (GNRs) are promising candidates to overcome the low on/off-behaviour of graphene – a zero band gap semiconductor – while still preserving the high charge carrier mobility that is essential for the fabrication of efficient field effect transistors. It has been shown that atomically precise GNRs can be fabricated by an on-surface bottom-up approach [1]. This versatile method has been successfully applied to the fabrication of armchair GNRs (AGNRs) of different widths [1-4] – and consequently different band gaps – as well as more complicated structures like chevron GNRs [1] or heterojunctions [5,6]. However, one of the most interesting types of GNRs has remained elusive: GNRs with zigzag edges (ZGNRs). ZGNRs are predicted to exhibit intriguing electronic properties like the existence of localized edge states with antiferromagnetic ordering across the ribbon width, thus giving rise to spin-polarized edges [7].

Here we will show how the on-surface synthesis approach can be extended to afford the fabrication of a new family of GNRs including atomically precise 6-ZGNRs, edge-modified variants thereof, as well as cove-edged GNRs. Spectroscopic evidence of the zigzag edge state is reported, with a significant energy splitting between occupied and unoccupied states that reflects the strong electron-electron interaction in these one-dimensional materials.

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