Graphene Nanoribbons – Merging the (1D) Conjugated Polymer and (2D) Graphene Worlds

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Graphenes and graphene nanoribbons (GNRs), their geometrical cutouts, are exciting additions to the rich carbon family. Graphenes hold enormous promise, for example, in energy technologies and non-linear optics. However, before they can be employed in electronics and their high charge-carrier mobility be utilized in field-effect transistors (FETs), an opening of their band gaps must be achieved. The best answer to this longstanding problem are GNRs, and this brings precision polymer synthesis into play. While protocols from lithography or unzipping of carbon nanotubes offer no control over length, width and edge structure, bottom-up synthesis is the method of choice.
We present unprecedented syntheses proceeding in, both, solution and on-surface. The latter approach, which can be scaled up by extension from UHV-conditions to chemical vapor deposition, also allows in-situ monitoring and proof of GNR-formation by scanning tunneling microscopy. Based on these material breakthroughs, we fabricate FETs from single GNRs and GNR-networks and compare the performance with that of conventional conjugated polymers. Surprisingly, the design of GNRs with appropriate combinations of arm-chair and zig-zag edges furnishes robust topological insulators in 2D as well as spin states with high correlation times. There is hope that these features provide entries into spintronics and even quantum computing.

References

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