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Carbon Nanoribbons: Tuned Electronic Properties by Bottom-Up Synthesis

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The development of carbon based nanoelectronics has been an important research goal ever since the discovery of carbon nanotubes (CNT) in 1991 and was boosted even more by the isolation of graphene in 2004. For digital electronics the biggest hurdle is the lack of control in the atomically precise synthesis of these carbon nanomaterials. For pure carbon nanotubes the chirality determines the electronic properties (metallic vs. semiconducting) and isomerically pure single walled carbon nanotubes (SWCNTs) of a specific chirality are thus needed to fully exploit their technological potential.

The situation is similar for graphene. Graphene is a semimetal and not a semiconductor. The lack of the electronic band gap makes it impossible to build a field effect transistor with a well-defined off-state. Theory predicts that graphene tailored into nanometer-wide ribbons, termed graphene nanoribbons (GNRs), gives rise to electronic properties that differ strongly from those of the semi-metallic parent material. These properties include sizable electronic band gaps due to quantum confinement and edge effects, as well as the spatial separation of spin channels due to spin-polarized edge states in zigzag GNRs. To preserve the outstanding electronic transport properties of graphene in the GNR the whole structure including the edges of the GNR has to be free from atomically defects. We have developed a simple method for the production of atomically precise GNRs of different topologies and widths, which uses surface-assisted coupling of molecular precursors into linear polyphenylenes and their subsequent cyclodehydrogenation. The topology, width and edge periphery of the GNRs are defined by the structure of the precursor monomers, which gives access to a wide range of different GNRs with particular electronic properties.

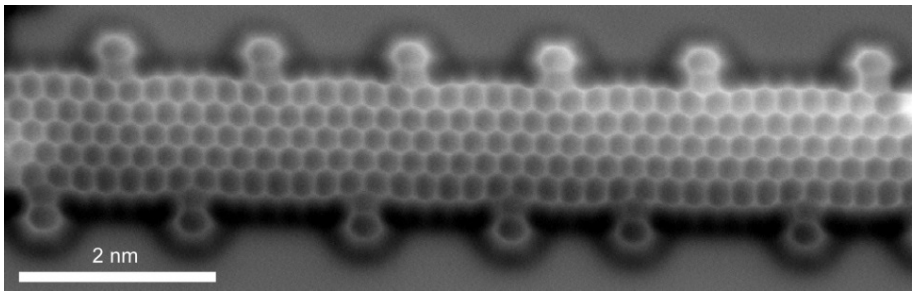

Figure: *Non-contact atomic force image of an atomically precise bottom-up synthesized graphene nanoribbon (GNR)*

Biography:

Pierangelo Groning joined Brown Boveri Company, after he got his master degree in Electrical Engineering in 1981, where he developed high power electronic converters for railways. After five years in the industry he went back to academia and studied Physics at the University of Fribourg (CH), where he obtained his PhD in Solid State Physics in 1993. From 1993 to 2002 he was Staff Scientist and Lecturer at the University of Fribourg (CH). In 2002 he joined the Swiss Federal Institute for Material Science and Technology (Empa). Since 2006 Dr. Gröning is head of the Department "Advanced Materials and Surfaces", director of the strategic research focus area "Nanostructured Materials" and member of the board of directors at Empa.