

Materials

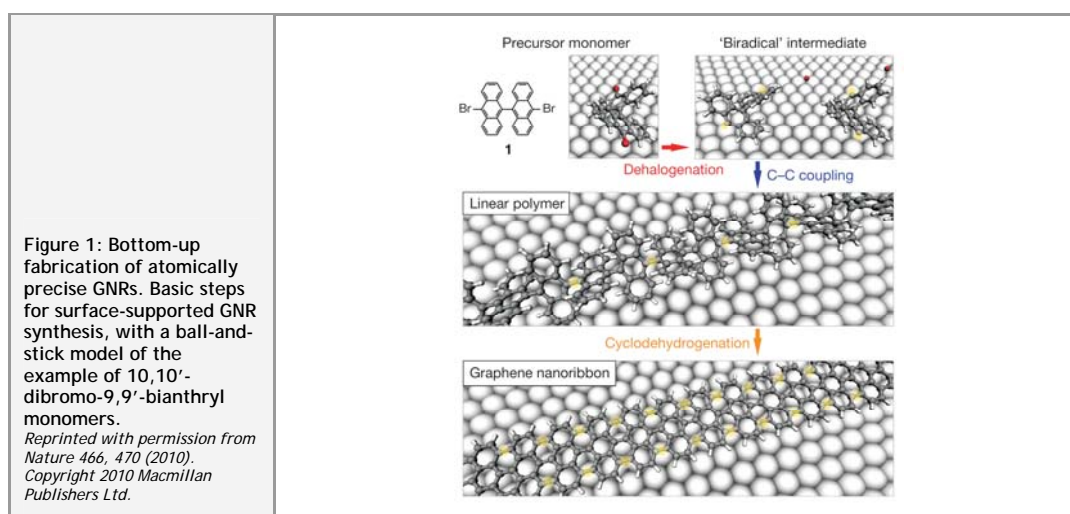
EMPA: Method to design and produce a great variety of graphene nanoribbons

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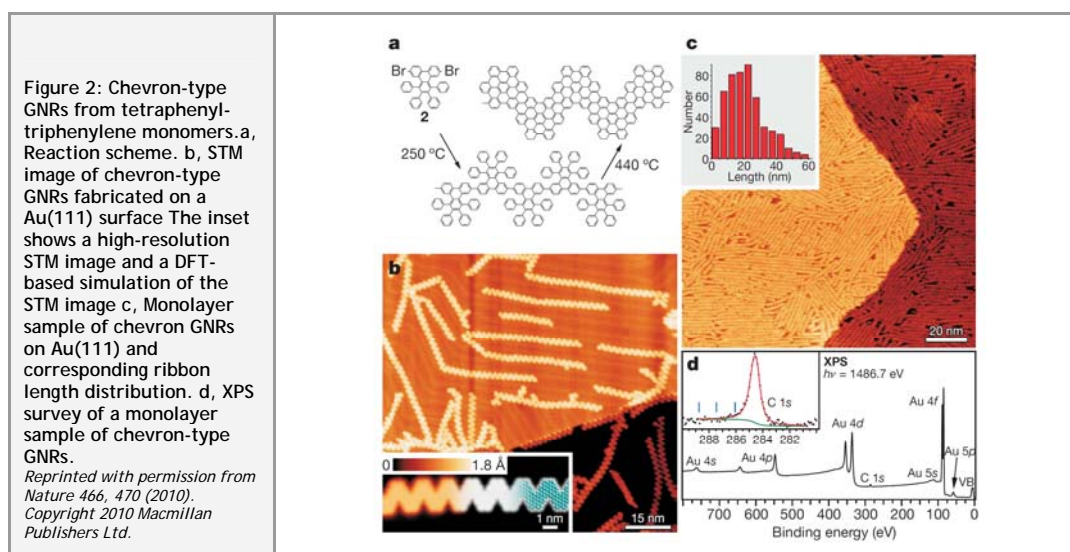
Bottom-up customized synthesis of surface-supported Graphene NanoRibbons (GNR) with tailored-made electronic properties



The authors from **EMPA** present a simple method for the production of graphene nanoribbons (GNR) of different topologies and widths, by employing the surface-assisted coupling of molecular precursors into linear polyphenylenes followed by cyclodehydrogenation. The structure of the GNR is determined by the structure of the precursor monomers; this approach allows designing very different graphene nanoribbons. The presented approach should allow to design and produce a great variety of graphene nanoribbons with desired chemical and physical properties, such as intraribbon quantum dots, superlattice structures and magnetic devices.



Fabrication of the atomically precise graphene nanoribbons allows detailed characterisation of electronic properties of this new class of semiconducting materials. All the fabrication steps are performed in situ using well-defined substrates so that the intrinsic properties of the GNRs can directly determined.



The elaborated bottom-up method of fabrication of GNRs requires modest temperatures (below 450°C) which is compatible with current CMOS technology. It

allows also to fabricate GNRs with different architecture and therefore with different electronic band structure. This opens new perspectives for the nanoscale electronics.

Figure 3: Synthetic strategy to straight armchair GNRs of width $N=7, 9$ and 11 with the values for the corresponding DFT band gaps (LDA) and quasiparticle band gaps (GW).

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precursor monomer	resulting graphene nanoribbon	family	N	band gap (eV)	
				LDA	GW
		$3p+1$	7	1.6	3.8
		$3p$	9	0.7	2.0
		$3p+2$	11	0.2	0.9

"Atomically precise bottom-up fabrication of graphene nanoribbons" ; J. Cai, P. Ruffieux, R. Jaafar, M. Bieri, T. Braun, S. Blankenburg, M. Muoth, A.P. Seitsonen, M. Saleh, X. Feng, K. Muellen, R. Fasel : *Nature* 466, 470 (2010).