Atomic Carbon Chains: A Perfectly One-Dimensional Carbon Phase Beyond Nanotubes

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Carbon chains can be considered as *sp¹*-hybridized strings of carbon atoms of monoatomic thickness, constituting the logical one-dimensional phase of carbon. They have been proposed since a long time until they were observed by electron microscopy. Recent experiments show that, by using a measuring system with an STM tip in a TEM specimen stage, carbon chains can not only be made but also characterized (O. Cretu et al., Nano Lett. **13**, 3487 (2013)). By passing a current through the chains, their electrical properties have been measured for the first time. The chains are obtained by unraveling carbon atoms from nanotubes or graphene ribbons while an electrical current flowed through the tubes or ribbons and, successively, through the chain. The electrical conductivity of the chains was found to be much lower than predicted for ideal chains. First-principles calculations show that strain in the chains determines the conductivity in a decisive way. Indeed, carbon chains are always under varying non-zero strain that transforms their atomic structure from *cumulene* (double bonds throughout the chain) to *polyyne* (alternating single/triple bonds), thus inducing a tunable band gap. New experiments show the bonding characteristics at contacts between metals and carbon chains as well as characteristic current-voltage curves, depending on the type of contact. The experiments show a perspective toward the synthesis of carbon chains and their application as the smallest possible interconnects or even as one-dimensional semiconducting devices.