Electrical transport in atomic carbon chains measured by in-situ electron microscopy

O. Cretu[1] A. R. Botello-Mendez[2] I. Janowska[3] C. Pham-Huu[3] J-C. Charlier[2] F. Banhart[1]

[1]Institut de Physique et Chimie des Materiaux, University of Strasbourg, France
[2]Institute of Condensed Matter and Nanosciences, Universite Catholique de Louvain, Belgium
[3]Laboratoire des Materiaux, Surfaces et Procedes pour la Catalyse, CNRS, Strasbourg, France

It is known since a few years that one-dimensional carbon exists, represented by chains of carbon atoms. These may be bonded by either alternating single/triple carbon-carbon bonds (polyyne) or by double bonds throughout the chain (cumulene). By using a combination of STM and TEM in an in-situ electron microscopy study, carbon atom chains have not only been made but also characterized electrically [1]. The chains were obtained by unraveling carbon atoms from graphene ribbons while an electrical current flowed through the ribbon 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 to polyyne, thus inducing a tunable band gap. The modified electronic structure and the characteristics of the contact to the graphitic periphery explain the conductivity of the locally constrained carbon chains. These are the first electrical measurements on atomic carbon chains and show a perspective toward their synthesis and application as the smallest possible interconnects or even as one-dimensional semiconducting devices.

[1] O. Cretu, A. R. Botello-Mendez, J.-C. Charlier, I. Janowska, C. Pham-Huu, F. Banhart, *arXiv* **0**, 1302.5207 (2013).