Fabrication of Graphene and Graphenoid Two-dimensional Materials from Self-Assembled Monolayers

A. Turchanin, A. Beyer, C.T. Nottbohm, M. Büenfeld, X. Zhang, R. Stosch[1], T. Weimann[1], J. Mayer[2], Ch. Kisielowski[3], A. Gölzhäuser

Fakultät für Physik, Universität Bielefeld, Bielefeld, Germany
[1]Physikalisch Technische Bundesanstalt, Braunschweig, Germany
[2]Gemeinschaftlabor für Elektronenmikroskopie, RWTH Aachen, Aachen Germany
[3]National Center for Electron Microscopy, Berkeley, CA, USA

A route for the fabrication of graphene and graphenoid (similar to graphene) materials, whose electrical and mechanical behavior as well as surface functionalization can be tuned, is presented. Self-assembled monolayers (SAMs) of aromatic biphenyls are cross-linked by electron irradiation into mechanically stable carbon films and then detached from the surface. This results in mechanically stable carbon nanomembranes with a thickness of 1 nm and sizes up to several cm^2. Upon annealing the nanomembranes at ~1200K, the cross-linked SAMs transform into a graphitic phase that consists of patches of single layer graphene and graphenoids [1]. This transition is accompanied by a drop of the sheet resistivity from ~10^8 to ~10^2 kΩ/sq and a mechanical stiffening from ~10 to 50 GPa. Hence, this method produces two-dimensional materials with tunable conductivity and stiffness. When transferred onto SiO_2/Si substrates, they can be visualized by Raleigh interference contrast. By using SAMs of appropriate biphenyls, a chemical surface functionalization of can be achieved, which allows their tailoring for applications. Devices and applications are discussed.

[1] A. Turchanin et al. , Adv. Mater. 21, 1233 (2009).

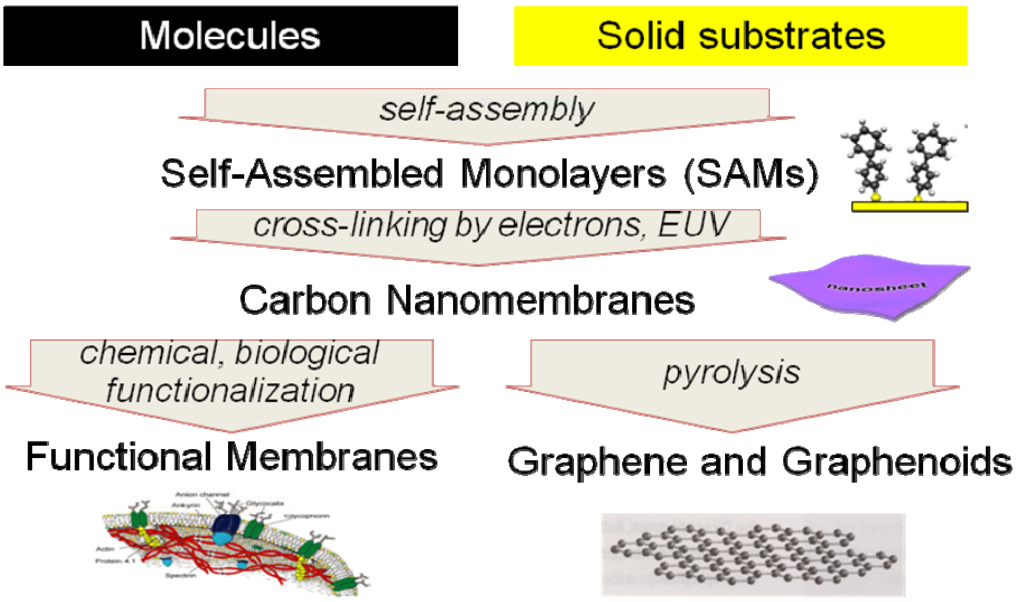

Fig. 1: A scheme for the controlled fabrication of two-dimensional carbon nanostructures utilizing a combination of molecular self-assembly and electron beam exposure to fabricate 1 nm thin carbon nanomembranes. These can be converted into functional membranes as well as into graphenoids and single layers of graphene.