1 nm thin carbon nanosheets with tunable conductivity and stiffness

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We present a new route for the fabrication of ultrathin (~1 nm) carbon films and membranes, whose electrical behavior can be tuned from insulating to conducting [1]. Self-assembled monolayers (SAM) of biphenyls are cross-linked by electrons, detached from the surface [2,3] and subsequently pyrolized (Fig. 1). Upon annealing at ~1000K, the cross-linked aromatic monolayer forms a mechanically stable graphitic phase consisting of nanosize patches of graphene. The transition is accompanied by a drop of the sheet resistivity from ~10^8 to ~10^2 kΩ/sq (Fig. 2) and a mechanical stiffening of the nanomembranes from ~10 to 50 GPa. The technical applicability of the nanosheets is demonstrated by incorporating them into a microscopic pressure sensor.

[1] A. Turchanin, A. Beyer, C. T. Nottbohm, X. Zhang, R. Stosch, A. Sologubenko, J. Mayer, P. Hinze, T. Weimann, A. Gölzhäuser, *Adv. Mater., in press (2009).*

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[3] C. T. Nottbohm, A. Beyer, A. S. Sologubenko, I. Ennen, A. Hütten, H. Rösner, W. Eck, J. Mayer, A. Gölzhäuser, *Ultramicroscopy 108, 885 (2008).*

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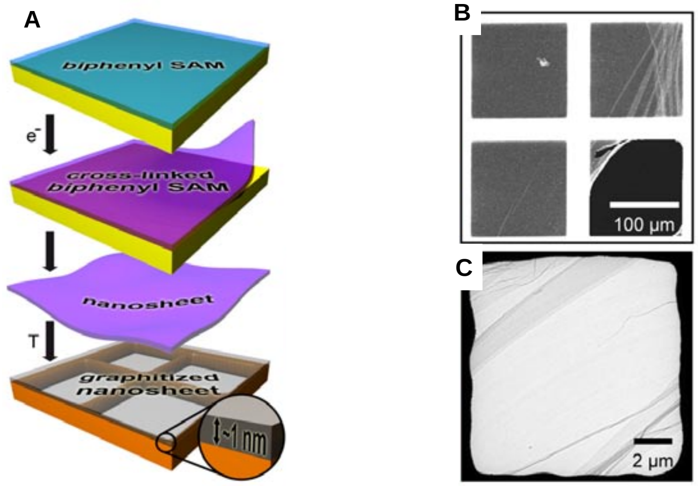

Fig. 1: Fabrication scheme and electron micrographs of carbon nanosheets. (A) A ~1 nm thick SAM of biphenyl molecules is irradiated by electrons resulting in a stable nanosheet that can be removed from the substrate. When transferred onto TEM grids, nanosheets suspend over openings. Upon pyrolysis, nanosheets transform into a graphitic phase. **(B)** SEM of a TEM grid with transferred nanosheet. The sheet in the upper right opening shows folds In the lower right, the sheet is ruptured. **(C)** TEM of a nanosheet after pyrolysis. The 11x11 μm^2 opening is covered with a single nanosheet. Some folds within the sheet are visible.

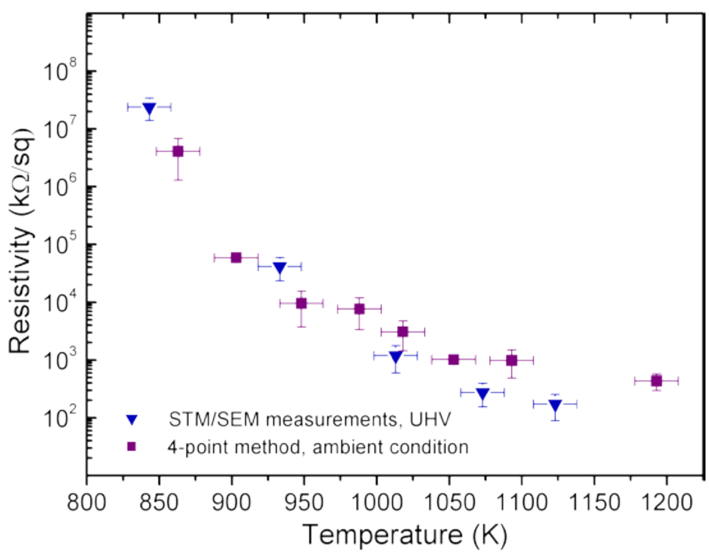

Fig. 2: Room temperature resistivity of carbon nanosheets as a function of annealing temperature. The sheet resistivity was determined by two-point measurements in an SEM/STM in UHV as well as with a four-point probe in ambient condition.