

**CAMPUS COLLOQUIA** series presents1<sup>st</sup> Carlo Taliani Memorial Lecture

# A Polymer Chemistry of Graphenes and Graphene Nanoribbons

**Klaus Müllen** - Max Planck Institute for Polymer Research, Mainz, 55128, Germany

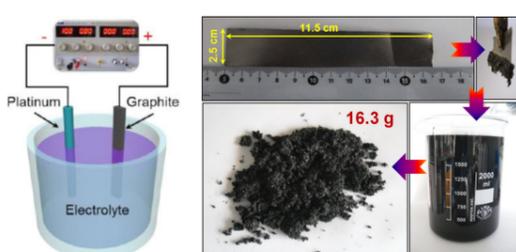
**Abstract:** Carbon materials are of immense practical importance, but are often known as structurally ill-defined “black stuff” such as soot. Graphenes and graphene nanoribbons (GNRs), their geometrically restricted cutouts, are new additions to the carbon

family which are widely praised as multifunctional wonder materials and rich playgrounds for physicists. Indeed, graphenes hold enormous promise as materials for energy technologies. Further, GNRs are regarded as a new generation of semiconductors superior to i) silicon in view of the required miniaturization of printed circuits and superior to ii) classical conjugated polymers due to better band structure control. Above all, however, graphene as a two-dimensional polymer and GNRs are true challenges for materials synthesis.

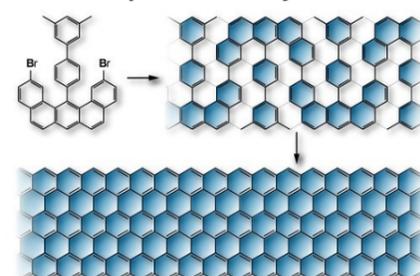
Herein, we approach graphene fabrication in two steps. “Top-down” protocols such as electrochemical exfoliation are applied for batteries, fuel cells and photodetectors. In the “bottom-up” synthesis of GNRs, repetitive cycloaddition reactions in solution are shown to afford multiply branched polyphenylene polymers which then serve as precursors for perfectly “graphitized”, solution-processable GNRs as long as 600 nm. An alternative on-surface synthesis utilizes immobilization of suitable monomers and in-situ STM-control of the polymerization to secure structural perfection.

It is thus a synthetic breakthrough which leads to new materials science and physics such as single-molecule field effect transistors from GNRs and even spintronics. The present fundamental study is far away from robust technologies, but an attempt can be made at predicting some future trends.

Top-down electrochemical exfoliation



Bottom-up chemical synthesis



**Klaus Müllen.** Born on January 2, 1947 in Cologne. Study of chemistry, doctorate Basel Univ. (1971), German Habilitation Technical Univ. ETH Zürich (1977), Professor Cologne Univ. (1979), Professor Mainz Univ. (1983), Director and Scientific Member at the Max Planck Institute for Polymer Research (1989 to 2016), Honorary Professor Mainz Univ. (since 1995). Emeritus since February 2016.

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