Carbon Nanostructures as Electronic Multitalents

Klaus Müllen

Max Planck Institute for Polymer Research, Mainz, Germany

This is a chemistry-driven journey through the fascinating landscape of carbon nanostructures with size and dimensionality of molecules as guidelines. A sequence of polyphenylenes will be considered, comprising 1D-conjugated polymers, nanographenes and related dyestuffs, quasi-1D graphene nanoribbons and 3D-dendritic polyphenylenes as shape-persistent nanoparticles. Graphene, the prototype of a 2D-material will be included for comparison, mainly in regard to energy technologies. The key question from a functional point of view is how electronic and optoelectronic properties can be precisely tuned by chemical design.

Some important examples are i) the dramatic increase of charge-carrier mobilities in field-effect transistors, ii) the opening of an electronic band gap in graphene nanoribbons – as opposed to graphene, iii) the occurrence of stable radical-bearing systems with defined spin-spin interactions, iv) the optimization of charge-storage capacities in batteries and supercapacitors as well as v) the detection of exotic quantum states. All achievements offer new fabrication concepts for devices, but also unprecedented technological opportunities, for example, in graphene-based electronic circuitry and in quantum technologies.

If there is time, some biomedical applications in diagnostics and therapy of tumors and neurodegenerative diseases will be dealt with as well.

Science *2019,* ***366****, 1107;* ***Nature Nanotechnology*** *2020,* **15***, 22;* ***Nature*** *2018,* ***557****, 69;* ***560****, 209;* ***561****, 507;* ***Nature Rev. Chem.*** *2017,* **2***, 01000;* ***Nature Synthesis*** *2022* ***, 1****, 289;* ***Progr. Polym. Science*** *2022,* ***123****, art. No 101489;* ***Nature Chemistry*** *2021,* ***13****, 581;* *Progr. Polym. Sci. 2022,* ***123****, art. no 101489;* **J. Amer. Chem. Soc**. *2022*, **144,** 11499; ***Chemistry-Eur. J.*** *2023, e202203735;* ***Nature Materials*** *2023****,*** **22**, 180-185; **Nat. Commun.** 2024, DOI: 10.1038/s41467-024-51806-8**;** ***J. Am. Chem. Soc****.* 2024, ***146***, 7480.

.