Prof. Dr. Klaus Müllen

emeritus professor at MPI-P

- 1966-1969 Studies in Chemistry, University of Cologne
- 1969 Degree in Chemistry (Professor E. Vogel)
- 1971 PhD-work, University of Basel (Professor F. Gerson)
- 1972-1978 Postdoctoral training and Habilitation (Professor J.F.M. Oth), ETH Zürich
- 1979-1984 Professor University of Cologne
- 1984-1989 Professor University of Mainz
- 1988 Offer from the University of Göttingen
- 1989 Scientific Member of the Max-Planck-Society and Director at the MPI-P in Mainz
- 1992 Offer from the University of Cologne

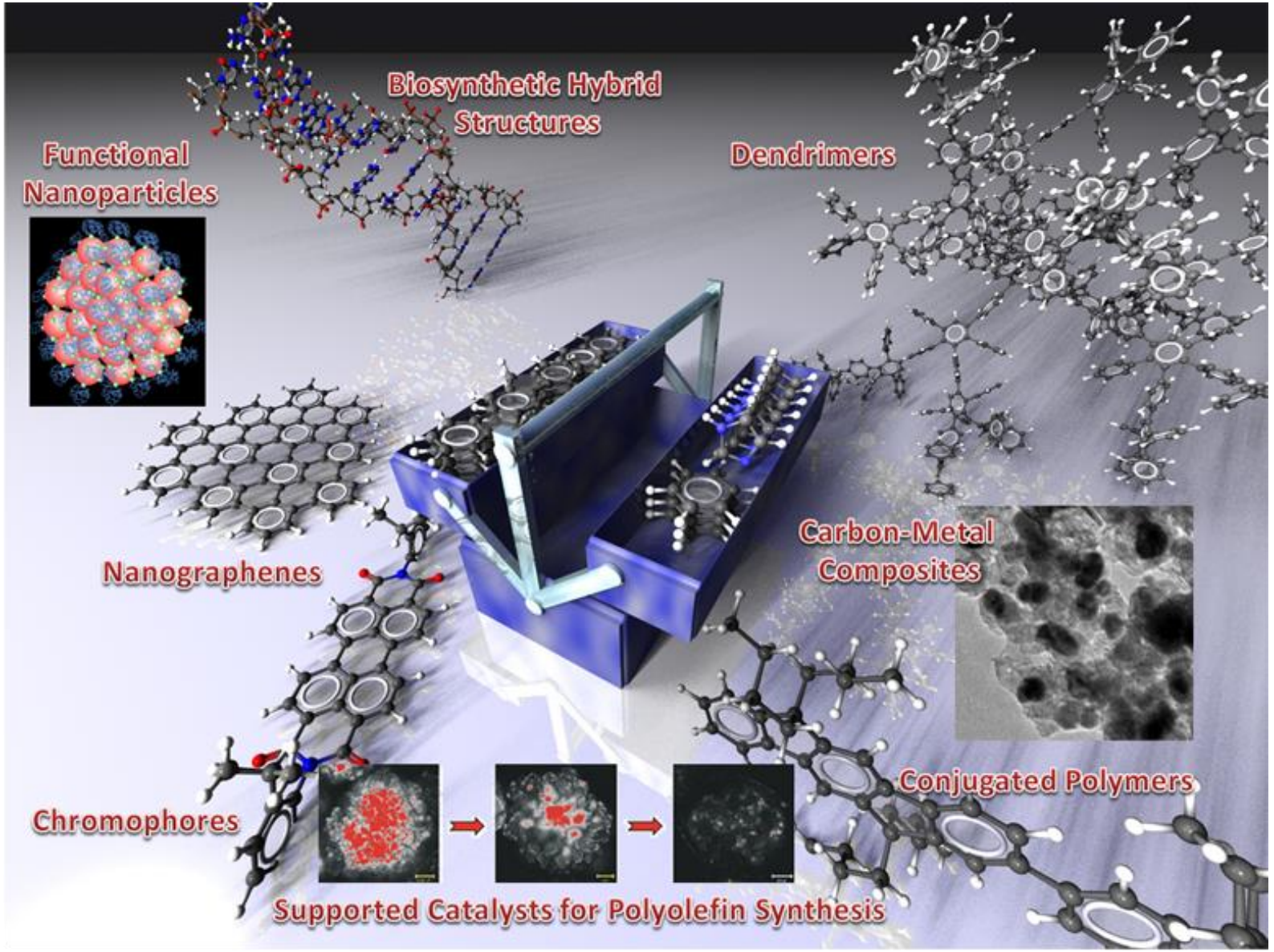
- More than 2013 scientific publications
- *h*-index: 150 (Mar. 2020)
- More than 50 former associates are now professors in academic institutions worldwide

1993: Max-Planck-Forschungspreis
1997: Philip Morris Forschungspreis
2011: ACS Award in Polymer Chemistry
2013: Adolf-von-Baeyer-Denkmünze
2014: Carl-Friedrich-Gauß-Medal
2016: Hermann-Staudinger-Award
2019: Karl-Ziegler-Award
2019: Cothenius-Medal of Leopoldina

https://www.mpip-mainz.mpg.de/de/muellen (02.04.2020)

Prof. Dr. Klaus Müllen

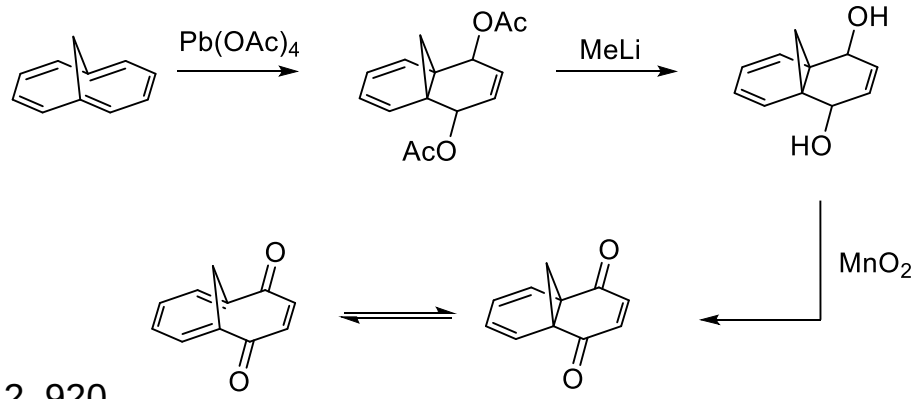
S. Fisher



https://www.mpip-mainz.mpg.de/de/muellen (02.04.2020)

Work in the group of Prof. E. Vogel:

- First interest in investigation of annulene structures
- Equilibrium between **1** and **2** is determined via NMR

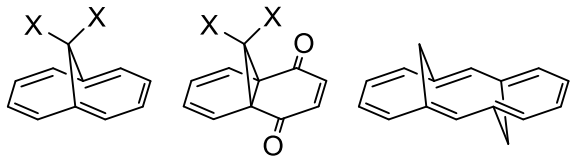


1 **2**

Angew. Chem. Int. Ed., **1971**, 10, 12, 920.

PhD-work in the group of Prof. F. Gerson:

- Put his focus deeper into structural analysis of annulenes
- Evolved skills in ESR analysis



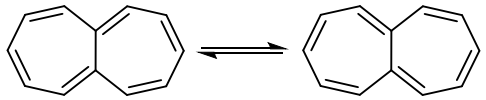
Helv. Chim. Acta **1971**, 54, 8, 2731.

J. Am. Chem. Soc. **1972**, 94, 9, 2942.

ETH Zürich under the guidance of Prof. J.F. M. Oth:

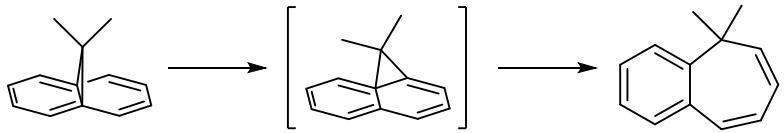
- Deepened his knowledge on annulenes and continued with more complex systems
- Mastered pericyclic reactions

- Isomerization of heptalene



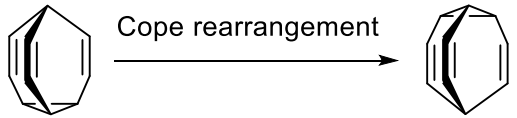
Angew. Chem. Int. Ed. **1974**, 13, 11, 732.

- Berson-Willcott rearrangement



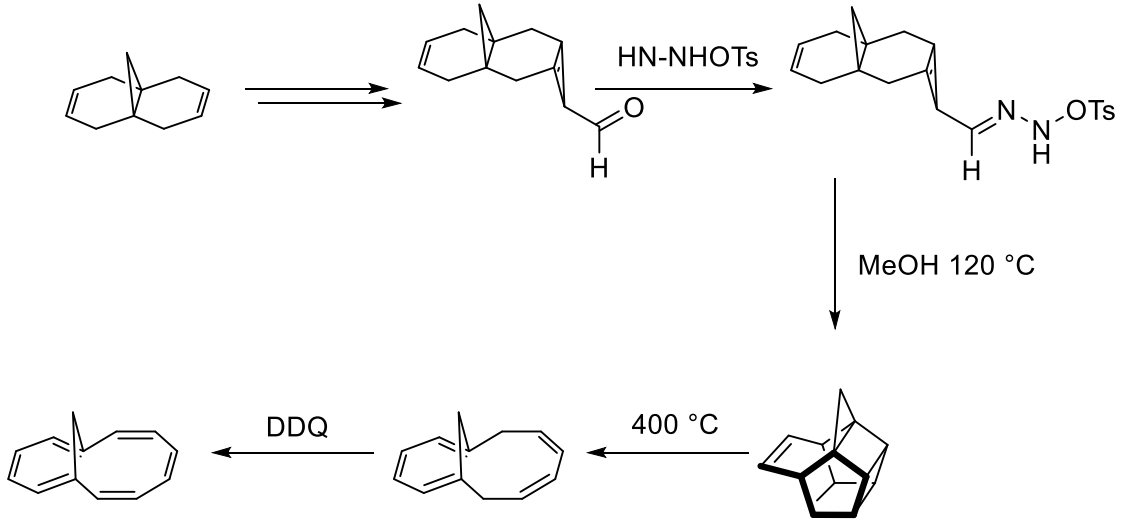
Angew. Chem. Int. Ed., **1978**, 17, 3, 208.

- Isomerization of bullvalene



For more detailed mechanism and theory see:
Helv. Chim. Acta **1974**, 57, 5, 1415.

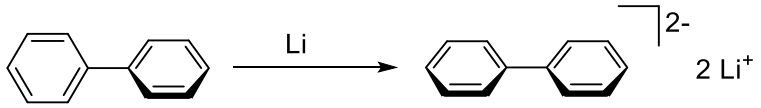
- Synthesis of diverse methano[n]annulenes



Angew. Chem. Int. Ed. **1974**, 13, 4, 283.

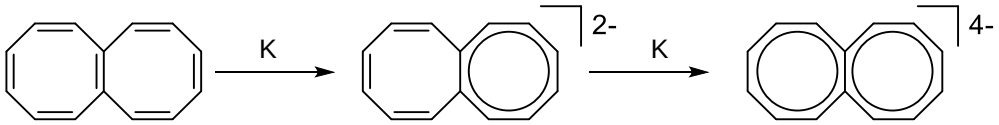
University of Cologne:

- Reactivity and structural differences of unreduced and reduced annulenes



Chem. Ber. **1981**, 114, 1318.

- Highly reduced annulenes



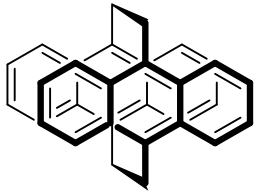
14π
non-planar

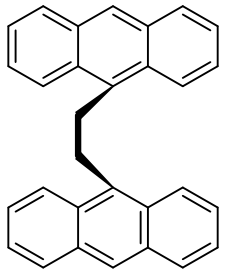
16π

18π
planar

Angew. Chem. Int. Ed. **1979**, 18, 3, 229.

- Spin states of reduced and unreduced linked anthracene molecules





1^{2-} singlet at -30°C

2^{2-} singlet at -30 °C
triplet at -150 °C

Angew. Chem. Int. Ed. **1983**, 22, 3S, 288.

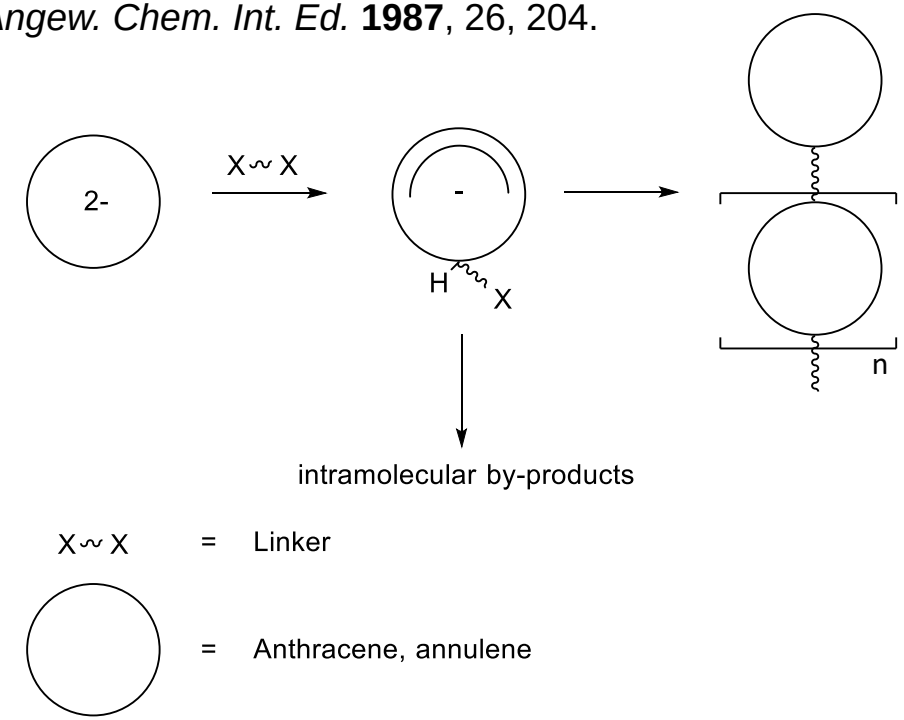
- Studies peaked into a review about the reduction and oxidation of annulenes

Chem. Rev. **1984**, 84. 603-646.

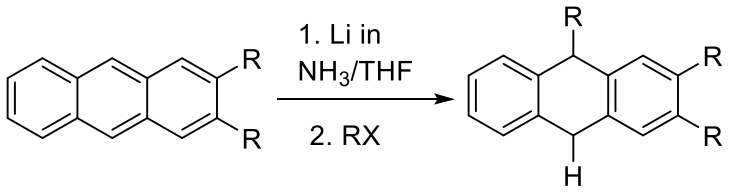
Application of his knowledge on polymer chemistry
University of Mainz:

- Interest in polymerization reactions of reduced annulenes and aromatic molecules

Angew. Chem. Int. Ed. **1987**, 26, 204.

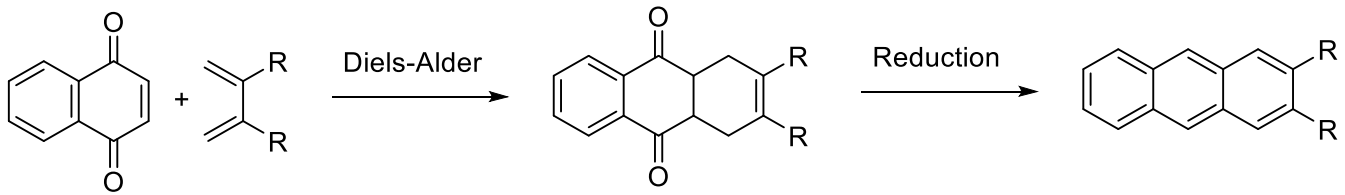


- Selective monoalkylation of anthracene in liquid ammonia



J. Am. Chem. Soc. **1985**, 107, 801.

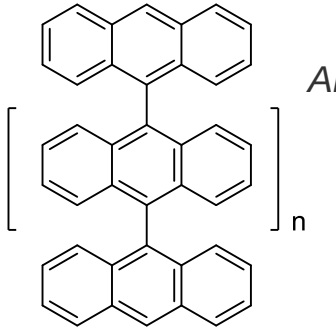
- Synthesis of new anthracene derivates as precursors



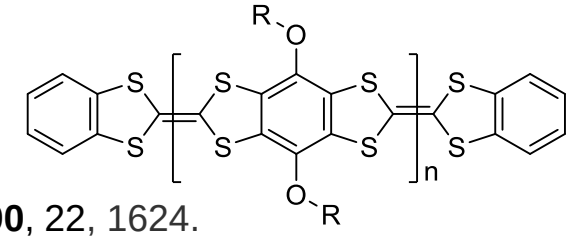
Chem. Ber. **1988**, 121, 1187.

Application of his knowledge on polymer chemistry
Director in MPI-P:

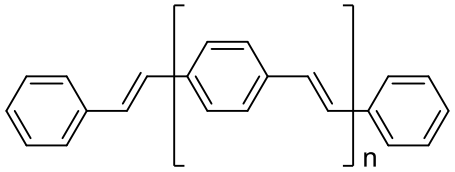
- Interest in electrochemical properties of polymers
  (see *J. Am. Chem. Soc.* **1991**, 113, 1121-1127.)



Angew. Chem. Int. Ed. **1992**, 31, 4, 448.

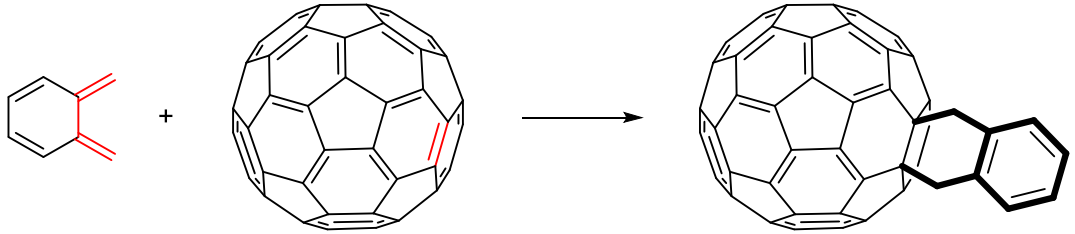


Chem. Comm. **1990**, 22, 1624.
Adv. Mater. **1994**, 6, 6, 439.



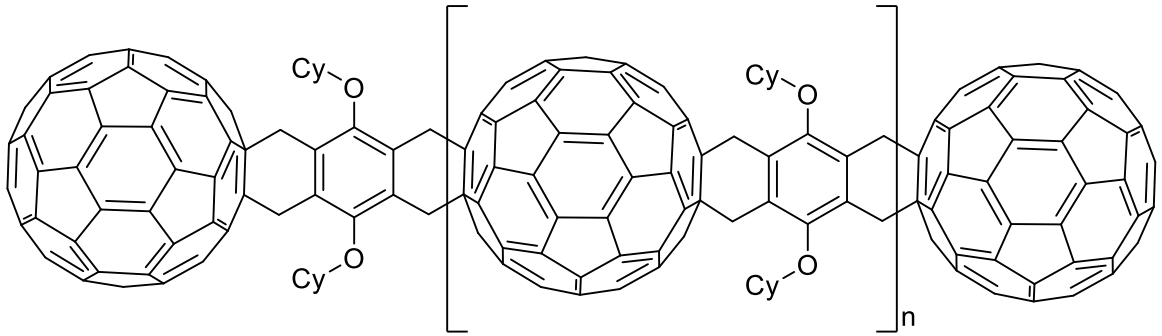
J. Am. Chem. Soc. **1991**, 13, 7, 2634.
J. Chem. Phys. **1991**, 95, 5, 3198

- Derivatization of C_{60} fullerenes via Diels-Alder reaction



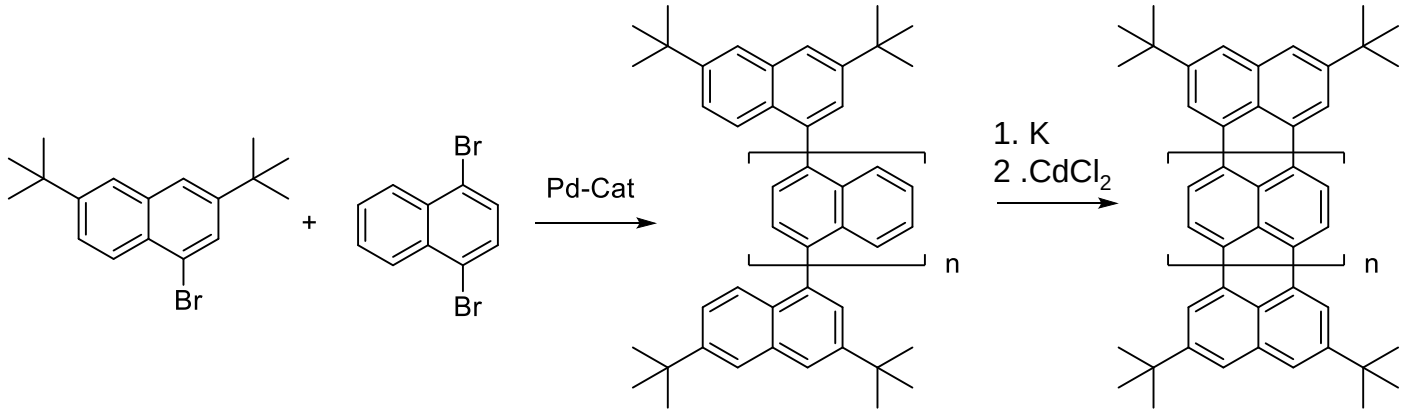
Angew. Chem. Int. Ed. **1993**, 32, 1, 78.
Chem. Eur. J. **1995**, 1, 4, 243.

- Polymerization of C_{60} fullerenes

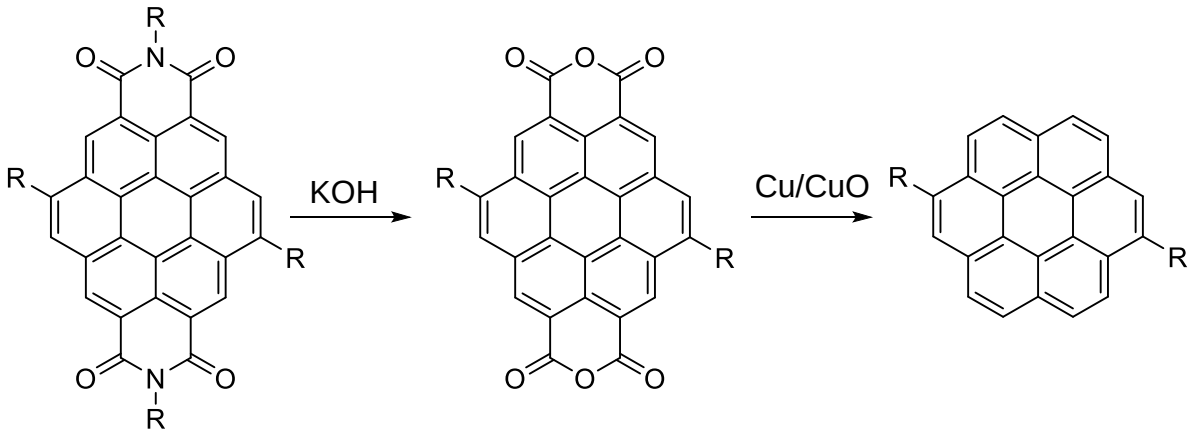


Tetrahedron **1996** , 52, 14,5007.

- Novel approach to poly(peri-naphthalenes) and electrochemical experiments



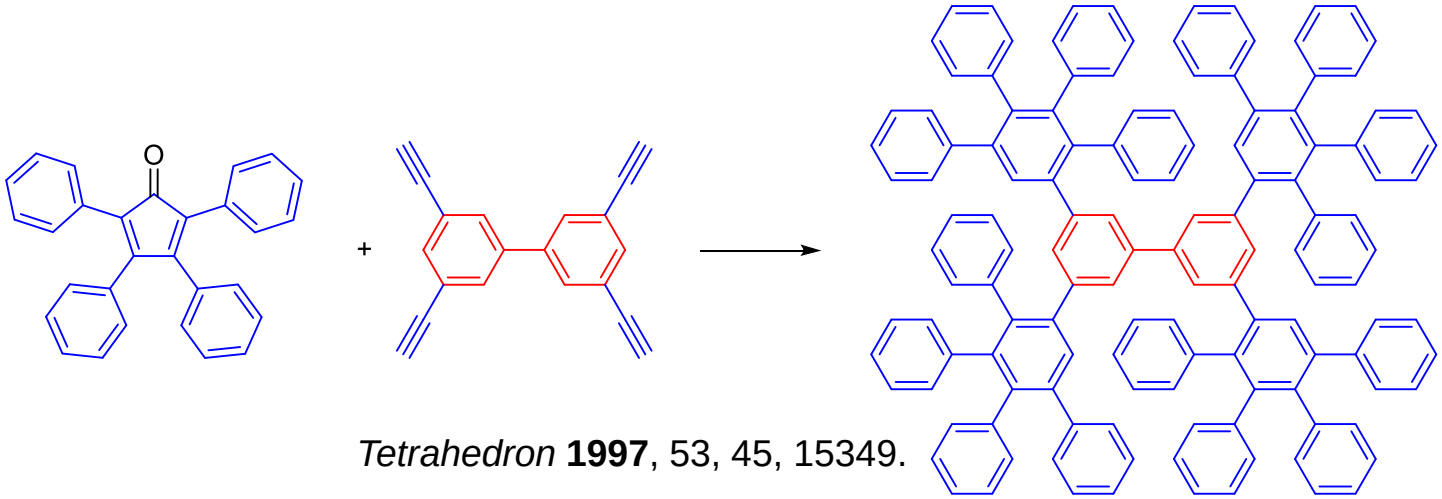
Angew. Chem. Int. Ed **1990**, 29, 5, 525.
Chem. *Ber*. **1991**, 124, 2091.



Angew. Chem. Int. Ed. **1998**, 37, 10, 1434.

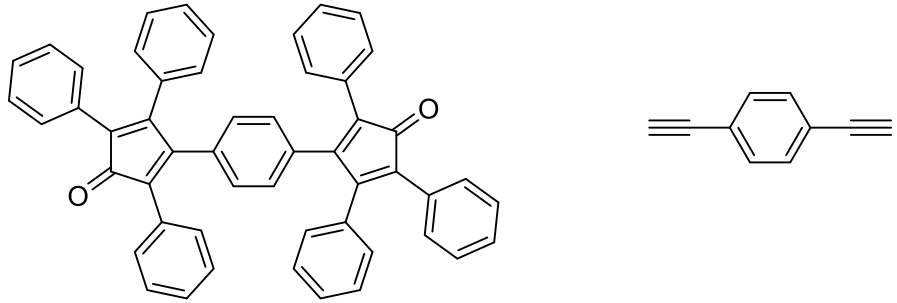
- Electrochemical studies on gold-film (see *J. Phys. Chem.* **1994**, 98, 11780.)
- Application as dyes and light emitting diodes

- Dendrimers synthesized via Diels-Alder reaction
- Cyclopentadienone and acetylen as building-blocks



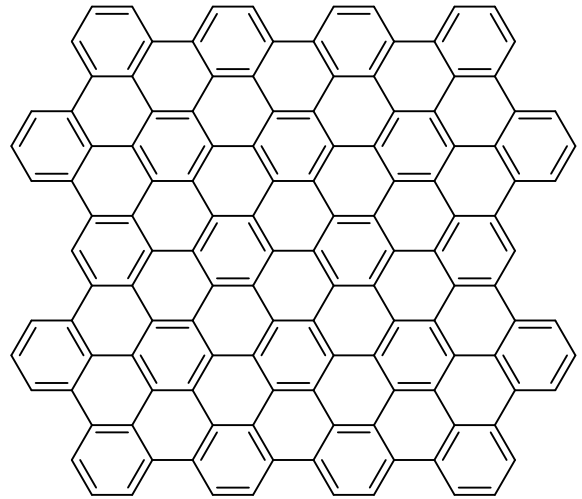
Tetrahedron **1997**, 53, 45, 15349.

- Building blocks for polymeric structures



Macromolecules **2003**, 36, 19, 7082.

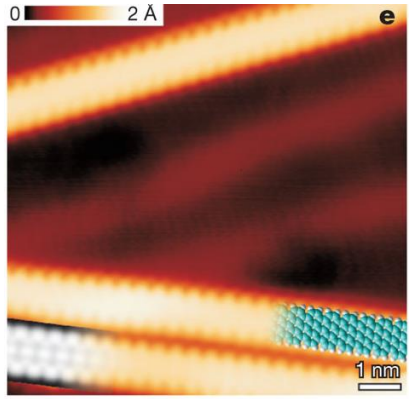
$FeCl_3$

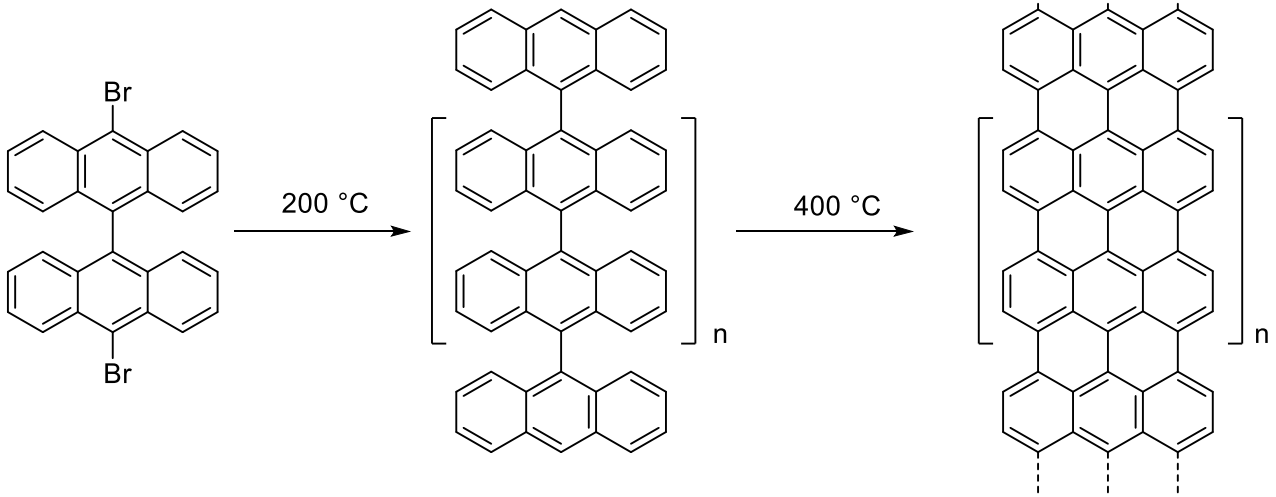


J. Am. Chem. Soc. **2000**, 122, 7707.

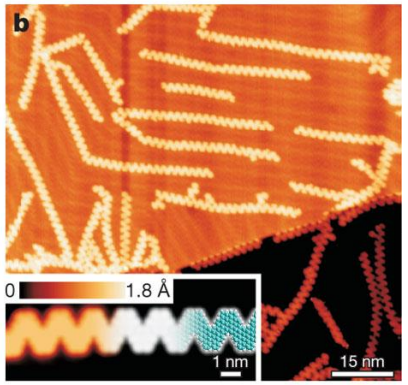
- Dendrimeric structures by cyclodehydrogenation
- Graphene sub-structures in defined shapes and sizes
- Structures has shown potential as charge carriers

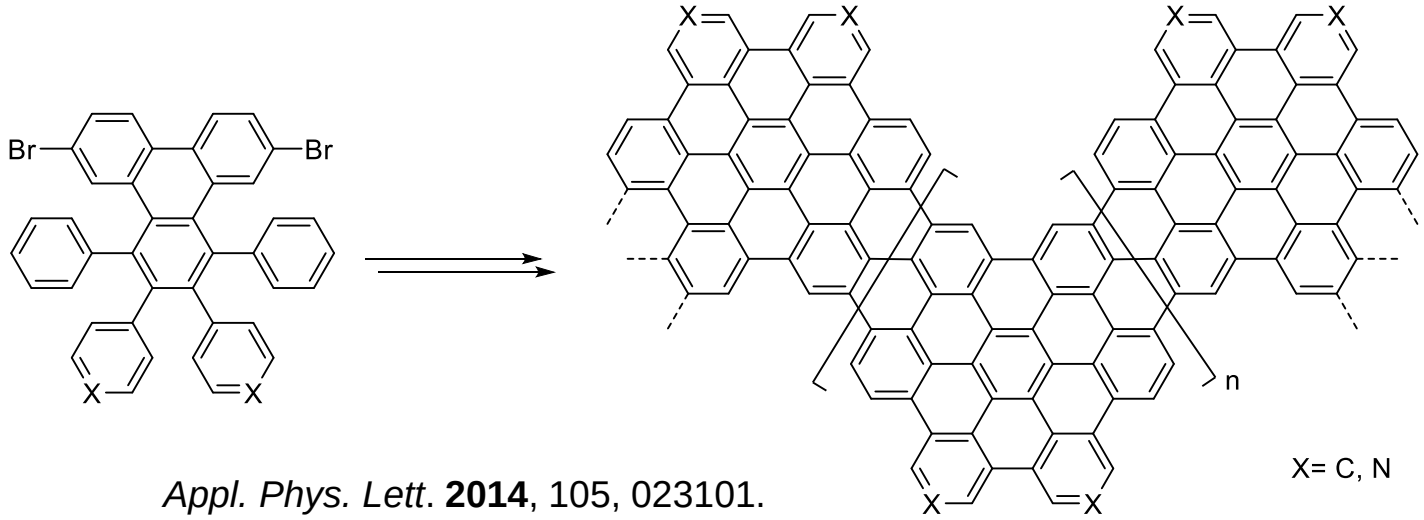
Adv. Mater. **1999**, 11, 17, 1496.





Nature **2010**, 466, 470.



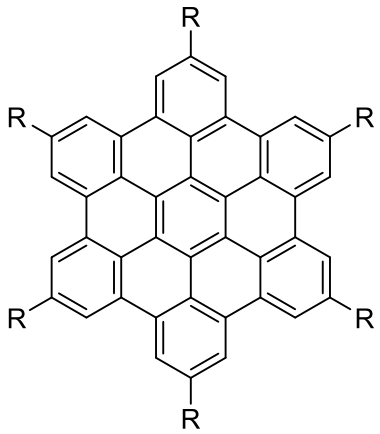


Appl. Phys. Lett. **2014**, 105, 023101.

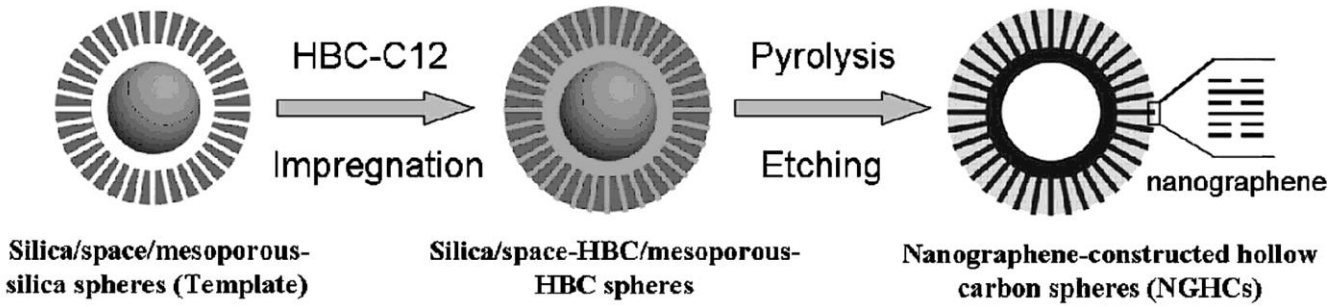
X= C, N

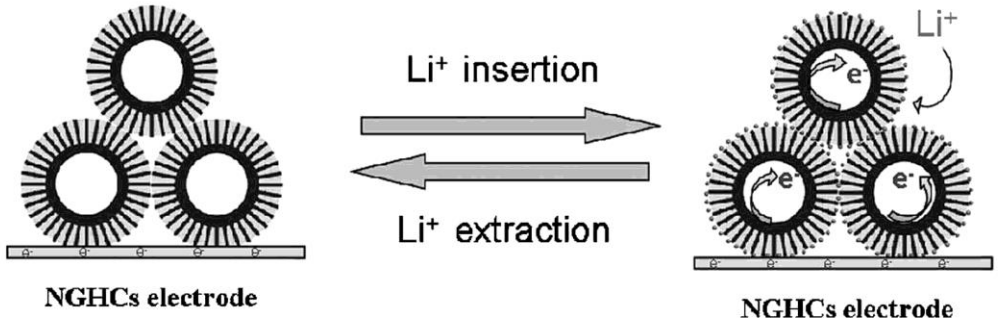
Prof. Dr. Klaus Müllen

- Hollow carbon spheres for lithium storage

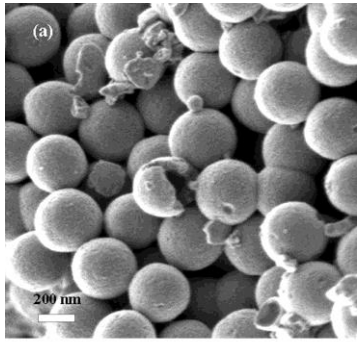


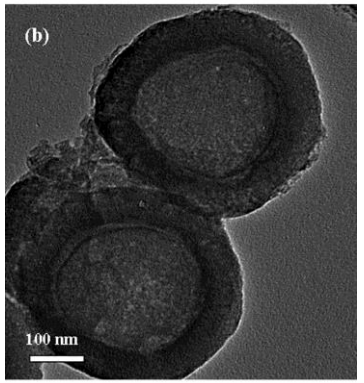
J. Am. Chem. Soc. **2003**, 125, 1682.

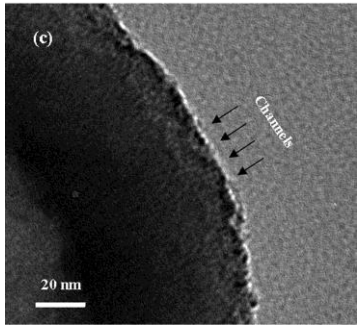




Adv. Mater. **2010**, 22, 7, 838.





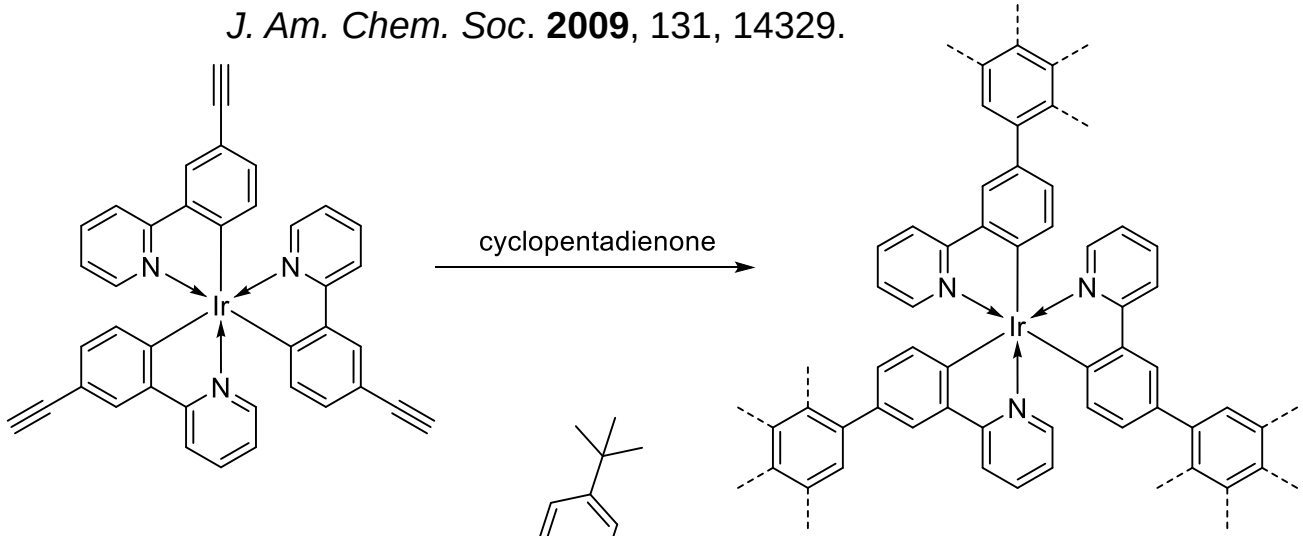


Other strategies for Li storage:

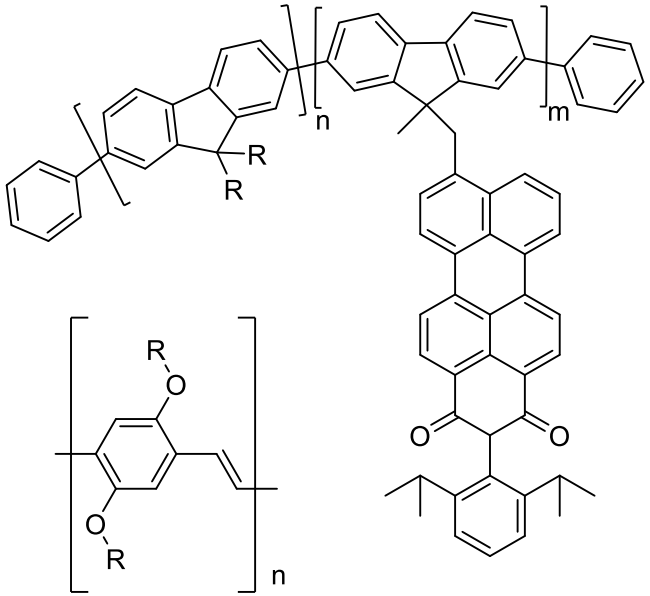
- Graphene-encapsulated oxide or metal nanoparticles
  For examples see: *Angew. Chem. Int. Ed*. **2010**, 49, 8408 and *Small* **2007**, 3, 12, 2066.
- Cobalt/graphene composites
  Example: *ChemSusChem* **2010**, 3, 236.

- Dendrimers with Ir core
- Color tunable by size

J. Am. Chem. Soc. **2009**, 131, 14329.

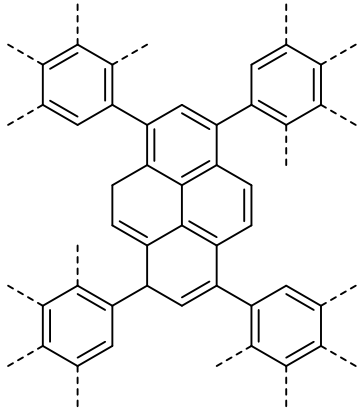


- Organic diodes

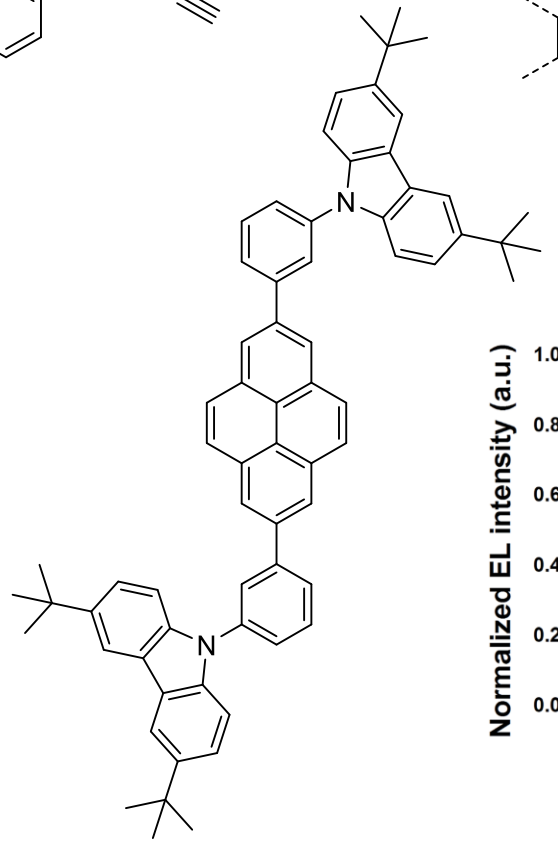


App. Phys. Lett. **2002**, 80, 12, 80.

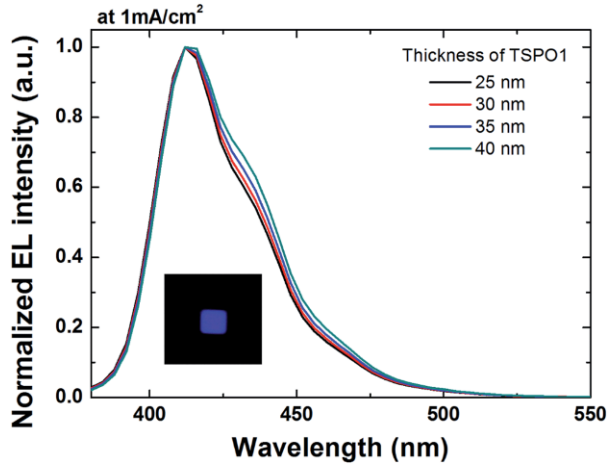
- Pyrene cores:



J. Am. Chem. Soc. **2011**, 133, 1301.



J. Mater. Chem. C **2014**, 2, 9083.



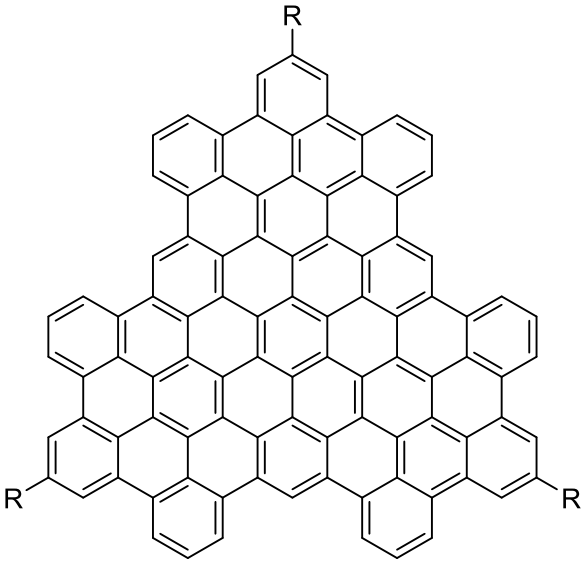
- Synthesis of various dyes/buildingblocks including:
  - Perylene building blocks:
    Advantage: tunable absorption wavelength

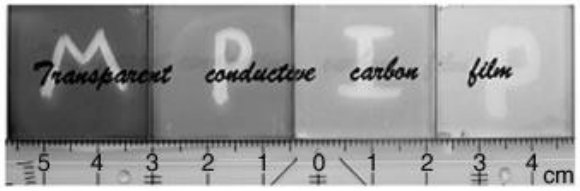
J. Phys. Chem. C **2007**, 111, 42, 15137.

  - Polycarbazoles

J. Mater. Chem. **2006**, 16, 96.

- Dendrimers and graphene units as transparent electrodes for solar cells
- Alternative for ITO



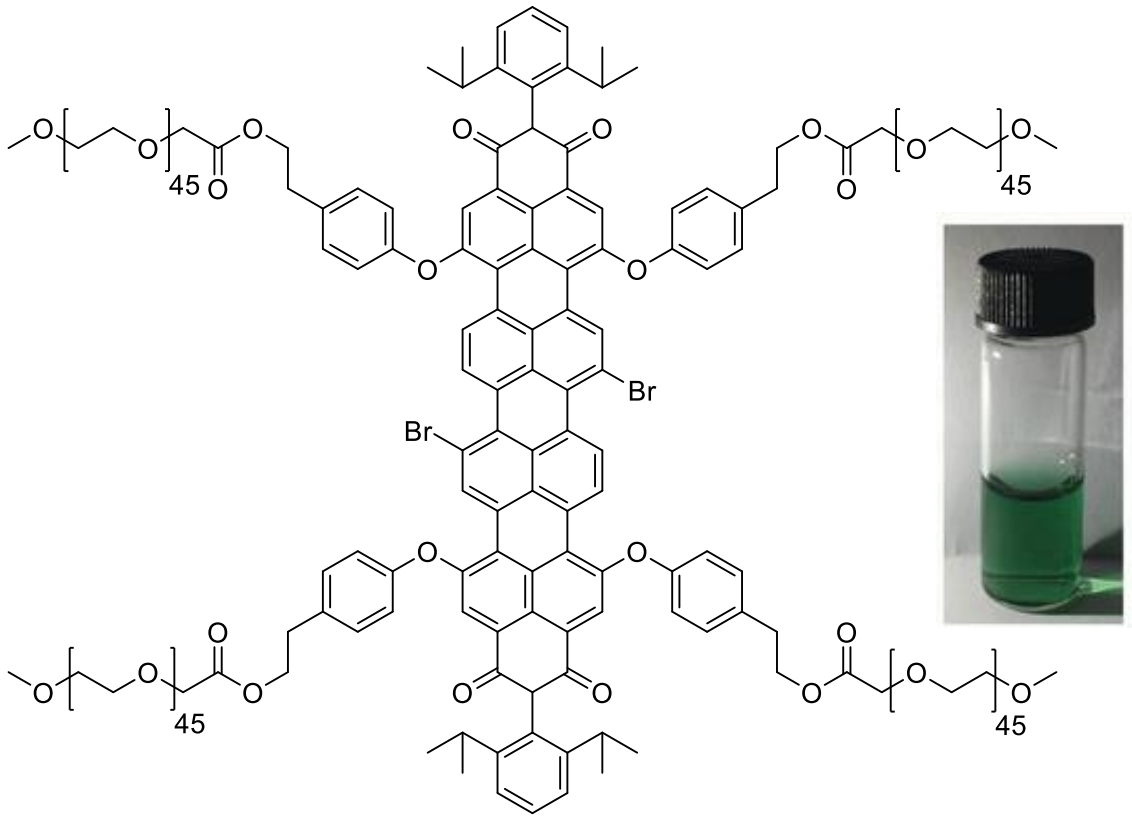


Nano Lett. **2008**, 8, 1, 323.

Angew. Chem. Int. Ed. **2008**, 47, 2990.

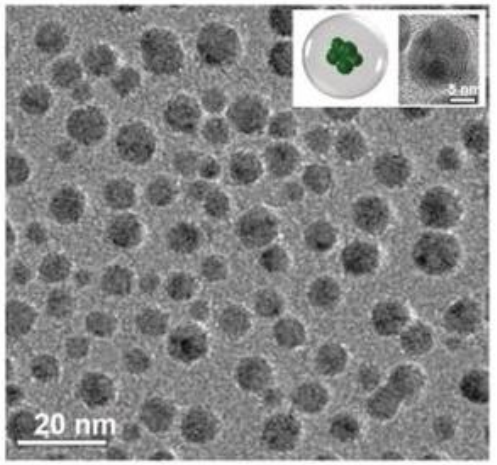
	anode	power conversion efficiency
monochromic light of 510 nm	ITO	1.5
	TGF	1.53
simulated solar light	ITO	1.17
	TGF	0.29

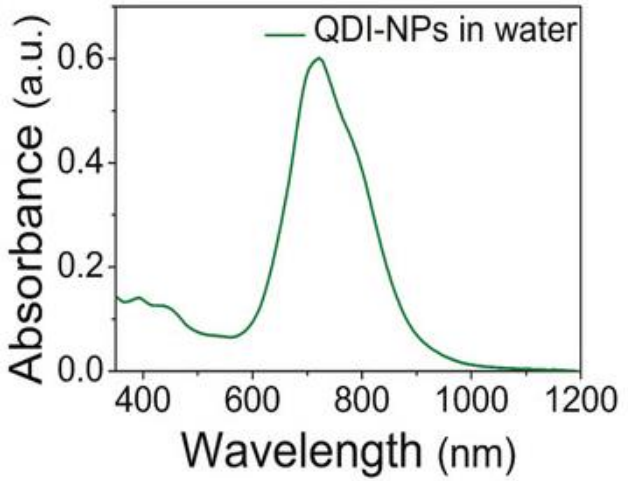
- Cancer treatment with quaterrylenediimide chromophore

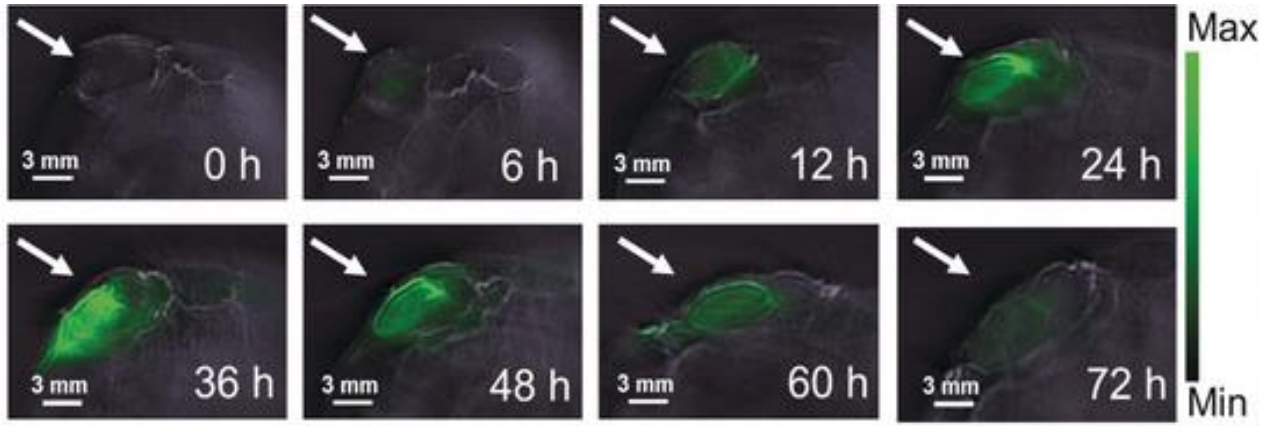


Angew. Chem. Int. Ed. **2019**, 58,1638.

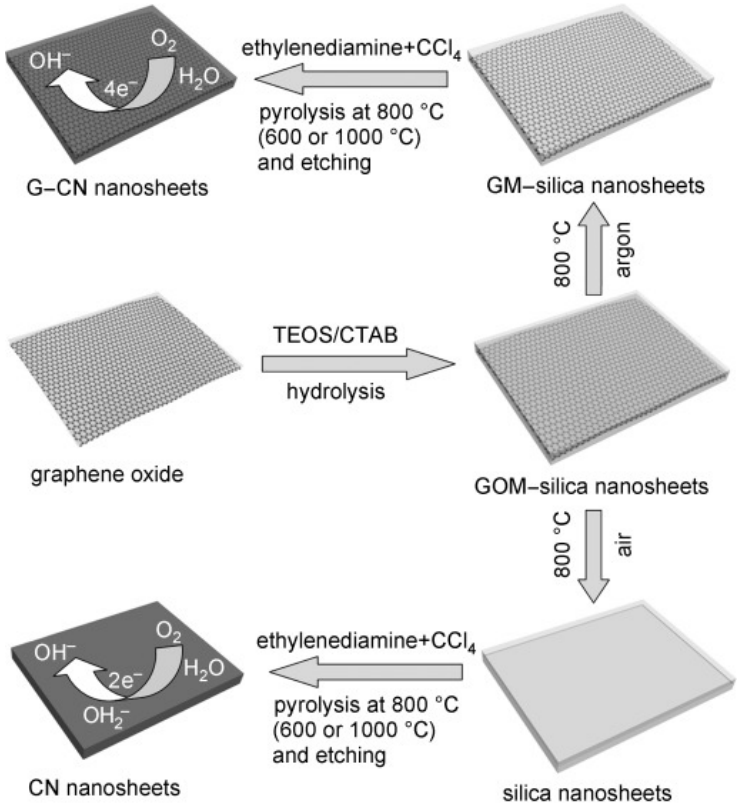
- Self-assembly in water
- Upon excitation with NIR radiation cancer cells are destroyed







Oxygen reduction

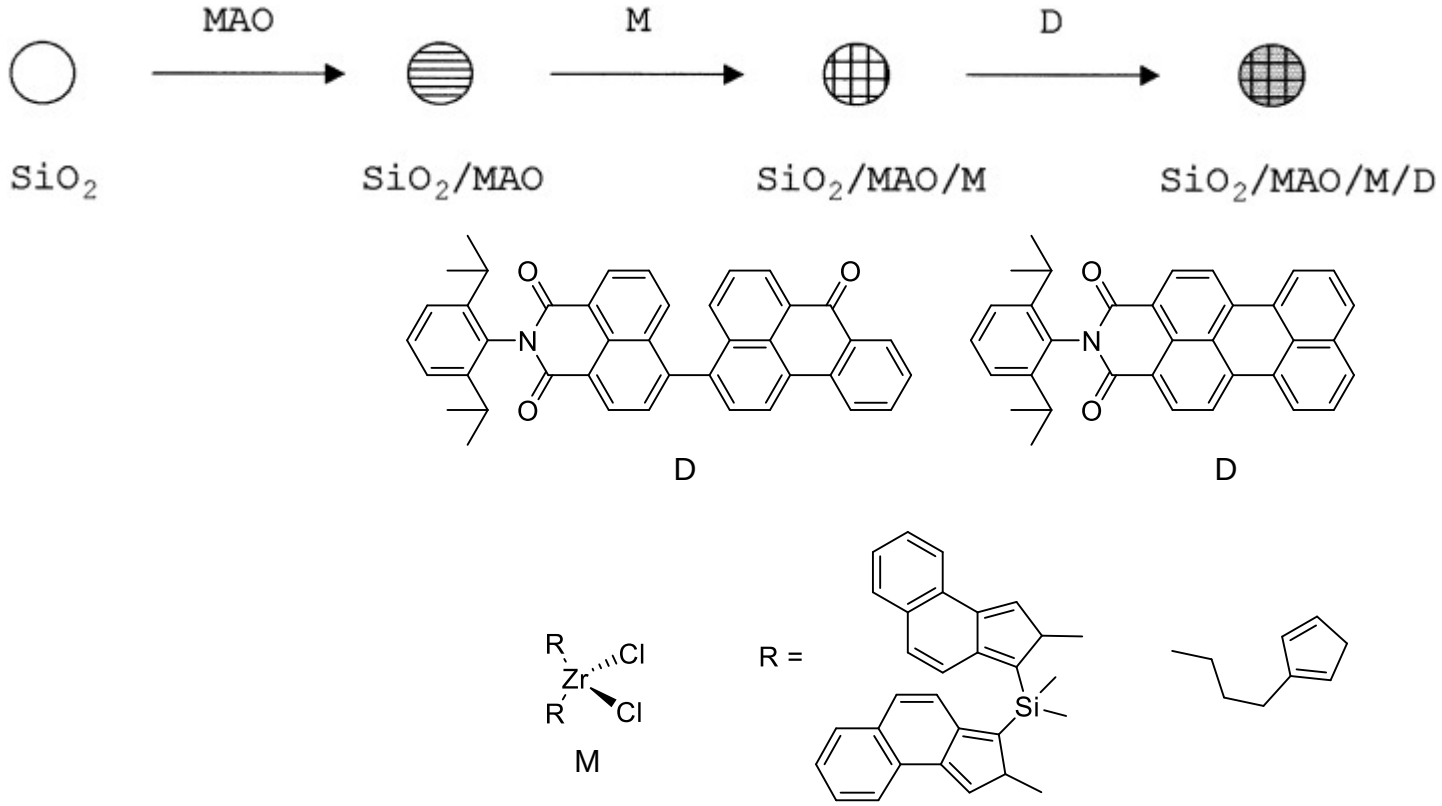


Metal free: *Angew. Chem. Int. Ed*. **2011**, 50, 5339.

Co/Fe: *J. Am. Chem. Soc.* **2013**, 135, 16002.

Olefin metathesis

Angew. Chem. Int. Ed. **2000**, 39, 23, 4367.



Nanocomposites
Quantum dots
Transistors