3D-Hybrid Networks
with Controllable Electrical Conductivity
by Electrochemical Deposition of
Terthiophene-Functionalized Polyphenylene
Dendrimers

J. Heinze
University of Freiburg
Institute of Physical Chemistry
Albertstrasse 21,
D-79104 Freiburg, Germany

A new class of monodisperse nanostructured macromolecules which exhibit remarkable physical and electrochemical properties are dendrimers. We have studied the electropolymerization and conductivities of shape-persistent polyphenylene dendrimers decorated with peripheral terthiophene units [1].

Upon electrochemical oxidation the hedgehog-type core-shell system 1 forms a network which can be charged and discharged in the potential range between 0.4 and 1.5 V. In-situ conductivity measurements (Figure 1) of the coupling product of 1 show an increase of the conductivity during voltammetric charging of the thiophene chains in the deposited material. This conductivity passes a maximum approximately at the half-charged level. At higher potentials the conductivity increases again indicating a three-dimensional charge transport.

Obviously, the hopping processes of charge carriers are facilitated in the 3D network. The results offer new insights into conductivity mechanisms of conjugated polymers. The great similarity between the conductivity behaviour of this material and that of radical ion salts supports the view of almost identical transport mechanisms.

It should be mentioned that the conductivities of all conjugated polymers, which have been measured in our group, are a function of the doping potential. They always pass a maximum and decrease again at a charging level higher than 0.4 V.

Figure 1: In situ conductivity measurements of poly-1 in a monomer-free cell at room temperature, v = 5 mV s⁻¹, CH₂Cl₂ / TBAPF₆.

a) potential range between 0.0 and 1.2 V
b) potential range between 0.0 and 1.5 V.

The film was generated in solution of 1 by polymerization (2 potentiodynamic cycles between 0.0 and 1.5 V, 50 mV s⁻¹, c = 10⁻³ mol l⁻¹ in CH₂Cl₂ / TBAPF₆).