Kolloquium Energie- und Halbleiterforschung

Universität Oldenburg
Institut für Physik
Abteilung Energie- und
Halbleiterforschung

Dienstag, 17.04.2018, 16.15 Uhr in W0 0-001

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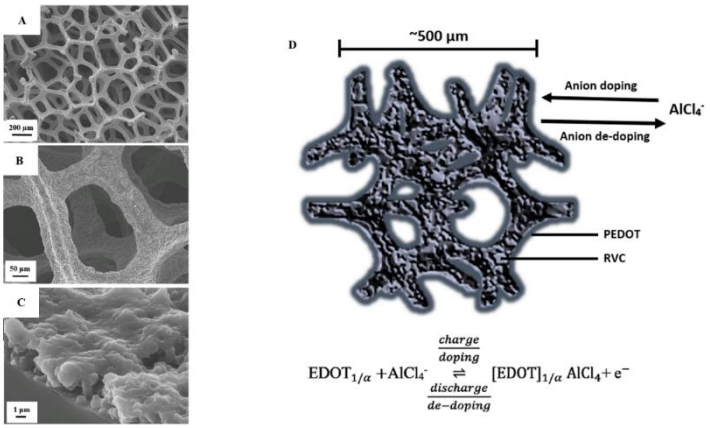
3D Conductive Polymer-Carbon Composites in Ionic Liquids as Energy Storage Material

The drive towards sustainable energy, especially electro-mobility, requires energy storage technologies, combining high specific energy and power as well as sustainability, in one system. A promising approach to realise such systems is the use of conductive polymers as an electrode material in contact with highly stable and non-toxic solvents such as ionic liquid electrolytes. Conductive polymers like poly(3,4-ethylenedioxythiophene) (PEDOT) have the unique characteristic to undergo a redox reaction like in a battery. In addition, the polymer is doped/charged (de-doped/discharged) by anions contained in the ionic liquid and stored in the porous polymer structure as electrical charges, providing capacitor characteristics to the polymer. Because of the combination of faradaic and capacitive properties in a single electrode, these conductive polymers can be classified as hybrid battery-capacitors [1,2].

The electro-polymerisation of a thin film nano/micro-porous structure of PEDOT on a high surface area materials such as three-dimensional conductive carbon-based substrate, assures larger availability of active material (“footprint-area” [3]) without decreasing the energy per active electrode material. This type of composite material provides an increased capacitance while the high surface area of the carbon substrate acts as a rigid framework and helps to overcome stability problems often associated with conducting polymer electrodes such as swelling/contraction during charging/discharging processes.

This study focuses on the synthesis and characterisation of thin electro-active PEDOT films on a macro-porous surface of reticulated vitreous carbon (RVC) substrates by electro-polymerisation in Lewis neutral 1-ethyl-3-methylimidazolium chloride aluminum chloride (EMImCl-$AlCl_3$) ionic liquid with $AlCl_4^-$ as doping/de-doping anion and its charge/discharge electrochemical properties.



(A-C) PEDOT electro-polymerised on RVC and (D) schematic illustration of the three-dimensional RVC-PEDOT composite, which is doped (charged) and de-doped (discharged) with $AlCl_4^-$ anions of a chloroaluminate ionic liquid.

[1] Chemical Reviews 110 (2010) 4724–4771.
[2] Chemical Society Reviews 44 (2015) 1777–1790.
[3] Advanced Materials 26 (2014) 2440–2445.