SUPERCAPACITOR ELECTRODES PREPARED FROM HIGH SURACE AREA CARBON BLACK FEATURING HIGH PSEUDO-CAPACITANCE AND ELECTROLYTIC DOUBLE LAYER CAPACITANCE

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Supercapacitors (supercaps) have found world-wide attraction as high power electrochemical energy source for applications in electronic devices and electric vehicles. They usually function on the basis of the formation of an electrolytic double layer (EDL) at the interface of electrodes composed of high specific surface area materials [1]. Carbon materials are very suitable for the preparation of supercap electrodes since they are not very expensive, have a large surface area (approx. 1000 $m^2 g^{-1}$) and show strong adsorptive properties.

Highly reversible redox active substances attached to the electrode surface as a very thin film can even enlarge the charge storage capabilities, especially when the capacity of the redox active compound (= pseudo-capacitance) is available in addition to the double layer capacitance [2,3]. For the preparation of supercaps with EDL capacitance and pseudo-capacitance we used the procedures mentioned in Ref. [4], reporting that the attachment of *o*-amino-naphthol on the surfaces of carbon fibres enhances considerably the pseudo-capacitance of the electrode. We transferred this technique to electrodes containing high surface area carbon black [5]. After preparation of the electrodes, the *o*-amino-naphthol can be immobilized on the surface by electrochemical reduction of the corresponding *o*-nitro-naphthol. The reversible oxidation of amino and hydroxy groups by release and acceptance of protons is the actual redox reaction used for charge storage (Figure 1). The irreversible reduction of the *o*-nitro-naphthol can be observed very well by cyclic voltammetry (Figure 2). The enormous increase of capacitance after treatment of the carbon electrode with the nitro-compound is indeed due to a large redox capacity as indicated by the peak-shaped cyclic voltammogram (Figure 3). However, the capacitance due to the formation of the EDL could apparently be maintained after attachment of the naphthol. The fast oxidation/reduction reaction can be repeated for a large number of cycles with high efficiency suggesting very good adherence of the redox system on the carbon surface. Apart from excellent electrochemical performance, the used redox system benefits from the fact that it is a proton donor, and thus it can be combined with the quite large number of redox systems for supercaps, that are proton acceptors.

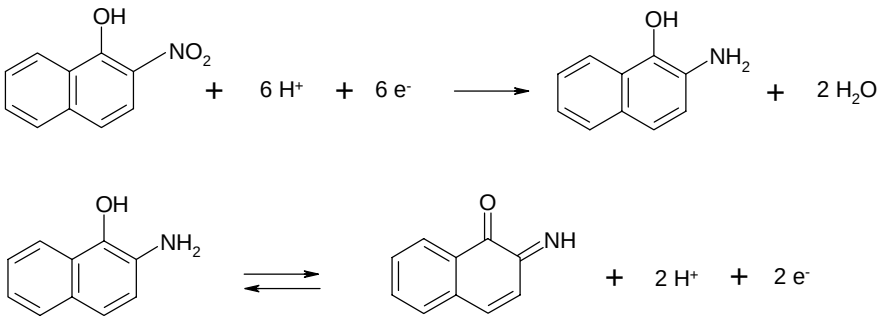

Figure 1: (Top) Formation of o-amino-naphthol by irreversible electrochemical reduction of o-nitro-naphthol (=immobilization). (Below) Subsequent reversible cycling of o-amino-naphthol as pseudocapacitive material in supercapacitors (the actual reversible redox reaction mechanism can be more complex)

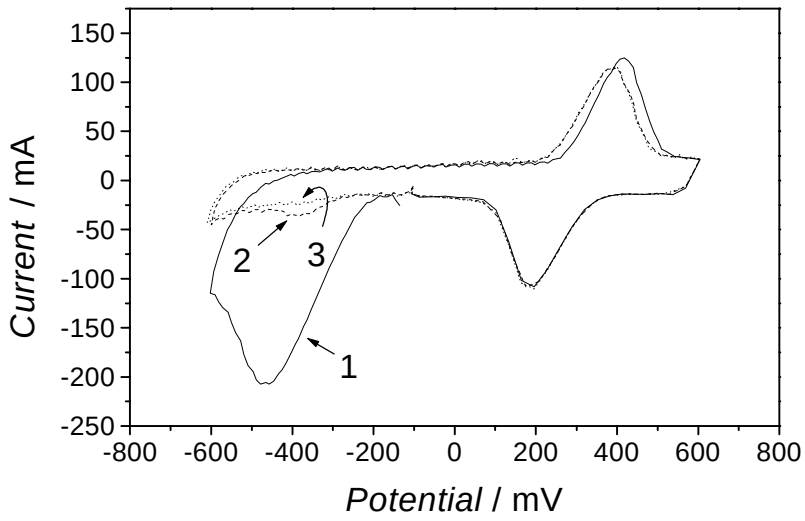

Figure 2: Cyclic voltammograms (ν = 20 mV s^{-1}) at/on a carbon black electrode (Printex XE2, Degussa), 10 % poly(vinylidenefluoride)) in 0.5 M H_2SO_4, showing the irreversible reduction of o-nitro-naphthol at approx. -400 mV vs. SCE and the reversible cycling of o-amino-naphthol immobilized on carbon at approx. +300 to + 500 mV vs. SCE. Numbers indicate the cycle number.

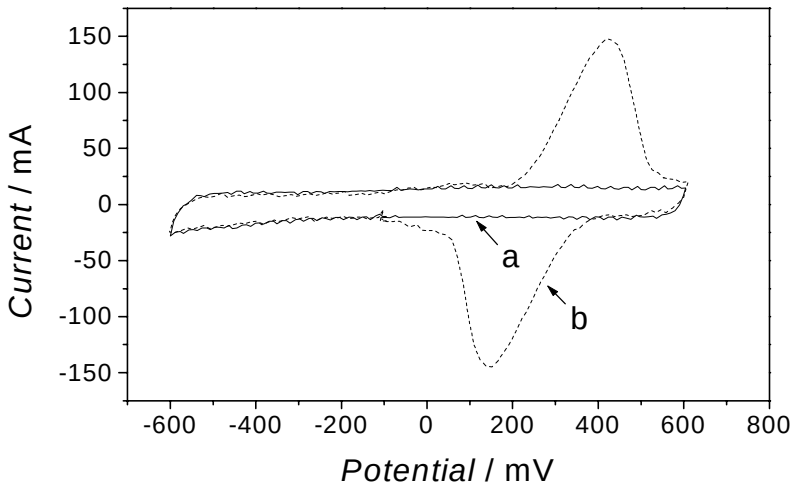

Figure 3: Cyclic voltammograms (same measurement conditions and materials as in Figure 2) of a carbon electrode without (a) and with (b) o-amino-naphthol immobilized on the surface.

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Reference:

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