CHEMICAL MODIFICATION OF ACTIVATED CARBON WITH QUINONE-TYPE MOLECULES FOR APPLICATIONS AS ELECTROCHEMICAL CAPACITOR ELECTRODE MATERIAL

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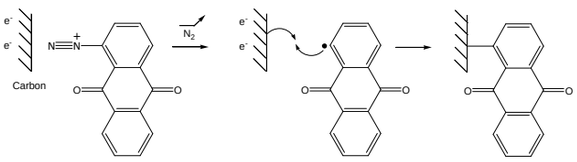
Due to the growing needs for electrical energy storage devices, electrochemical capacitors are widely studied worldwide because they can store more energy than capacitors and deliver higher power density than a battery. In these devices, the energy storage is based on the formation of a double layer at the interface between the electrodes and the electrolyte due to electrostatic interactions. Due to its high specific surface, good chemical and thermal stability as well as low resistivity, activated carbon is currently the electrode material of choice. Carbon electrodes present a double layer capacitance of 16-50 µF/cm² [1] and thus, to improve the charge storage it is necessary to increase the specific surface area[2]. Nevertheless, it has been shown that there is no linear relationship between the specific surface and the capacitance[3,4]. On the other hand, immobilization of electroactive molecule which could exchange more than one electron is another promising approach to increase the electrode capacitance. Redox reactions, which occur at the carbon surface with immobilized quinone-type molecules will add a Faradaic contribution and then increase the total capacitance[5].

We successfully modify carbon powder with quinone-groups by the diazonium chemistry. The diazonium salt is *in-situ* generated from the corresponding amine and spontaneously reduced to a radical, which can eventually form a covalent bond with the carbon surface. The reaction steps are summarized in Scheme 1 for the grafting of anthraquinone groups.



Scheme 1 : Grafting of anthraquinone groups

In this work, several quinone molecules were studied and the stability of grafted and adsorbed molecules was compared. Thermogravimetric analysis (TGA) measurements revealed that both adsorbed and grafted groups are stable up to at least 300°C. For the adsorbed-carbon powders, a significant mass loss is observed at 400°C and attributed to the departure of the quinone species. In the case of grafted carbon the mass loss appears at higher temperature, which suggests that the molecules are strongly attached to the carbon surface. The amount of grafted molecules estimated by TGA is in good agreement with that obtained by electrochemical characterization.

The attachment of quinone groups on porous carbon allows to double the specific capacitance compared to a simple carbon electrode and grafted electrodes are shown to be more stable than adsorbed ones during charge/discharge cycling.

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