On the development of activated carbons with high affinity for ionic liquids based electrolytes

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During the last decade, electrochemical double layer capacitors (EDLCs) have been extensively studied due to its important application as energy storage devices. Typically, EDLCs contain activated carbon (AC) as electrode active material and a quaternary ammonium salt dissolved in propylene carbonate (PC) or acetonitrile (ACN) as electrolyte. These conventional EDLCs have operative voltages in the range of 2.5 – 2.8 V[1], high power density (10 kWkg^{-1}), extraordinary cycle life, fast charge/discharge rates (< 1 second) as well as operation in an extended temperature range (-40 to 100 °C)[2, 3, 4].

The current research on EDLCs is focused on the development of materials and electrolytes capable of improving the energy and power densities of these devices. The energy (*E*) of EDLCs is described by the equation $E=1/2CV^2$, where C and V are the capacitance and operative voltage of the EDLCs[5], respectively. Considering this expression, it appears evident that the most convenient way to increase the energy of EDLCs is to increase the operative voltage of these devices.

Ionic liquids (ILs) are presently considered one of the most attractive electrolytes for the realization of high energy EDLCs, and several studies showed that the use of ILs make possible the realization of safe EDLCs with operative voltage as high as 3.8V[6,7].

ILs-based electrolytes can be divided into two main categories: solvent-free and solvent-containing electrolytes. In the first one ILs are used as the sole electrolyte[6], while in the second-one ILs are dissolved in organic solvents, e.g. PC or ACN and act as conducting salt[8]. It is important to note that both categories usually display higher viscosity and different dielectric constants compared to conventional organic electrolytes.

However, almost all ACs currently available have been developed for use either in aqueous or organic solvents, and consequently they display characteristics optimized for these electrolytes[9,10]. For that, when these carbonaceous materials are used in ILs-based electrolytes, their capacitance might be significantly reduced.

Considering this point, in view of the development of ILs-based EDLCs the study of the influence of the ACs characteristics, e.g. pores structure and surface area, on the electrode capacitance in ILs-based electrolytes appears therefore of particular importance.

In this work we report a study regarding the development of ACs with high affinity for IL-based electrolytes. The activated carbon PEAC presents a BET surface area of 1104 m^2/g, as shown in Figure 1, and displays higher performance in IL-based electrolytes. PEAC exhibits, in fact, a specific capacitance of 120 F/g, which is considerably higher than that displayed by commercially available AC. Moreover, it also shows good capacitance retention during tests at high current densities.

Taking these characteristics into account, PEAC appears therefore as an interesting AC candidate for the development of high performance, high voltage ILs-based EDLCs.

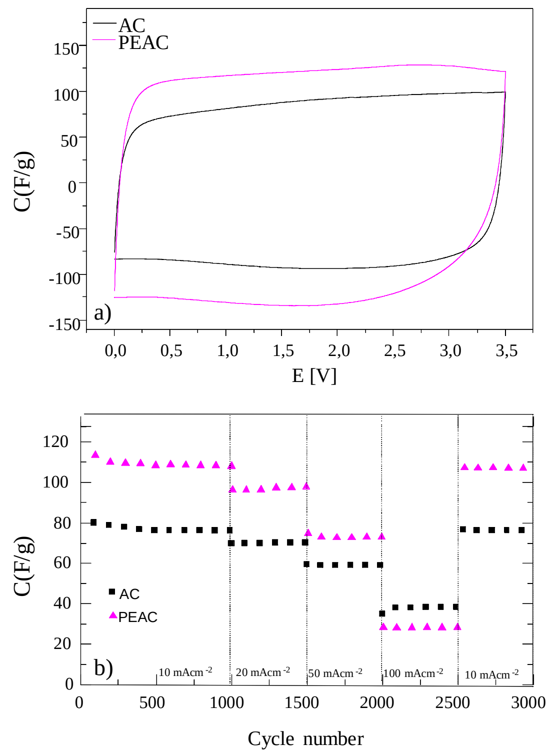

Figure 1. Specific capacitance values of commercial activated carbon (black) and PEAC (pink) in a 1:1 mixture of PYR14-TFSI/PC a) from cyclic voltammetry at a scan rate of 20 mV/s and b) from galvanostatic charge-discharge measurements at 10, 20, 50 and 100 mA/cm^2.

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