Energy Storage in Hybrid Organic-Inorganic Nanocomposite Materials.

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Combining electroactive organic polymers and electroactive inorganic species to form single nanocomposite materials is an appealing way to merge the best properties of each of the components into a hybrid electrode material. But in addition to this eclectic view, the hybrid approach also allows the design of materials with synergic activity or with properties, performance or applications unattainable outside the hybrid framework.[1] In our laboratory we have pursued in recent years the design of electroactive hybrid materials with conducting polymers and all sorts of electroactive inorganic species as well as their application to the field of energy storage and conversion and will present here an overview of this topic including recent results.

The range of materials studied is relatively wide, spanning from systems in which conducting polymers such as polyaniline (PAni) or polypyrrole (PPy) are inserted into extended layered inorganic solids (V_2O_5 [2,3] or $VOPO_4{\cdot}2H_2O$ [4]), to systems in which the same polymers constitute the matrix in which molecular inorganic species with well know electroactivity are integrated and put to work for energy storage applications. A good example of the latter is the integration of hexacyanoferrate in PPy [5,6]or Pani[7,8] leading to hybrid materials in which the redox couple $[Fe(CN)_6]^{3-}$ / $[Fe(CN)_6]^{4-}$ is part of the active material in hybrid positive electrodes for plastic lithium batteries.

In between extended and molecular inorganic species, clusters compounds such as polyoxometalates constitute an intermediate state of aggregation [9,10] that provides further opportunities to isolate electroactive as well as multifunctional materials.[11,12] Hybrids based on these polyoxometalates provide a case study of the importance to target specific applications for specific materials. Thus the cluster nature of polyoxometalates which makes of them ultimately dispersed oxide particles represents an opportunity to apply these materials in electrochemical supercapacitors.

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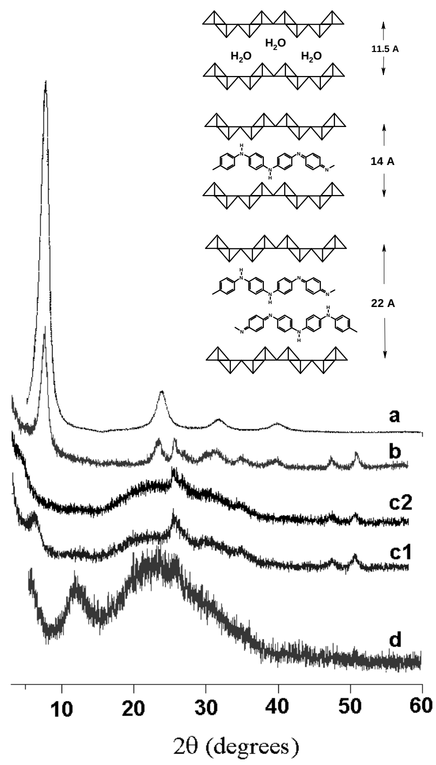

Figure 1.- . X-ray diffraction patterns for V_2O_5 and related hybrid materials.

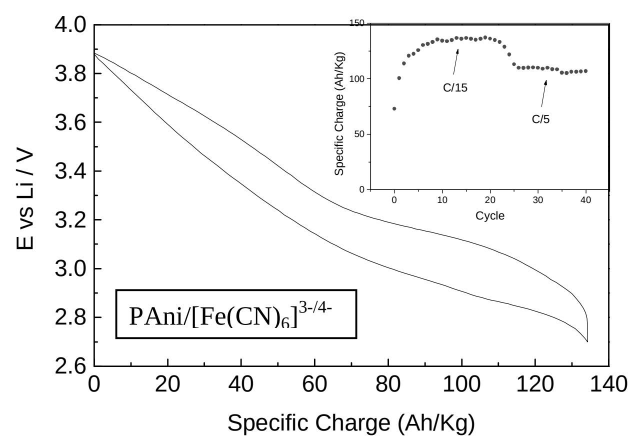

Figure 2.- Charge-discharge cycle (10th) (at C/15) of a lithium cell with PAni/HCF as active cathode material, Li metal anode and 1M LiPF6 in EC:DMC 1:1 electrolyte

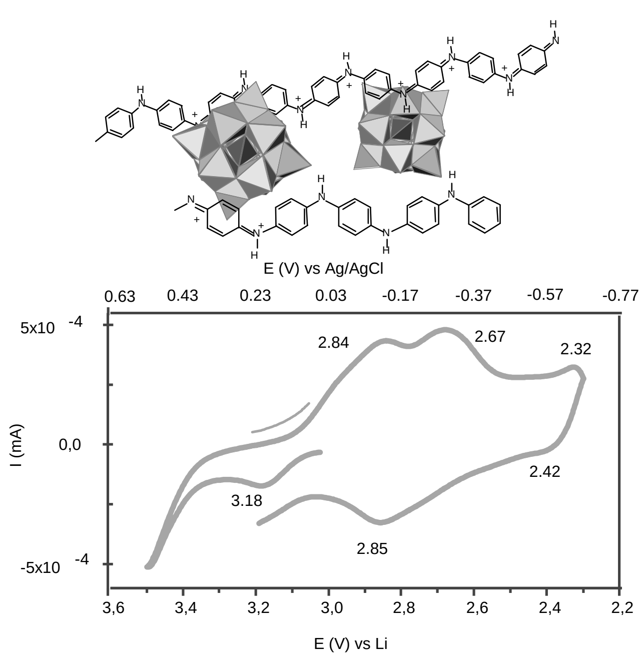

Figure 3.- .- Schematic representation and cyclic voltammogram of the hybrid PAni/$[PMo_{12}O_{40}]^{3-}$.