Rechargeable Batteries: From Hybrid Materials to Hybrid Electrodes and Devices

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The realization that cheap oil is extinct has suddenly moved long overdue projects such as the development of viable electric vehicles from the drawers of scientists and engineers onto the desktops of CEOs and Ministers. And everybody agree that in this race batteries are the limiting step. But, despite the two centuries since Volta's inventive discovery, battery technologies are still lagging behind the harsh performances demanded by industry. A combination of high specific energy for extending driving ranges and higher specific power for acceleration is very hard to get for electro-ionic devices like batteries. That is why there is still room for new and novel types of materials in this trade.

Hybrid materials offer opportunities for synergic behavior and improved properties with respect to their individual components.[1] Among many possible combinations, those formed by electroactive and conducting elements are of particular interest for energy storage applications.[2] As a matter of fact, hybrid nanocomposite electrodes integrating electroactive oxides (or phosphates) and conducting carbons have long been prepared and studied for rechargeable lithium batteries.[3]

In our group we have developed a whole line of work dealing with the prospective research of hybrid combinations of electroactive and conductive materials for energy storage applications. Among electroactive components we have used a wide variety of inorganic species, from oxides (or phosphate) [4] to polioxometalate (POM) clusters,[5] but also conducting organic polymers (COPs) or carbon materials (See Figure), the later two also providing suitable conducting properties.

As a matter of fact we have prepared hybrids along the three sides of the triangle shown, [4-7] as will be discussed in this presentation.

But in addition to hybrid materials and hybrid electrodes another line of action deals with the possible design and implementation of hybrid devices between batteries and supercapacitors. This is an even more challenging line of work which could begin with but eventually go beyond the combination of capacitive – faradaic electrodes in an attempt to develop the intensely sought-for combination of high power and energy densities.

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