Nanomaterials for Energy Storage

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The trends in energy consumption and production are changing toward a more sustainable model. Within this new framework, the development of improved energy storage systems is essential for the consolidation of different renewable energy sources as well as to give response to the increasing number of portable electronic devices, starting from consumer electronics and reaching the hybrid electric vehicle (HEV).

In this change of energy paradigm, the role of energy storage systems is crucial. Batteries and supercapacitors are the most efficient electrochemical energy storage technology currently available. The design and development of advanced materials, which can be used to fabricate highly efficient electrochemical systems, appears to be the fundamental requirement in fulfilling the energy needs of the society. Nanoscaling of electrodes for batteries has yielded great benefits in terms of the delivered capacity and rate capability. By reducing particle size to nano, the improved cathode/anode structure and the reduced Li+ (or Na+) diffusion path lengths can facilitate fast Li+ (or Na+) insertion/extraction reactions. Nanostrutured electrodes can also provide larger area to host cations as well as the spaces to accommodate expansion during cation hosting. Nevertheless, low volumetric efficiency and accelerated undesirable surface reactions also need to be considered when working with nanomaterials.

In the case of supercapacitors, most of the research efforts in the field of materials are directed toward the energy density improvement, and in order to get to this goal nanostructuring is of paramount importance. Capacitance is proportional to the number of active sites, and thus, high specific surface area (SSA) nanoporous materials are required as electrode materials. In this scenario, graphene and graphene-like carbons have become recently popular, however, activated carbons (ACs) still remain the materials of choice for commercial supercapacitor devices for cost reasons. In fact, the highly unfavourable mass production of nanomaterials is in general a major drawback for their industrialization both in supercapacitor and in battery fields.

In this talk we will present different nanomaterials as electrodes in Li and Na-ion batteries together with those for supercapacitors. The effect of these nanomaterials on the electrochemistry properties will be also discussed.