Hybrid Organic/Inorganic Nanostructures for Energy Conversion and Storage Devices on Flexible Substrates

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Research on existing and emerging energy conversion and storage technologies is pivotal to solve the economic and environmental challenges facing the energy sector. The general approach to meet both of these challenges is by exploring novel materials and device designs, such as those recently developed in organic and hybrid photovoltaic solar cells. In addition, progress in storing the produced energy is equally important. Interestingly, the co-integration of photovoltaic technologies and Li-ion batteries (LiBs) is expected to mark a turning point for nomade devices. However, to further improve the efficiency and stability of these devices, a better understanding of the device physics and how structural changes affects charge generation and transport at the nanometer scale is mandatory.

In this context, we used a range of state-of-the-art scanning probe microscopy techniques to characterize the morphological, electrical and mechanical properties of solid hybrid systems which could be considered for the realization of transparent and flexible photovoltaic cells and lithium ion batteries.

Here, we report on our approach to develop new grid-like hybrid three-dimensional architectures and devices based on semiconductor nanostructures or metal oxides and conjugated polymer materials. We demonstrate the use of a photoconductive Atomic Force Microscopy and Kelvin Probe Force Microscopy to locally study the electrical properties of prototype hybrid and organic solar cells. Results of the use of new grid-like electrodes coated with electrically interconnected metal nano-shells to improve the performance of Li-ion batteries will be also presented.