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Technological hybrid materials: From investigation of their micro- & nanostructure to engineering of their chemical & physical properties

Abstract

The development of any new material for applications in different fields, e.g., for use in transportation systems, biomedicine, energy harvesting, sensing and electronics, has typically a long history behind. This starts from the conceptual development of an idea and very often ends in a combination of several materials that leads to the design and synthesis of innovative structures. One highly appealing approach are novel hybrid materials that carry the features derived from their single components.

The practical realization of a new class of materials inevitably passes through a long series of structural and compositional studies, in order to design and define the chemical/physical properties, and ultimately drives the scientific community to synthesize and prototype new materials and technologies.

In the seminar, several scientific cases will be presented and discussed where the development of the material and its chemical modification and/or its functionalization with molecular precursors, together with the engineering of their chemical and physical properties, led to the creation of devices and materials for applications in different fields ranging from transportation to nanomedicine to organic electronics.

In particular, technological materials such as metal alloys (e.g., **Al-Si cast alloys**) were chemically modified, whereas metal oxides (e.g., **ZnO, ITO**), nanostructured materials (e.g., **SiC/SiO2 core/shell nanowires**), and 2D materials (e.g., **2D-MoS2**) were functionalized with **molecular precursors**, engineered and extensively characterized. Different techniques such as (soft) X-ray photoemission and absorption using synchrotron radiation, in combination with high-resolution imaging techniques, were adopted to investigate and understand the interface properties of such hybrid materials. The comprehensive understanding allows us to better tailor and engineer the different systems and ultimately helps for the optimization of the materials and devices' performance.