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Beyond nanoparticles: Active interfaces for safe-by-design nanotechnology

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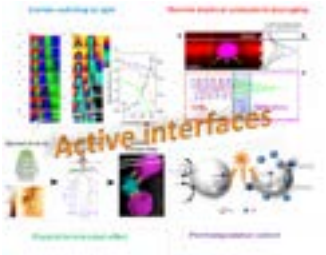
Beyond the advantages of nanoparticles, one of the priorities is to avoid potential adverse effects related to their nanotoxicity. There are different examples of how new and surprising functional properties are produced by the control of interfaces between dissimilar materials at the nanoscale. The existence of interfaces in nanocomposite materials in which the accumulation of electric charge occurs to dissimilar crystal structures allows developing the concept of active interface. Such active interfaces tailor the performance of the nanomaterial. The nanostructured nature allows preserving the advantages of the nanoscale avoiding the disadvantages of the same. From the point of view of toxicity, the nanostructured material behaves like a micromaterial. The nanostructure safe-by-design materials are engineering materials that allows moving to massive or industrial applications overcoming the technological barriers that are insurmountable in many cases. In this presentation relevant examples of how the engineered active interface behaves: 1) Isolated physical antimicrobial effect based on Schottky barriers of ZnO. The wide spectrum antimicrobial effect is demonstrated in single domain of rotated stacked nanoplatelets aligned in the (001) wurzite direction of the semiconductor. 2) Effective decoupling of thermal and electrical properties in thermoelectric composites based Skutterudite materials. The presence of electrical charge at the metal/oxide interface is on the origin of thermoelectric figure of merit enhancement. 3) UV blocking in TiO_2 modified with ZnO by sol-gel. There is a synergism to increase absorption of UV-light and in addition a decrease of free radical formation occurs because of the suppression of electrons and holes pairs due to their recombination at the TiO_2-ZnO interfaces. 4) Reversible domain switching by polarized light of highly charged ferroelectric 90º domain in charge. This light-matter coupling is modulated by an internal strain gradient within each domain, which is observed using in situ Confocal Raman microscopy (CRM).



Biography

José F Fernández is Professor at the Electroceramics Department of the Institute of Ceramics and Glass, CSIC, Madrid, Spain. He is the Leader of the Smart System Group (CSS). He has extensive experience in the ceramic processing of functional ceramics whose properties are based on complex micro and nanostructures. Research activities have been crystallized in the development of several concepts in functional ceramics and nanotechnology such as surface modification of ceramic particles; Grain boundary engineering in semiconductor ceramics; Sintering of lead-free piezoceramics; Confocal Raman Microscopy of Ceramics; Proximity effects at the nanoscale; Dry nanodispersion of metal oxides; Functionalization of traditional ceramics through nanotechnology; and unusual properties in nanostructured ceramics. His interests are focused on the development of advanced ceramics to integrate in smart systems, involving actions of transfer of knowledge towards the industrial sector.

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