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Nanoparticles and nanostructuring of transition metal compounds for advanced applications

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Nanoparticles and nanostructuring of transition metal compounds have opened a way for the development of novel materials for advanced methods in medicine, environmental applications, electronic devices, energy production, etc. These novel materials are typically based on metal oxides, chalcogenides, or even nitrides that are prepared in the form of discrete nanoparticles, compact nanocrystalline samples, or nanocomposites with connectivity of the 0-3 type.

The presentation will summarize our recent efforts devoted to the development of nanomaterials based on transitional metal compounds, whose intrinsic properties (structure and chemical composition) and extrinsic properties (size and surface effects in nanoparticles and nanostructuring of compact samples) are carefully adjusted for a given application. Moreover, advanced applications of magnetic nanoparticles with complex surface functionalization will be demonstrated.

As model examples, three distinct forms of perovskite phases $La_{1-x}Sr_xMnO_3$ within the ferromagnetic metallic region ($0.2 \leq x < 0.5$) will be described, specifically the discrete nanoparticles, dense nanocrystalline phases and 0-3 dim nanocomposites. Then, nanoparticles of Mn-Zn ferrite and substituted magnetites, i.e. ferrimagnetic spinel systems, will be shown as promising magnetic cores, whose suitable surface modifications lead to theranostic particles, sorbents for magnetic solid phase extraction, and sensitive analytical probes. Core-shell systems with thermoresponsive coatings and ferrite cores that enable magnetically triggered release of drugs and gold-coated magnetic particles for SERS will be introduced. Furthermore, ε-Fe_2O_3 phase, its doped counterparts, and α''-$Fe_{16}N_2$ nitride will be demonstrated as exotic materials for medical applications. Finally, tailoring of $BiFeO_3$, a prototypical multiferroic material and a perovskite phase with intriguing magnetism, by means of nanostructuring will be considered.

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