Strategies for the Molecular-Level Design of Fine Particles for Contemporary Electroceramic Technologies

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Synthesis of fine particles presents the first step in fabrication of advanced materials, be it for the sake of their direct application in form of powders or for a further processing. Different procedures of synthesis lead to different characteristics of the obtained powders and of the final solid material or component as well. Therefore, enormous efforts are being invested in the development of new approaches to synthesis and processing, capable of enabling the production of materials with complex sets of multifunctional properties.

Various methods for preparation of fine particles - with the aim of promoting the production of powders and compact materials with highly controlled properties - have been developed in our laboratory during the previous years. Among them are ultrasonic spray pyrolysis, mechanochemical, sonochemical and hydrothermal syntheses, self-propagating high-temperature synthesis, centrifugal atomization, sol-gel and precipitation from the solution as well as various polymerization processes and methods for the production of inorganic-organic nanocomposites. Numerical models derived from the study of general process parameters and their optimization are also included in this study. The preparation methods were developed for oxide, non-oxide, metallic, polymeric and nanocomposite fine particles, many of which exhibited ideal spherical shapes and narrow size distribution, ranging from nano to micro scales. A wide diversity of functional materials, including electronic, energy-related, sensory, optical, catalytic and different biomedical materials has comprised the subject of our investigations. Their aim is also to approach the solution for some of the critical problems of sustainable development in the areas of energy, health, environment, water and other global challenges dominating our present and near future.