

Tailoring dc-tunability properties of functionally graded ceramics by core-shell approach

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Abstract: The nanoscale coating of small particles with materials with different compositions, results in the formation of core-shell structures, is a relatively new and active area of research. The coating changes both the interaction of the particles with environment and their properties. New functionalities can be imparted with the cores depending on the properties of the shell. Using several synthetic approaches, dissimilar materials (metals, semiconductors, ceramics, polymer etc.) can be combined for many different applications in the areas of coating, electronics, catalysis, and drug delivery.

Core-shell particles can be used as building blocks for the fabrication of bulk composite materials with 0-3 connectivity using appropriate densification techniques. The coating prevents percolation even for high-volume fractions of the core phase (>50%), a result not attainable with the conventional preparation routes. The functional properties of composite materials can be modified by changing the shell composition. The coating exerts a significant effect of temperature and frequency dependence of dielectric permittivity. Inorganic composites are usually consolidated by sintering, a process that requires high temperatures. So, the final microstructure and properties will be strongly conditioned by the amount of residual porosity, the occurrence of grain growth and coarsening, the extent of the interdiffusion between the core and shell and the possible formation of the intermediate phases by reaction at phase boundary. These interfaces phenomena can be minimized by using rapid sintering methods, such as spark plasma sintering (SPS) and field assisted sintering.

In the last years, we focused our attention on preparing and investigating the functional properties of dense composite ceramics obtained from core-shell nanopowders. We passed from magnetoelectric composites to dielectric-ferroelectric composites to understand the role of core-shell structure on the electrical response of ceramics.

This presentation includes different electroceramics prepared from core-shell structures:

- (i) Magnetoelectric ceramics (Mag@BaTiO₃) where the role of magnetic core and microstructure on the new functional properties were investigated
- (ii) Functionally graded ceramics (BaTiO₃@SrTiO₃) where the role of local composition gradients generated by core-shell structure on the temperature dependence permittivity and tunability were investigated.

Keywords: core-shell structures, dc-tunability, functionally graded ceramics

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