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MULTIFERROIC CERAMIC COMPOSITES: PROCESSING AND MICROSTRUCTURE

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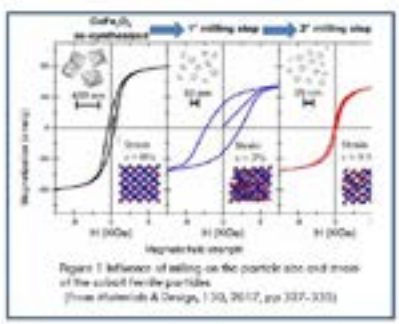
Among multifunctional materials magnetoelectric multiferroics are a special class with coupled ferromagnetic and ferroelectric orders. They are particularly appealing because they not only show the characteristic of the single ferroic orders where the electric field *E*, magnetic field *H*, and stress σ control the electric polarization *P*, magnetization *M*, and strain ε, respectively, but also because interactions between them lead to additional functionalities. Therefore in a magnetoelectric multiferroic, *H* may control *P* or *E* may control *M*. In composite materials the electric and magnetic degrees of freedom are located in different components and are interfacially coupled to each other. Several applications, including magnetic sensors, high-frequency inductors, memory devices, and high-frequency signal processing devices, (very high-density memory storage media) have been proposed and demonstrated. Nanopowders are mainly synthesized by solid state synthesis, coprecipitation, hydrothermal and sol-gel methods and the magnetic properties vary by changing the processing parameters and/or the stoichiometry. The magnetostrictive and piezoelectric materials used as constituents of magnetoelectric (ME) composites are ferromagnetic oxides, including ferrites like cobalt ferrite (CFO), manganites, 3d-transition metals/alloys for the magnetic phase and lead zirconate titanate (PZT), barium titanate (BTO), or lead magnesium niobate-lead titanate (PMN-PT) for the ferroelectric phase. Bulk and thin or thick film structure are produced where the connectivity of the phases plays a critical role; and the 3-0 type particulate structure, 2-2 type laminate structure and the 1-3 type cylinder matrix are the most frequently investigated. The influence of the processing on the microstructure and final properties is shown for PZT-CFO particulate and laminate composites with focus on the role played by the milling and densification treatments that allow producing high- and low-coercivity nanosized cobalt ferrite nanoparticles and fully dense composites.



Recent Publications

1. Srinivasan G, Priya S and Sun N X (ed) (2015) Composite magnetoelectrics: materials, structures, and applications, Cambridge: Woodhead, ISBN: 978-1-78242-254-9.
2. Galizia P, Ciuchi I V, Gardini D, Baldisserri C and Galassi C (2016) Bilayer film based on composite $CoFe_2O_4/TiO_2$ and niobium-doped PZT by electrophoretic Deposition Journal of the European Ceramic Society 36(2):373–380.
3. Galizia P, Baldisserri C, Capiani C and Galassi C (2016) Multiple parallel twinning overgrowth in nanostructured dense cobalt ferrite. Materials and Design 109:19–26.
4. Galizia P, Ciomaga C E, Mitoseriu L and Galassi C (2017) PZT-cobalt ferrite particulate composites: densification and lead losses control by quite-fast sintering Journal of the European Ceramic Society 37:161–168.
5. Galizia P, Cernea M, Mihalache V, Diamandescu L, Maizza G and Galassi C (2017) Easy batch-scale production of cobalt ferrite nanopowders by two-

step milling: structural and magnetic characterization. Materials and Design 130:327–335.

Biography

Carmen Galassi is a Research Director at CNR-ISTEC, Italy. She is the Head of the Research Project – Smart multifunctional ceramic materials: piezoelectrics, ferroelectrics, antiferroelectrics, multiferroics with main expertise in ceramic processing (powder treatments, shaping and densification), chemico-physical characterization of dispersed ceramic systems, R&D on piezoelectric ceramic materials, magnetic ceramic materials and relative composites, multifunctional materials. Her main activity is research projects coordination and dissemination on ceramic materials development, processing and characterization and tutoring MSc and PhD students. She has got the National Scientific Qualification to function as Full Professor of Materials Science and Technology in Italian Universities. Out of 259 papers co-authored, 168 are published in international, refereed journals.

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