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Nanostructured high critical current superconducting wire research and development

There is a worldwide huge effort in the R&D of high current superconducting wires for large scale power applications and magnets which encompasses many materials science and engineering challenges. Coated conductors based on epitaxial $YBa_2Cu_3O_7$ (YBCO) films are one of the most promising alternatives to reach the required performance goals, as well as to reduce the cost down to the levels required to make a reality these technological expectances. Within Europe, a large consortium of academic and industrial partners (EUROTAPES) has been collaborating to advance in these demanding challenges. In this presentation, several topics related to the recent progress in the different aspects covered by the project will be presented with emphasis on the solution chemistry approach as a bottom-up strategy to reduce the figure of merit cost / performance of the conductors. On one hand, I will report on the efforts in increasing the robustness of the ABAD coated conductor architecture and, particularly, on the progress on using Ink Jet Printing to produce multilayered structures with high total critical currents. On the other hand, different approaches related to achieving nanostructured superconductors with enhanced flux pinning and high magnetic field performances will be also presented. Particularly, a novel path towards nanostructured coated conductors based on colloidal solution precursors will be reported. The YBCO nanocomposite films include $BaZrO_3$ or $BaHfO_3$ as second phase randomly distributed nanoparticles within an epitaxial matrix. The correlation between atomic scale defects, the nanoscale strain, evaluated from X-ray diffraction line broadening and from HRTEM and STEM, and vortex pinning efficiency at different temperatures and magnetic fields will be analyzed. Our work stresses that CSD is a bottom-up approach with a strong potential to create cost-effectively coated conductors with outstanding performances for a new generation of magnets, motors and generators, fault current limiters and cables.

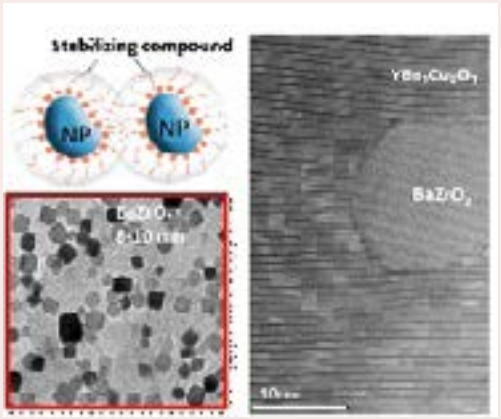

Figure: Colloidal nanoparticles of $BaZrO_3$ prepared by solution chemistry used to grow $YBa_2Cu_3O_7/BaZrO_3$ superconducting nanocomposites.

Recent Publications

- X Obradors, T Puig (2014) Coated conductors for power applications: materials challenges. Supercond. Science Technology 27(12):1-17.
- A Llordés, A Palau, J. Gázquez, M Coll, R Vlad et. al. (2012) Nanoscale strain-induced pair suppression as a vortex pinning mechanism in high-temperature superconductors. Nature Materials. 11:329-336.
- P Cayado, K De Keukeleere, A Garzon, L Perez Mirabet, A. Meledin et. al. (2015) Epitaxial $YBa_2Cu_3O_7$-x nanocomposite thin films from colloidal solutions. Supercond. Science Technology. 28(12).
- J Gazquez, R Guzman, R Mishra, E Bartolomé, J Salafranca et. al. (2016) Emerging diluted ferromagnetism in high-TC superconductors driven by point defect clusters. Advanced Science 3(6):1500295
- P Cayado, C F Sánchez-Valdés, A Stangl, M Coll et. al. (2017) Untangling surface oxygen exchange effects in $YBa_2Cu_3O_6$+x thin films by electrical conductivity relaxation. Phys. Chem. Chem. Phys. 19(21):14129-14140

Biography

Xavier Obradors is a Research Professor and Director of the Institute of Materials Science of Barcelona (CSIC). His scientific interests include materials preparation with controlled micro/nano structures and the comprehension of the physical mechanisms underlying the superconducting, magnetic and electronic properties of nanostructured materials, particularly complex oxides. He has published more than 490 articles (> 9600 citations, h=47), he has filed more than 12 patents and he was one of the creators of the spin-off company OXOLUTIA. He has received several awards: Fellow of Institute of Physics; Doctor Honoris Causa University of Pitesti; ENDESA Novare and National Materials Science Awards; Member of Academy of Sciences and Arts of Barcelona; Narcisi Monturiol Medal of Catalonia; French Academic Palms; City of Barcelona Prize. He served as the Editorial Board of Superconductor Science and Technology and he is Editor of Physica C. He was President of European Society of Applied Superconductivity.

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