can induce dislocation of Hf atoms from their native location in HfO_2 throughout the lattice.

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NUCLEAR BASED TECHNIQUES IN MULTIFUNCTIONAL MATERIALS CHARACTERIZATION

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The Nuclear Science and its technologies have provided fundamental tools for the understanding of new chemical and physical properties that help the development of the new age of multifunctional materials such as the Perovskites for photovoltaics and fuel cells, the luminescent oxides for lighting and biomarkers and the thin films in semiconductors. One of the most important parameters that defines key properties of the Perovskites to be applied as the cathode in fuel cells is their crystal structure and its point defects (e.g. oxygen vacancies), which can be determined by neutron diffraction (Fig. 1a).

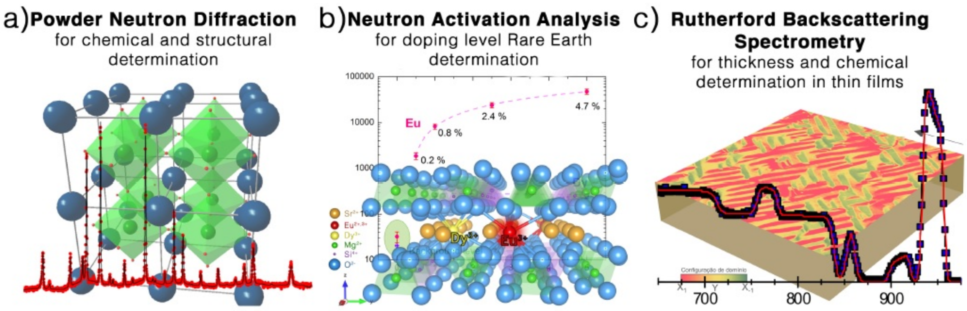

Figure 1: Nuclear based techniques applied on the characterization of multifunctional materials such as Perovskites for Fuel Cells (a), Rare earth doped luminescent oxides for lighting and biomarkers (b) and ferroelectric thin films for logic devices (c)

Photonic materials like luminescent nanoparticles, once doped with Rare Earth ions, they can emit light when excited with UV/IR, being used in probing bioassays. In this case, the precise determination of Rare Earth concentration by Instrumental Neutron Activation Analysis (INAA) leads to ensure the desired spectroscopy properties to prepare efficient probing nanoparticles (Fig.1b). Furthermore, nuclear based techniques such as Rutherford Backscattering Spectrometry (RBS) help us in determining the thickness and the elemental composition of thin films (Fig. 1c), which is not usually easy through other conventional techniques. In other words, the nuclear based techniques applied on materials characterization play a key role in providing a solid understanding on the physical and chemical properties of the condensed matter. In summary, this work presents three cases where the use of the Nuclear Techniques improves the characterization of different materials. All the data shown here were collect and published somehow, as indicated below.

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PRODUCTION AND STUDY OF NANOPARTICLES MAGNETIC PROPERTIES BY HYPERFINE INTERACTIONS

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In the past years nanotechnology was highlighted as a quick growing field, with many applications in science and technology including information storage, drug delivery and medical images, in which gadolinium-based nanoparticles (NPs) have been studied as contrast agent for magnetic resonance image. On the other hand erbium oxide NPs present potential for many applications due to their optical, electrical and photoluminescence properties, and can be used in display monitors, carbon nanotubes for "green" chemistry and in bioimaging, and iron-based NPs have been studied for application in hyperthermia due to its superparamagnetic properties. At the Hyperfine Interactions Laboratory (LIH) NPs are synthesized by thermal decomposition and co-precipitation. Structural characterization is made using X-ray diffraction (XRD) and transmission electron microscopy (TEM) and magnetic properties are studied by magnetization, both at partner laboratories, and perturbed angular correlation (PAC) spectroscopy using ^{111}In(^{111}Cd) as probe nuclei at LIH. PAC spectroscopy is based on the angular correlation between nuclear radiations emitted by radioactive probe nuclei, which is a well-established method in nuclear spectroscopy. Perturbation occurs in this correlation by electromagnetic interactions external to the nucleus when it is inserted in a material, which can provide information on the electronic distribution of the neighborhood. In this work, an important material was investigated by PAC spectroscopy using ^{111}In, which decays to ^{111}Cd by electron capture, as probe nuclei. Results have shown that NPs produced by thermal decomposition present narrow size distribution, with average size of 5 nm. On the other hand, results related to NPs produced by co-precipitation have shown that NPs don't have a homogeneity in size and shape distribution.
