Contribution ID: **156**　　　　Type: **E-Poster**

Study on Pulsed Electron Deposition as a new method for thin films growth of room temperature multiferroic BaFe2O4

According to the formal definition, materials can be described as multiferroics if they exhibit the coexistence of two or more primary ferroic orderings, such as ferroelectricity and ferri/ferro/antiferro-magnetism. Most of the increasing interest around this class of materials arises from the possibility of mutual control of both electric and magnetic domains, as this feature could allow to achieve significant advances in various innovative fields (from improving the capacity of data storage and reducing energy consumption in logic-memory devices to exploiting different ferroic orders in heterostructures in order to obtain spin valves) [1]. However, to date very few single-phase materials are known being characterised by stable electric and magnetic states at room temperature [2]. $\gamma - BaFe_2O_4$, a non-centrosymmetric stuffed tridymite-type compound (space group $Cmc2_1$), is an interesting example of a previously unrecognized single-phase multiferroic material with high ordering temperatures ($T_{FE} > 1038K$ and $T_N = 890K$). By comparing single-crystal X-ray and neutron diffraction data with magnetic and ferroelectric macroscopic measurements, we found out that this barium ferrite is an antiferromagnetic improper ferroelectric (G-type spin ordering and P_Cca2_1 magnetic space group; coercive electric field E_c = 12 kV cm^{-1} and remnant polarization $P_r = 0.18\ \mu C\ cm^{-2}$). Since all the mentioned results are related to the bulk form of barium ferrite, the next critical step is to transfer all the structural features into a thin film form, in order to have suitable conditions for devices fabrication. Therefore, a thin film growth method was performed by using Pulsed Electron Deposition (PED), a technique based on the formation of a plasma plume from the interaction between a high energy pulsed electron beam and a target material with proper composition. The $\gamma - BaFe_2O_4$ films were grown on various substrates in the temperature range 700-850° C. Powder X-ray diffraction (XRD) patterns, combined with Raman spectroscopy and energy dispersive X-ray analysis, allowed to identify the formation of the target phase over all the tested substrates, without significant amounts of impurities. Moreover, partial control of crystalline orientation was achieved through the proper choice of the substrate, growth temperature and deposition parameters, as confirmed by texture coefficients determined from XRD data and pole figures measurements. The relevance of this step is related to the strong anisotropy of the polar $mm2$ point group, so that the device applicability strongly depends on the orientation of crystals with respect to the substrate surface. In conclusion, despite more in-depth studies are needed to fully unveil the rich features of $\gamma - BaFe_2O_4$, the present results suggest that the PED technique is optimal for producing good quality barium ferrite films compatible with key materials in the electronic device industry.

Primary author: CASAPPA, Michele

Co-authors: Dr ORLANDI, Fabio (ISIS Facility, Didcot, United Kingdom); Dr DELMONTE, Davide (IMEM-CNR, Parma, Italy); Dr CALESTANI, Gianluca (Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma, Parma, Italy); Dr CAVALLI, Enrico (Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma, Parma, Italy); Dr GILIOLI , Edmondo (IMEM-CNR, Parma, Italy); Dr SHVARTSMAN, Vladimir (Institute for Materials Science and Center for Nanointegration, University of Duisburg-Essen, Essen, Germany); Dr GRAZIOSI, Patrizio (CNR-ISMN, Bologna, Italy); Dr RAMPINO, Stefano (IMEM-CNR, Parma, Italy); Dr SPAGGIARI, Giulia (Department of Mathematical, Physical and Computer Sciences, University of Parma, Parma, Italy); Dr SOLZI, Massimo (Department of Mathematical, Physical and Computer Sciences, University of Parma, Parma, Italy); Dr MEZZADRI, Francesco (Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma, Parma, Italy)

Presenter: CASAPPA, Michele

Session Classification: E-Poster Session

Track Classification: Interplay between Crystal Growth and Advanced Characterizations for Materials Development