Contribution ID: **999** Type: **Poster (Student, In Competition) / Affiche (Étudiant(e), inscrit à la compétition)**

New room-temperature multiferroic thin films of Ba2LnFeNb4O15 (Ln = Eu and Sm) deposited by pulsed laser deposition

Tuesday, 14 June 2016 19:50 (2 minutes)

The study of Ba2LnFeNb4O15 (TTB-Ln) bulk ceramics revealed that they have a tetragonal tungsten bronze crystal structure, are ferroelectric and that a magnetic phase of barium hexaferrite BaFe12O19 (BaFO) spontaneously forms within the TTB-Ln phase during the ceramic processing, resulting in a novel multiferroic composite material at room temperature.
Our goal is to investigate new room-temperature multiferroic thin films grown by pulsed laser deposition (PLD), namely thin films of the spontaneously forming composite BaFO/TTB-Ln (Ln = Eu and Sm). c-oriented thin films of TTB-Ln have been successfully grown on Nb doped SrTiO3(100) substrates by PLD. In specific and optimized growth conditions, the structural study of the BaFO/TTB-Ln thin films shows an epitaxial growth perpendicularly to the substrate plan and parallel to the c-axis of tetragonal crystal structure. Further structural analysis reveals two kinds of azimuthal orientation of the c-axis oriented grains of TTB-Ln onto the cubic substrate, with the a and b axes of TTB-Ln aligned at ⊠18° with respect to the a-axis of the cubic substrate. Ferroelectric macroscopic hysteresis loops demonstrate the existence of a spontaneous polarization at room temperature. An enhancement of the ferroelectricity due to the epitaxial growth has been evidenced. To further study the ferroelectricity in TTB-Ln thin films, local electromechanical properties were studied using piezoelectric force microscopy. These experiments allowed determining the piezoelectric coefficient and confirming that the ferroelectric nature of the studied thin films is conserved down to the nanoscale. Finally, the magnetic properties of BaFO/TTB-Ln thin films were studied which reveals that the PLD grown BaFO/TTB-Ln composite films exhibit a ferromagnetic behavior at room temperature, confirming their multiferroic nature at room temperature.

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Session Classification: DCMMP Poster Session with beer / Session d'affiches, avec bière DPMCM

Track Classification: Condensed Matter and Materials Physics / Physique de la matière condensée et matériaux (DCMMP-DPMCM)