Master 2 stage @ GREMAN – Université de Tours

" Tunable Magneto-Electric Nanostructured Materials"

A/ Brief description

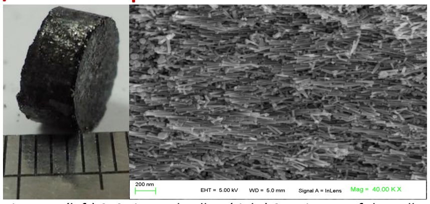

Figure 1: (left) SPS-sintered pellet; (right) SEM image of the pellet surface showing the organized nanowires

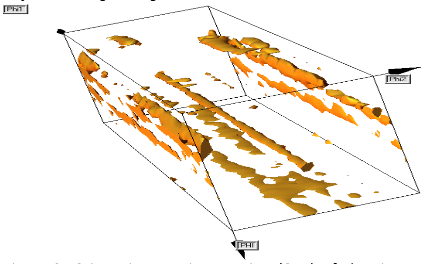

Figure 2: Orientation Density Function (ODF) of the sintered pellet obtained by using the pole figures by XRD.

The integration of magnetic nano-objects within functional matrices (e.g. ferroelectric, transparent, etc.) is at the origin of the development of composite materials artificially coupling two different functionalities. The coupling of the two phases makes it possible to choose the targeted functionalities as well as the coupling mechanism allowing the control of one functionality by the other. Optimizing the properties of these new materials in view of their integration into all kinds of devices requires the control of the size and shape of nano-objects, of their resistance to degradation of the physico-chemical properties and the optimization of the magnetic characteristics. Besides, the use of a technique assembling the nano-objects inside the matrix by controlling their organization within the composite material is mandatory. We propose to study the physic properties of massive nanostructured materials based on magnetostrictifs nano-inclusions (Co-based nanoparticles and nanowires) organized in a ferroelectric and lead-free inorganic matrix (KNN type). The study of the static magnetic properties of the sintered compounds will be carried out in parallel with the studies of the interfaces between the two phases in order to establish the link between the microstructure, the magneto-elastic behaviors of the nano-objects coupled with the piezoelectric properties of the matrix.

It is in this context that we propose to pay a particular attention to the various parameters that govern the magnetic properties and the macroscopic coupling of these composite materials: the organization of the grains, the quality of the interfaces, the size of the crystallites constituting these grains as well as their macroscopic physical properties (i.e. static magnetic behavior).

B/ Goals

The goal of this work is to understand the link between the static magnetic properties and the piezoelectric ones of the composites with their microstructure as function of various external parameters (temperature, magnetic and electric field). Few steps will be part of the job:

1. The study of the magnetic moment, the coercive field and the critical magnetic temperatures (T_C, T_B, ...) will be crucial to optimize the development of new strongly anisotropic macroscopic magnetic materials with adjustable magnetic energy as function of the nanostructuring conditions (i.e. different microstructure).
2. Piezoelectric characterizations (polarization cycles as well as PFM local images) will be also an important tools in order to understand the maximum ferromagnetic metal loadings in order not to increase the leakage current and destroy the quality of the coupling between the magnetic and piezoelectric properties.
3. A deep analysis of in-depth microstructure characterizations (TEM) as well as structural and surface properties (X-ray diffraction, SEM and AFM) obtained in the frame of collaboration, will need to be done in directly comparison with the magnetic and piezoelectric properties.

C/ Experimental Tools

The student will be principally working on GREMAN platform (Tours University – Parc Grandmont) and will be focusing on the development and measurements of magnetic and magneto-electric properties by using a PPMS 6000 (Quantum Design). He/She will also have the opportunity to use different techniques available inside the consortium that we have been establishing in order to develop these new magneto-electric composites.

D/ Demanded Skills

A solid knowledge in solid-state physics as well as a strong interest into the experimental technique used. A common sense for laboratory rules and an enterprise spirit for experiments as well as a cheer personality will be greatly appreciated.

E/ Terms of Contract

The fellowship will be remunerated in accordance with the French current law (3,90 euros/hour). The maximum length of the fellowship will be of 800hours, thus authorizing a fellowship total maximum remuneration of 3120 euros.

F/ Consortium and Main Contact

This fellowship takes place within the framework of collaboration between the IMN Laboratory (Ph. Moreau (Pr)), the LSPM (F. Schoenstein (Pr)) and the GREMAN (F. Giovannelli (MCF), I. Laffez (Pr), J. Bustillo (MCF) and S. Mercone (Pr)).

For application please send your detailed CV, a Copy of marks obtained during Master studies (M1 and first semester of M2) and a cover letter explaining the motivation for the Master work to:

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