

Title: Localization and spin waves excitation in MBE grown Co/Ag multilayers

Short description of the Project: The objective of the proposed work is the characterization of the spin waves excitations taking place in epitaxial Co/Ag multilayers exhibiting different Co concentrations, superlattice parameters and morphologies. These samples have been already deposited by using MBE, and thoroughly characterized from the morphological (XRR, TEM), structural (XRD) and chemical (XPS) standpoints. The results obtained from these measurements allow us to conclude on the presence in the samples of

- i) a narrow distribution of Co nanoparticles (average size 1.5 nm and confined to the nominal positions of the Co layers) for nominal Co concentrations lower than 0.12 (blocking temperatures lower than 20 K) [1, 2];
- ii) magnetic percolation (acquisition of extrinsic and hysteretic magnetic properties of the type corresponding to continuous Co nano-films) for Co concentrations in the range between 0.12 and 0.32 (for lower concentrations in this range the nanoparticles interact magnetostatically) and [3]
- iii) hysteretic behavior with parameters of the order of those measured in continuous nano-films (with different degrees of interaction between the layers of Co) [3]

In summary, our Co/Ag multilayers provide a wide range of morphologies that is fully adequate to study the excitation of spin waves in nano-systems having different characteristic sizes and interactions. We plan to address that study by measuring (VSM) the behavior of the films in high fields (up to 9 T) and low temperatures (down to 2 K). The analysis of the relationship between localization and excitation of spin waves will be carried out by discussing the fits of the thermal dependence of the saturation magnetization to Bloch-type ($T^{3/2}$ and $T^{3/2} + T^{5/2}$) laws with Stoner corrections for strong and weak ferromagnets.

[1] E. Navarro, M. Alonso, A. Ruiz, C. Magen, U. Urdiruz, F. Cebollada, Ll. Balcells, B. Martínez, F. J. Palomares, and J. M. González; “Low temperature superspin glass behavior in a Co/Ag multilayer”; AIP Advances 9, (2019) 125327; <https://doi.org/10.1063/1.5130158>;

[2] Enrique Navarro, María Alonso, Ana Ruiz, Cesar Magen, Unai Urdiruz, Federico Cebollada, Lluís Balcells, Benjamín Martínez, Jesús M. González, and F. Javier Palomares; “Critical magnetic behavior in [Ag8/Co0.5]x64, [Ag8/Co1]x32 and [Ag16/Co1]x32 epitaxial multilayers”; AIP Advances 11, (2021); 025220 <https://doi.org/10.1063/9.0000086>;

[3] E. Navarro; Ph.D. Thesis “Vidrio de superespines de nanocristales de Co en multicapas Co/Ag crecidas por MBE”; UAM, November 2018.

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The tutors bring together extensive experience in the preparation, chemical and structural characterization, and characterization and design for applications of extrinsic magnetic properties of nano-films. They have collaborated for more than twenty-five years on these issues and jointly developed national and European projects.

For a relationship of the Group most recent publications see (under Growth and Properties of Heterostructures in the Nanoscale Group):

<https://www.icmm.csic.es/publications/list-of-papers-2021.php> and
<https://www.icmm.csic.es/publications/list-of-papers-2020.php>.