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# Experimental and computational study of heteroepitaxial thin Fe/Pt spintronic bilayers

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Fe/Pt thin bilayers constitute a spintronic system for the prominence of the next generation of data processing, transfer, and storage devices 1–3. These magnetic heterostructures exhibit the ability to inject spin current through the interfaces via the spin pumping (SP) effect 4. However, only a few efforts investigate the magnetic properties of the systems through the interfacial morphology, purity, and surface symmetry, even if the spin pumping, the spin mixing conductance, and the magnetic proximity effects are pure interfacial mechanisms.

In the specific study, Fe (12 nm)/Pt (6 nm) thin bilayers were epitaxially grown by the electron beam evaporation method in ultra-high vacuum conditions, using different substrate temperatures of 30oC, 150oC, 300oC, and 450oC. The epitaxial model was studied by Molecular Dynamics with Monte Carlo simulations. The simulations were experimentally confirmed by X-ray photoelectron spectroscopy, resolving the interfacial and the chemical state of the interfaces. We confirmed that, during the deposition and because of the kinetics, the atoms of the different layers are diffused through the interface. The Pt heteroepitaxy on Fe, sputters the Fe atoms of the deposited surface, resulting in its local deformation. The diffused Fe atoms inside the Pt lattice, after an annealing process, tend to return to the interface, resulting in increased interfacial roughness. The short-range interdiffusion/interfacial roughness of ≈ 2 nm which was confirmed both from the simulations and the XPS depth profiling, creates free energy stairs at the interface, that affect the magnetization reversal 5. The magnetic anisotropy and static magnetic properties of the different samples were compared by magneto-optical Kerr effect microscopy in the longitudinal alignment (L-MOKE) and magnetic hysteresis loops were recorded in the longitudinal geometry for all the crystallographic in-plane axis of the samples. Combining the overall findings, we reported the Fe/Pt epitaxial model that could serve as a useful "tool"for a deeper comprehension of the origin of the magnetic properties in nanoscale and the potential interfacial induced phenomena in magnetism.

**References**

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