

Ballistic transport of spin waves in ultrathin disordered $[\text{Fe}_{1-c}\text{Ni}_c]_n$ alloy nanojunctions between Co leads using an EFT-PFMT formalismElie A Moujaes¹, Michel Abou Ghantous² and Vinod Ashokan³¹Federal University of Rondônia, Brazil²American University of Technology, Lebanon³Panjab University, India

Transition metal (TM) multilayers, such as those involving Fe and Ni, hold great expectations underpinning the next generation of magneto-electronic devices. Previously, we used a combination of effective field theory (EFT) and mean field theory (MFT) to calculate single site spin correlations in multiple layered disordered $\text{Fe}_{1-c}\text{Ni}_c$ nanojunctions with Co leads, c being the concentration of Ni in the Fe-Ni alloy. In this work, calculations are presented for the spin wave scattering and ballistic transport for ferromagnetic iron-nickel nanojunctions between Co leads with Ni concentrations $c = 0.5$ and 0.81 . The $[\text{Fe}_{1-c}\text{Ni}_c]_n$ alloys themselves are randomly disordered forming n hcp lattice planes between hcp planes of Co leads. To study the spin dynamics for $1 \leq n \leq 7$, the sublattice magnetizations were previously evaluated on each layer with the help of a virtual crystal approximation (VCA) particularly valid at the length scale of the nanojunctions at submicroscopic spin wave (SW) wavelengths. Localized and propagating magnon modes in the nanojunction are examined within the phase field matching technique (PFMT). These magnonic modes propagate in the symmetry plane of the nanojunction with spin precession amplitudes decaying or matching the SW states of the semi-infinite Co leads. Eigenvectors corresponding to such amplitudes and illustrating some of the cases encountered are given. This same approach is used, together with the Landauer-Büttiker formalism to determine the reflectance and transmittance for the SW incident from the Co leads onto the multilayered nanojunctions. Our results show Fabry-Perot type resonance assisted maxima for the SW transmission spectra of all layered nanojunctions and for both values of the Ni concentration, due to the interactions between the incident modes coming from the Co leads and the nanojunction magnon modes. As the Ni concentration is changed and the thickness of the nanojunction increases, by adding more layers, the positions of such maxima are modified.

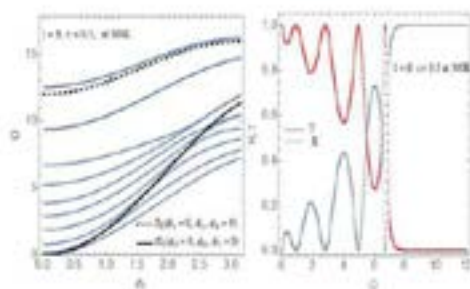


Fig.1: The magnon dispersion (on the left) as well as the transmittance (T) and reflectance (R) of the coherent spin waves (on the right) across a six layered nanojunction with Co leads. The continuous and dashed black curves are the dispersion modes of the pure Co leads.

Biography

Elie A Moujaes has done BA in Physics from the Lebanese University in 1999, MSc in Theoretical Physics from the American University of Beirut in 2003 and PhD in Theoretical Condensed Matter Physics from Nottingham University (2007). At the end of 2009, he has moved to Brazil where he worked on several projects in graphene, including calculations of electronic structure of grain boundaries and molecular dynamics of carbon nanotubes with polymers in the groups of Marcos A Pimenta and Ricardo W Nunes from the Federal University of Minas Gerais (UFMG), in Belo Horizonte, Brazil. He is currently an Adjoint Professor at the Department of Physics/UNIR- Brazil. My general research areas involve electron-phonon interactions, electronic structure calculations of two-dimensional materials, and phase transitions in magnetism.

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