ФИЗИКА КОНДЕНСИРОВАННЫХ СРЕД

THEORETICAL STUDY OF THE LOCALIZED SPIN STATES AT THE SURFACE OF A FERROMAGNETIC DIATOMIC ALLOYS

R. Challali, M. Boucherrab, B. Bourahla

From the spin dynamics matrix describing the precession of ferromagnetically coupled spins, in a semi-infinite fcc diatomic alloy, we easily access to the localized magnons spectra of the surface of the material. The modeling is carried out by a calculation based on a Heisenberg Hamiltonian with the nearest neighbor interactions and in the presence of the anisotropy term. The localized magnon spectra are calculated and analyzed for different probabilities of the values of the integral exchange and the anisotropy field at the surface of the perfect diatomic alloy waveguide. The simulated cases investigate the magnon modes response to variations in surface parameters (exchange integrals, anisotropy intensity, as well as to the direction of propagation of the exciting spin wave). The numerical results yield an understanding the interference effects between the continuum and the localized spin states on the atomic layers which constitute the surface domain.

Keywords: spinwave excitations, fcc lattices, magnonic spectra.

Introduction. Most electronic components are based on electrical conductors such as metals and semiconductors [1, 2]. Their operation mode makes them less attractive today; it is because of the heating, the dissipation of heat in the material caused by the movement of electrons. Magnonic waveguides, on the other hand, are very good competitors to these technologies [3, 4], they carry the spinwave for the processing and storage of information without causing the movement of electrical charges, therefore do not generate much heat

Faculty of Sciences, M. Mammeri University, BP17RP, 15000, Tizi-Ouzou, Algeria; e-mail: boualem.bourahla@ummto.dz.

and can provide spin information even in dielectrics. Spinwaves propagate over significant distances and offer the scalability necessary to process the ever-increasing amount of data in our information and communication society [5, 6]. The technological challenge for the development of magnonic devices is more fundamental. It corresponds to a better description and understanding of the spin dynamics in subatomic structures [7]. At this scale, effects related to the local variation of geometry can have a significant impact on spin excitations [8]. The properties of nanoscale objects depend not only on their atomic nature, but also on their structure, shape, and physical environment. Their magnetic behavior is complex and requires a numerical simulation approach [9], and above all it must be methodical, for a good interpretation of experimental observations, carried out on samples with uniform and non-uniform magnetization.

At the same time, theorists are working to understand and predict magnetic behaviors related to the role of surface or interface anisotropy, the relaxation of atomic layers in thin films and roughness at the interface between ferromagnetic and antiferromagnetic layers. In the case of periodic systems, the problem does not arise; Bloch's theorem applies without difficulty and spin precession fields are continuous. But, in the low-dimensional systems, the problem of symmetry breaking, linked to the presence of a surface or interface, is significant [10]. To circumvent it, one solution is to simulate the basic parameters (exchange interaction, magnetic anisotropy and spin value) at the atomic level. This approach was adopted to characterize spin dynamics in the surfaces of diatomic ferromagnetic alloys. The study of spin dynamics in these magnetic objects requires the integration of several scales in the problem. The most promising avenue seems to lie in multi-scale methods...

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