Institute of Spintronics and Quantum Information
Faculty of Physics
Adam Mickiewicz University, Poznań

Symposium on Spintronics and Quantum Information 2024

Book of Abstracts

The Będlewo Palace
Research and Conference Centre of the Polish Academy of Sciences
January 11-13, 2024

MULTIMODAL WAVEGUIDE FOR SPIN WAVES BASED ON A MAGNONIC BRAGG MIRRORS

G. Centała[1] and J. W. Kłos[1]

[1] *ISQI, Faculty of Physics, Adam Mickiewicz University Poznań, Uniwersytetu Poznańskiego 2, 61-614 Poznań, Poland*

Information can be transmitted through either charge transport or wave phenomena. Wave-based technologies offer an alternative to power-consuming but easy-to-build electrical devices. Magnonics is a wave technology that utilizes spin-wave propagation and is considered promising due to its capability to reduce Joule heating and enable the reconfigurability of magnonic devices [1]. A core element, essential to the construction of magnonic devices and circuits, is the waveguide.

In this study, we focused on developing a multimodal waveguide that enables the propagation of spin wave modes. Bragg mirrors, operating in frequency gaps, are widely used in optical waveguides [2]. Here, we propose the magnonic equivalent of this type of waveguide. We utilized a CoFeB layer as a conductor for spin waves. The surface anisotropy was applied periodically on the top and bottom faces of the layer, creating a pair of Bragg mirrors that confine the spin waves in a channel (waveguide) between them. The width of the frequency gaps relies strictly on the strength of the surface anisotropy and the film thickness. However, using too thin layer to create such a device is not possible, since the value of the group velocity decreases as the layer becomes thinner. The interplay of these parameters allows for the design of a waveguide that supports strongly confined modes that propagate with high group velocity. The proposed design is simple (requiring only the periodization of non-magnetic materials) and resolves the issue of unwanted edge modes induced by demagnetizing effects.

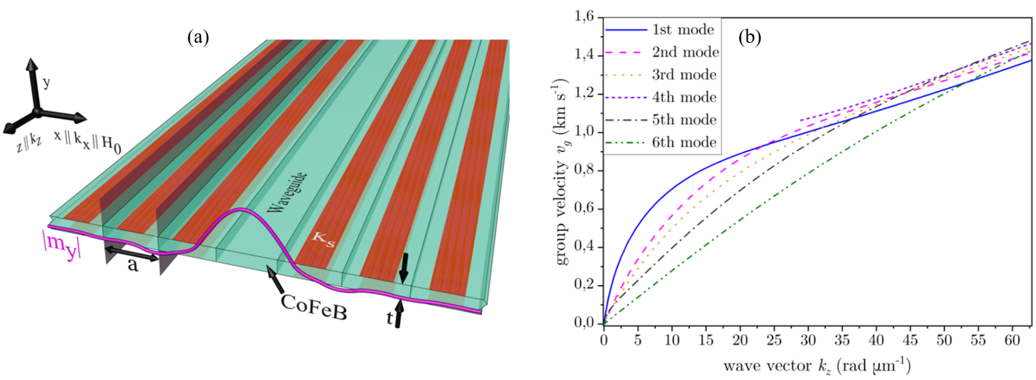

Fig. 1: (a) On the top and bottom face of the CoFeB layer (of the thickness t = 6 nm), we applied the surface anisotropy (K_S=1.05 mJ/m^2) in the periodically repeated (a = 100 nm) areas (red stripes of width 50 nm). These periodic patterns form the pair of Bragg mirrors which confine the spin wave modes (magenta profile) in the waveguide. (b) The group velocity (v_g) of the spin wave modes propagating along the waveguide, is shown as a function of the wave vector (k_z). The 4th mode is plotted for k_z>28 mm^{-1}, since for smaller values of k_z, the mode is not confined by Bragg mirrors.

Acknowledgements: *Authors would like to acknowledge the support from the National Science Center – Poland grants No. 2020/39/O/ST5/02110, 2021/43/I/ST3/00550 and the Polish National Agency for Academic Exchange grant BPN/PRE/2022/1/00014/U/00001.*

References:

[1] A. V. Chumak et al., IEEE Transactions on Magnetics 58, 6 (2022).

[2] Y. Meng .et al.. Light Sci. Appl. 10, 235 (2021).