Shaping spin wave spectra of 1D magnonic crystals via geometrical parameters

J. Rychły,[1] J. Walowski,[2] T. Tuband,[2] C. Denker,[2] M. Münzenberg,[2] and J. W. Kłos[3]

[1] *Institute of Molecular Physics, Polish Academy of Sciences, Mariana Smoluchowskiego 17, 60-179 Poznan, Poland*
[2] *Institute of Physics, Universität Greifswald, Germany*
[3] *Faculty of Physics, Adam Mickiewicz University in Poznan, ul. Uniwersytetu Poznańskiego 2, Poznań 61-614, Poland*

The spin wave spectra in one-dimensional magnonic crystals (1D MCs) is complex and depend on many factors. We performed a combined experimental and theoretical study of the influence of geometrical parameters of constituent stripes and separation width between them on the spin wave spectrum of 1D MC. These geometrical factors affect directly (by geometrical constrains – spin waves are confined inside the stripes) or indirectly (by spin wave pinning – spin waves can be freed to different extend on the edges of stripes) on the spin wave frequency [1]. We have performed the TR-MOKE measurements of the frequencies of long-wave modes, corresponding to the ferromagnetic resonance (FMR) modes, for 1D MCs in the form of the arrays of stripes of different widths (500 nm, 860 nm, and 1000 nm) and separations ranging from 100 nm up to 1000 nm [2]. We have compared these results with frequency-domain finite element method calculations. For each given stripe's width, we can distinguish two limits of the FMR frequencies – the upper limit for a single stripe (which is a good approximation for arrays of stripes separated by very wide spacers – in order of thousand nanometers) and the bottom limit for the stripes attached to each other (for spacers' widths tending to zero), building thin magnetic layer. The dipolar SW pinning is enhanced when the separations between constituent stripes are increasing. These changes lead to the lifting of the FMR frequency and are more significant when the separations are still small. The increase of FMR frequency is accompanied by the reduction of spin wave group velocity. We showed that changes in geometrical parameters of 1D MCs significantly influence, via dipolar interactions, spin wave pinning which, in turn, is a key factor for the FMR frequency changes of 1D MCs observed in the TR-MOKE experiment.

References:

[1] G. Centała, M. L. Sokolovskyy, C. S. Davies, M. Mruczkiewicz, S. Mamica, J. Rychły, J. W. Kłos, V. V. Kruglyak, and M. Krawczyk, Physical Review B, Vol. 100. 2019, pp. 224428

[2] J. Rychły, J. Walowski, C. Denker, T. Tuband, M. Münzenberg, and J. W. Kłos, in preparation

J.R. acknowledges the financial support of the National Science Centre – Poland: ETIUDA project No. 2017/24/T/ST3/00173, Sonata Bis project No. 2018/30/E/ST3/00267, J.R., and J.W.K. – OPUS project No. 2016/21/B/ST3/00452.