Spin-wave transport controlled by the magnetic state of CoFeB nanodisk arrays on a YIG film

J. Hyun,[a] K. Szulc,[b,c] N. A. Kuznetsov,[a] L. Flajšman,[a] M. Krawczyk,[c] P. Gruszecki,[c] A. Gopakumar,[d] C. Dubs,[d] and S. van Dijken[a]

a: Department of Applied Physics, Aalto University, Espoo, Finland;

b: Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland;

c: Faculty of Physics and Astronomy, Adam Mickiewicz University, Poznań, Poland;

d: INNOVENT e.V. Technologieentwicklung, Jena, Germany.

Reconfigurable magnonic devices are essential for the advancement of spin-wave-based computing [1]. In this work, we demonstrate control of spin-wave transport through the micromagnetic state of CoFeB nanodisk arrays integrated on a YIG film. Our system consists of a YIG film (thickness 63 nm or 70 nm), a 4 nm Ta spacer, and a CoFeB nanodisk array (thickness 30 – 50 nm, diameter 120 – 240 nm, period 390 – 630 nm). By employing broadband spin-wave spectroscopy, super-Nyquist sampling magneto-optical Kerr effect (SNS-MOKE) microscopy, and micromagnetic simulations, we investigate the evolution of spin-wave propagation in YIG as the magnetization of the CoFeB nanodisks transitions between vortex and single-domain states. Distinct spin-wave transmission gaps are observed in both magnetization states, arising not from conventional Bragg scattering, but from the hybridization of propagating spin-wave modes with modes quantized perpendicular to the spin-wave propagation direction. Variations in spin-wave transport between the two states are attributed to changes in the effective magnetic field within the YIG film. Furthermore, the frequency, width, and depth of the spin-wave transmission gaps can be tuned by adjusting the nanodisk array's period or disk diameter. This hybrid magnonic structure offers a versatile platform for engineered and reconfigurable spin-wave control, paving the way for the development of magnonic circuits.

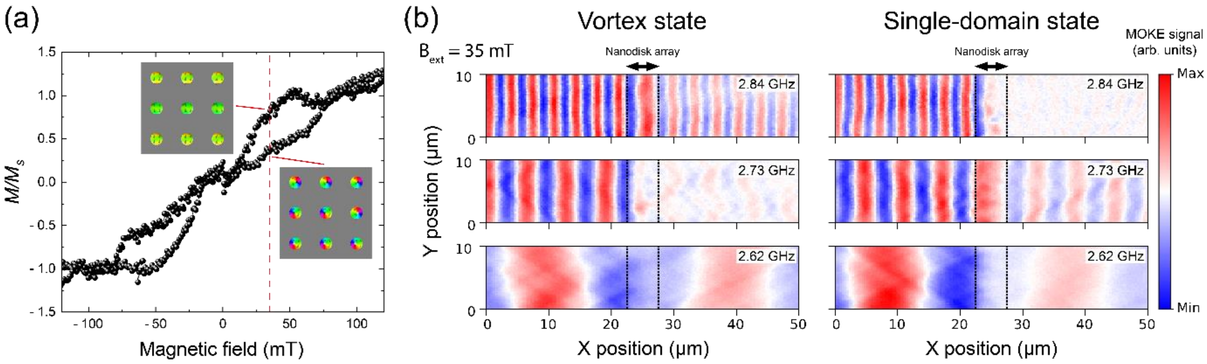

Fig. 1. (a) Magnetic hysteresis loop of CoFeB nanodisks (thickness: 38 nm, diameter: 180 nm, period: 630 nm) on a 63 nm-thick YIG film. The red line marks an external magnetic field of 35 mT, with corresponding micromagnetic simulations of the nanodisk states shown for both field-sweeping directions. (b) SNS-MOKE images of spin-wave transport in the YIG film across the nanodisk array (indicated by dashed lines) for vortex and single-domain states under a 35 mT bias field at excitation frequencies of 2.62, 2.73, and 2.84 GHz.

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[1] A. V. Chumak et al., Advances in Magnetics Roadmap on Spin-Wave Computing, *IEEE Transactions on Magnetics*, vol. 58, pp. 1-72 (2022).