Contribution ID: **102** Type: **Invited Talk**

Dynamical dipolar coupling in pairs of 25 nm thick YIG nano-disks

Friday, 24 February 2017 11:24 (36 minutes)

In the past years, ultra-thin films of Yttrium Iron garnet (Y3Fe5O12, YIG) have become highly desirable in the context of magnonics [1] and its coupling to spintronics [2]. Due to its record low damping (= 3x10ˆ-5 in bulk), YIG is the magnetic material of choice to propagate and manipulate spin-waves. Having YIG films with thickness down to a few tens of nanometers is important to enhance interfacial effects with an adjacent metallic layer, e.g. to reach sizable spin-orbit torques at a YIG/Pt interface [3]. It is also required to pattern those films by standard nanofabrication techniques, e.g. to engineer the spin-wave spectrum of individual nanostructures [4]. Nanometer thick epitaxial YIG films with excellent dynamical quality (down to 2x10ˆ-4) have recently been grown by pulsed laser deposition [5]. Liquid phase epitaxy (LPE), the reference method to grow micrometer thick films with bulk-like dynamical properties, has long be thought to be inappropriate for thinner films, despite some encouraging results obtained on 200 nm thick films [6]. In this study, we will show that LPE can actually be used to grow YIG films with thickness from 17 nm to 200 nm and with damping parameters ranging from less than 4x10ˆ-4 down to 7x10ˆ-5 (extracted from broadband FMR between 1 GHz and 20 GHz). In order to characterize the dynamical dipolar interaction between YIG nanostructures, we have patterned from a 25 nm film pairs of YIG nano-disks with variable diameters and edge-to-edge separation. We use a magnetic resonance force microscope (MRFM) and take advantage of the stray field gradient produced by the magnetic tip to continuously tune and detune the resonance frequencies of adjacent nanodisks [7]. The magneto-dipolar interaction is revealed by the frequency anti-crossing and by the variation of the resonant peaks amplitude. In a pair of touching nano-disks with diameter of 470 nm, the strength of the dynamical dipolar coupling is Omega/gamma = 20 Oe, more than five times the resonance linewidth. This is a promising result to achieve control of the spin-wave dispersion in magnonic crystals based on YIG nanostructures.

References

[1] V. V. Kruglyak, S. O. Demokritov, and D. Grundler, J. Phys. D 43, 264001 (2010); A. A. Serga, A. V. Chumak, and B. Hillebrands, J. Phys. D 43, 264002 (2010).
[2] Y. Kajiwara, et al., Nature 464, 262 (2010); A. V. Chumak, V. I. Vasyuchka, A. A. Serga, and B. Hillebrands, Nature Phys. 11, 453 (2015).
[3] A. Hamadeh, et al., Phys. Rev. Lett. 113, 197203 (2014); M. Collet, et al., Nature Comm. 7, 10377 (2016).
[4] C. Hahn, et al., Appl. Phys. Lett. 104, 152410 (2014).
[5] O. dAllivy Kelly, et al., Appl. Phys. Lett. 103, 082408 (2013).
[6] C. Hahn, et al., Phys. Rev. B 87, 174417 (2013).
[7] B. Pigeau, et al., Phys. Rev. Lett. 109, 247602 (2012)

Primary author: KLEIN, Olivier (SPINTEC, CEA, CNRS, Universite Grenoble Alpes, CEA Grenoble, France)

Co-authors: DE LOUBENS, G. (SPEC, CEA, CNRS, Universite Paris-Saclay, CEA Saclay, France); BEAULIEU, N. (SPEC, CEA, CNRS, Universite Paris-Saclay, CEA Saclay, France and Laboratoire de Magnetisme de Bretagne, CNRS, Universite de Bretagne Occidentale, France); LI, Y. (SPEC, CEA, CNRS, Universite Paris-Saclay, CEA Saclay, France); NALETOV, V. V. (SPINTEC, CEA, CNRS, Universite Grenoble Alpes, CEA Grenoble, France and Institute of Physics, Kazan Federal University, Russian Federation); BEN YOUSSEF, J. (Laboratoire de Magnetisme de Bretagne, CNRS, Universite de Bretagne Occidentale, France)

Presenter: KLEIN, Olivier (SPINTEC, CEA, CNRS, Universite Grenoble Alpes, CEA Grenoble, France)