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Effect of the current-induced magnetic field on spin-torque nano-oscillator with point contact geometry

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1. Introduction

Micromagnetic simulations [1] and X-ray imaging [2] have revealed that the current-induced magnetic field (H_{Oe}) has an important role on the current-driven magnetization dynamics in the fully patterned nano-pillars. Using micromagnetic simulation, we study effects of the H_{Oe} on the current-driven magnetization dynamics in a spin valve structure with point-contact geometry.

2. Modeling

We design the spin-valve structure using point-contact geometry (Fig. 1(a)). It consists of Py 5nm as a free layer, Cu 5nm as a spacer, and $Co_{90}Fe_{10}$ 20nm as a pinned layer. The contact diameter is 40nm and the external magnetic field of 0.74T oriented 75° from the film plane is applied [3]. To study the role of H_{Oe}, three different models are compared. First, the H_{Oe} is not considered and the current distribution is assumed to be uniform and confined only in the contact area (Model A). Second, the H_{Oe} is considered corresponding to the current of Model A (Model B). Finally, the H_{Oe} is considered corresponding to the realistic non-uniform current distribution (Model C) (Fig. 1(b)).

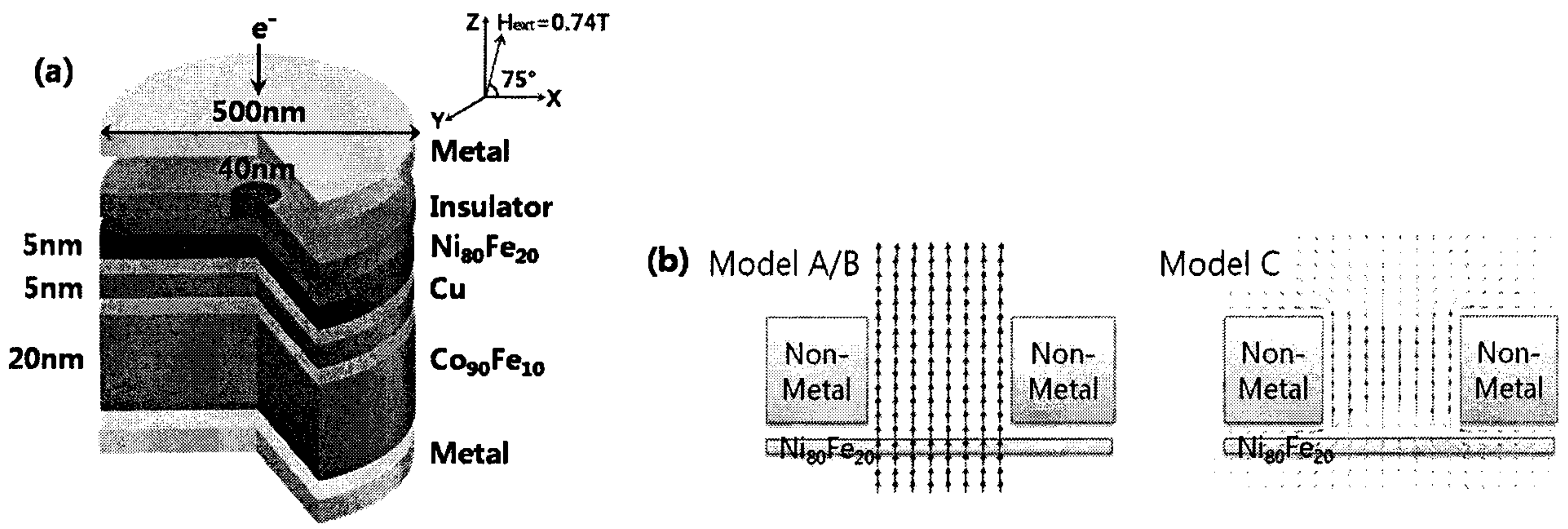

Fig. 1. (a) Structure of point-contact geometry (size and materials) (b) The current distribution in the free layer of model A, B, and C (purple colored bar).

3. Simulation results and discussion

In model A, the current (I) for the onset of magnetization precession is 8.5mA. The frequency increases with current when I<22mA. At I=22mA, the magnetization switching occurs. The frequency and power decrease with increasing current when I≥22mA. In model B, the frequencies are higher than those of model A. When I>18mA, incoherent mode is caused by the H_{Oe}. In model C, all critical currents are larger than the other cases, because the current is diverged at the free layer. The frequency becomes similar to that of model A. But, model C shows different magnetization dynamics from model A (Fig 1(C)). Moreover, anisotropic spin-wave emission is observed in model B and C. In the presentation, more details of spin-wave propagation will be discussed.

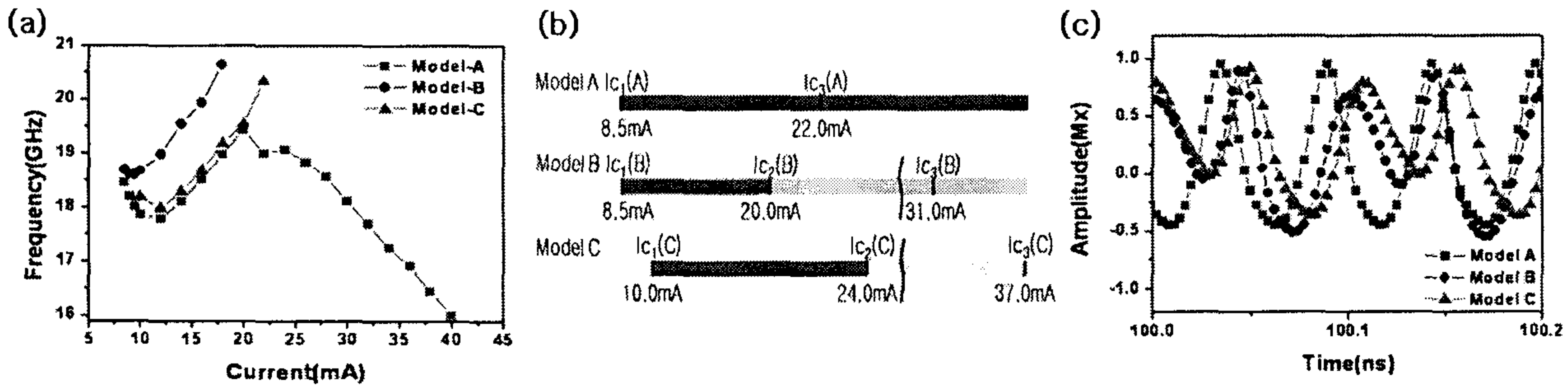

Fig. 2. Model comparison: (a) frequency as a function of current, (b) critical currents for onset (Ic_1), phase transition from coherent to incoherent dynamics (Ic_2), and magnetization switching (Ic_3), (c) Time-evolution of magnetization (I=16mA).

4. References

[1] K. J. Lee et al., Nature Materials **3**, 877 (2004) K. J. Lee and B. Dieny, Appl. Phys. Lett. **88**, 132506 (2006).

[2] Y. Acreman et al., Phys. Rev. Lett. **96**, 217202 (2006).

[3] S. Kaka et al. Nature (London) **437**, 389 (2005).