Microwave assisted switching on CoCrPt based granular media

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Microwave assisted magnetic recording (MAMR) is one of the candidate technologies to realize further recording density [1]. In MAMR, magnetization switching field is reduced by radio-frequency (rf) field with GHz frequency range so that media with higher thermal stability can be used. Magnetization switching behavior under rf field, so-called microwave assisted switching (MAS), has been widely studied experimentally and theoretically [2-5]. Analytical and numerical studies based on the macrospin model have predicted that the switching field linearly decreases with increase of rf field frequency (f_{rf}) up to the critical frequency, at which assistance effect vanishes [2,3]. Experimental results on isolated nanostructures also follows the theoretical prediction, indicating that the MAS behavior can be well described by the macrospin model in isolated structures [4]. From practical point of view, it is important to study MAS behavior of CoCrPt granular media, in which there exist intergranular exchange/magnetostatic interaction and distribution of crystalline/magnetic properties. Experimentally reported MAS behavior of CoCrPt granular media shows different tendency from that of the macrospin model, for instance smaller assistance effect and broader frequency dependence [5]. Numerical studies on granular media have suggested that rf field with sufficiently large amplitude is required to realize large switching field reduction. Recently we have reported that MAS effect in granular media shows strong field amplitude dependence, and the coercivity reduction ratio can reach to 50 % by applying linearly polarized rf field with amplitude close to 1 kOe [6].

In this study, we present experimental results of MAS behavior on CoCrPt granular media quantitatively evaluated by detecting anomalous Hall effect (AHE). Figure 1 shows schematic structure of the prepared sample. CoCrPt granular film of 15 nm in thickness was patterned into a rectangular shape of 1.0 × 3 μm^3, with four terminal electrodes for AHE measurement. A gold line of 1.0 μm in width for rf field application was fabricated underneath the structure separated by a SiO_2 layer of 100 nm in thickness. In-plane linearly polarized magnetic field was generated by applying rf pulsed current with frequency f_{rf} = 2 – 25 GHz to the gold line. The maximum field amplitude was evaluated to be 950 Oe at the sample position. The rf field was applied as pulses with fixed duration of 20 ns to minimize heating effect due to Joule heating. All AHE curves were measured by detecting AHE as a function of dc field along film normal. Figure 2 shows normalized AHE curves measured as a function of dc field H_{dc}. Coercivity decreases with increase of rf field frequency, without significant change of the slope of AHE curves. The coercivity reaches minimum value of 2.4 kOe at f_{rf} = 18 GHz, which is almost half of the coercivity for without rf field (4.7 kOe).

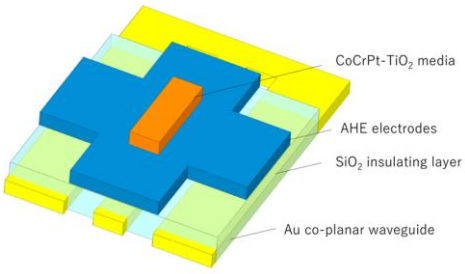

Fig. 1 Schematic illustration of fabricated sample

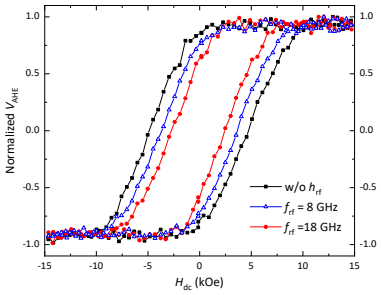

Fig. 2 AHE curves of CoCrPt media measured with rf field (f_{rf} = 8, 18 GHz) and without rf field.

Reference
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