Microwave assisted magnetization switching behaviors of the CoCrPt-oxide granular ECC medium

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Microwave assisted magnetization switching (MAS) is one of the promising candidate technologies for future ultra-high density magnetic recording. Recently, our group gives an experimental verification of very large MAS effect on a perpendicular CoCrPt-oxide granular single layer[1]. But the layer structure is relatively simple comparing with that of a widely adopted perpendicular CoCrPt-oxide high-density recording medium which has an exchange-coupled (ECC) multilayered structure. From the view point of practical application, it is essentially important to carry out the MAS measurements on the ECC CoCrPt-oxide granular medium to verify the potential for the microwave assisted magnetic recording. In this work, we systematically investigate the MAS behaviors of the ECC CoCrPt-oxide granular medium and have clearly found a significant reduction in coercivity under the assistance of rf fields. The anomalous Hall resistance of the device does not change during the rf pulse injection, indicating that the Joule heating effect is negligibly small.

The ECC CoCrPt-oxide granular film was grown on Ru underlayer by HGST Company. The magnetic element layers and underlayers were patterned into a rectangular shape of 1×3 μm^2 and a cross shaped anomalous Hall effect (AHE) electrode, respectively, by using electron beam lithography and Ar ion etching. After covering the magnetic element with an insulating SiO_2 layer, an Au stripe line with 2 μm in width was fabricated just above the magnetic element. Flowing an rf current into the Au strip line generates a linearly polarized rf field of ~ 310 Oe. The rf current is chopped into a pulse train with the pulse width of τ_{rf} = 20 ns ~ 100 μs.

Figure 1 shows the AHE curves under the assistance of rf field of τ_{rf} = 2 μs at various rf frequencies f_{rf}. The rf-field-free coercivity of ~ 5 kOe shits to a smaller value with increasing the frequency f_{rf} until the coercivity reaches a minimum value of ~ 4.5 kOe at rf frequency ~ 14 GHz. Figure 2 shows the frequency dependent coercivity $H_{c,rf}$ for τ_{rf} = 20 ns, 2μs, and 100 μs. Contrary to our previous results which exhibit the very large τ_{rf} dependent $H_{c,rf}$ in CoCrPt-oxide granular single layer[1], very small τ_{rf} dependent $H_{c,rf}$ is found in the ECC CoCrPt-oxide granular film, suggesting the small thermal agitation effect in the ECC CoCrPt-oxide granular film. Detailed discussion on the MAS effect in the ECC CoCrPt-oxide granular film needs a further elaborate evaluation of thermal agitation effects with and without the microwave assistance. We greatly acknowledge the sample provision from HGST Japan, Ltd.

Reference

1) S. Okamoto et al., Appl. Phys. Lett., 103, 202405 (2013).

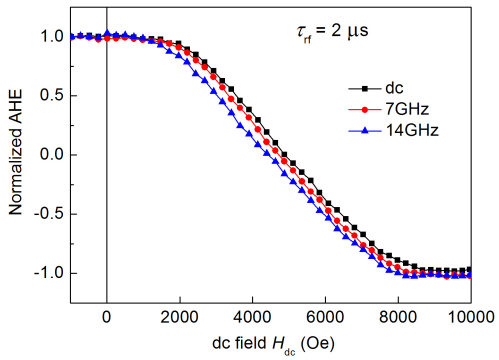

FIG. 1. AHE curves under pulsed rf fields with the pulse duration of 2 μs at various frequencies.

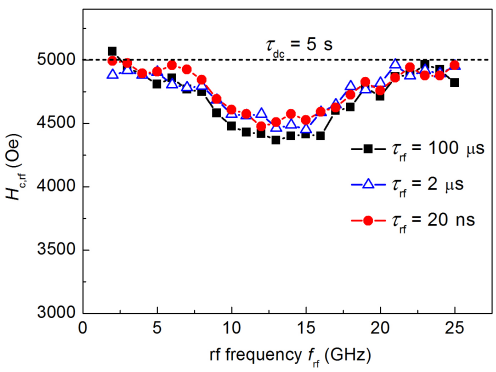

FIG. 2. Frequency f_{rf} dependence of coercivity $H_{c,rf}$ under different pulse duration conditions.