MAGNETIZATION SWITCHING OF A DOT COMPOSED OF DOUBLE AFC LAYERS UNDER THE ASSISTANCE OF RF FIELDS

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I. INTRODUCTION

Microwave-assisted magnetization recording (MAMR) has been expected as one of the next generation ultra-high density magnetic recording technologies [1]. By introducing MAMR technology, rf frequency becomes a writing parameter as well as a magnetic field. This allows us to realize multilevel recording by using a layered recording media with different resonance frequency. By tuning the frequency and magnetic field, the magnetization of each layer can be selectively switched. Very recently, this selective magnetization switching using a dot of two magnetic layers has been successfully demonstrated [2]. In terms of practical use, interlayer and/or interdot dipolar interactions have to be suppressed as small as possible because the dipolar interaction modifies the resonance frequency of each layer depending on the surrounding magnetization state. As a solution for this problem, antiferromagnetically coupled recording media has been expected [3-5]. In this study, we have studied the microwave-assisted switching behavior of a dot composed of double AFC layers.

II. EXPERIMENTALS

The dot of double AFC layers with the diameter of 400 nm is fabricated from a film of MgO sub./Ta(1)/Pt(25)/AFC^1/Pt (10)/AFC^2/Pt(10) by using electron beam lithography and Ar ion etching. The numbers in brackets are the layer thickness in nanometers. The AFC layer is composed of hard and soft Co/Pt multilayers (MLs) coupled with a thin Ru interlayer. By turning the Co layer thickness, the hard Co/Pt ML of AFC^1 exhibits somewhat larger switching field than that of AFC^2. The Pt underlayer is patterned into a cross shaped electrode for anomalous Hall effect (AHE) measurements. An Au stripline is fabricated just above the dot after covering the dot with an insulating layer. A microwave signal from a signal generator is fed into the Au stripline, and then the linearly polarized rf field of 470 Oe is generated.

III. RESULTS AND DISCUSSION

Fig. 1 shows the AHE curve of the dot in the absence of rf field. Starting from the negative saturation, the magnetization directions of soft-Co/Pt MLs in AFC^1 and AFC^2 gradually change in the field range from −4 to −2 kOe, and then antiferromagnetic magnetization states in AFC layers are obtained. With increasing the magnetic field furthermore, clear steps can be observed at around 4 kOe and 5.5 kOe. These steps correspond to the switching fields H_{sw1} and H_{sw2} of the hard-Co/Pt MLs in AFC^1 and AFC^2, respectively. Here, the step heights of these switching are quite different, and the remanence AHE signal is not zero, due to the electrical shunt effect. Under the assistance of rf fields, the values of H_{sw1} and H_{sw2} significantly decrease as shown in Fig. 2. Fig. 2 is the contour plot of the AHE signal as functions of magnetic field and rf frequency f_{rf}. The values of H_{sw1} and H_{sw2} linearly decrease with increasing the rf frequency f_{rf} until the certain critical frequencies over which the microwave-assistance effect disappears. These behaviors are identical to that observed in a single layer dot [1]. The critical frequencies for AFC^1 and AFC^2 are about 14 and 12 GHz, respectively. Except for the frequency range of 12 ~ 14 GHz, H_{sw2} is always smaller than H_{sw1}, indicating that the switching sequence of AFC^1 and AFC^2 does not change. On the other hand, for the

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frequency range of 12 ~ 14 GHz, H_{sw1} and H_{sw2} become the same. The representative AHE curves correspond to the vertical dotted lines in Fig. 2 are also shown. Obviously, the AHE curve for the frequency range of 12 ~ 14 GHz exhibits a single step. Thus, we have not succeeded to change the switching sequence of AFC^1 and AFC^2 using this film structure of double AFC layers. We will further explore to realize the selective switching using a double AFC dot.

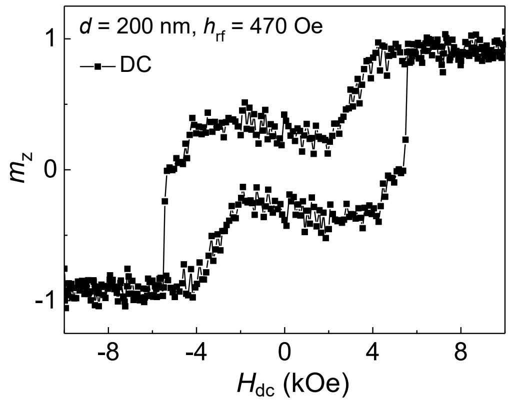

Fig. 1 AHE curve of dot composed of double AFC layers.

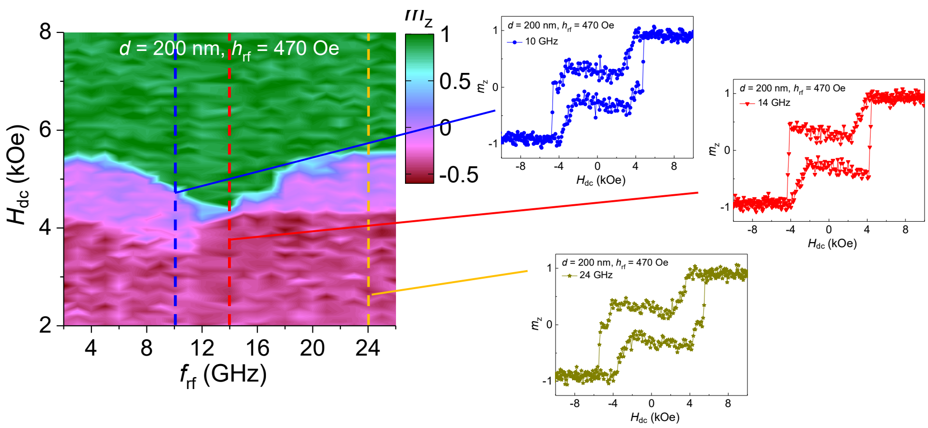

Fig. 2 Contour plot of AHE signal as functions of magnetic field H_{dc} and rf frequency f_{rf}. Representative AHE curves corresponding to the vertical dotted lines are also presented.

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