

## Spacer layer insertion effect on magnetic properties of Cr<sub>2</sub>O<sub>3</sub>/Co exchange coupling system

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Magnetoelectric material Cr<sub>2</sub>O<sub>3</sub> has received much attentions as a promising candidate for voltage-controlled spin devices. We have demonstrated the voltage control of perpendicular exchange bias in Cr<sub>2</sub>O<sub>3</sub>/Co all thin film system [1,2], which make the practical applications more realistic. In these reports, it was essential to reduce the magnitude of exchange bias ( $H_{ex}$ ) by inserting metal spacer layer such as Pt and Cr between Cr<sub>2</sub>O<sub>3</sub> and Co to achieve the voltage-control of perpendicular exchange bias. It is noted that the role of metal spacer layers are not only reduce the magnitude of  $H_{ex}$  by make “space” between Cr<sub>2</sub>O<sub>3</sub> and Co. The spacer layers largely affect to the magnetic properties of Co. In this study, we investigated the spacer layer effect on  $H_{ex}$  and magnetic properties of Co.

We use three metals, Pt, Ru, and Cr, for spacer layer. The sample structure is Al<sub>2</sub>O<sub>3</sub> sub./Pt 25/Cr<sub>2</sub>O<sub>3</sub> 250/spacer/Co 1/Pt 5(nm). Figure 1 shows the typical magnetization curve with different spacer layers. Obviously, the magnetic anisotropy differ according to the spacer materials. In additions, difference in magnetization was clearly observed. The spin polarization of Pt spacer or cap layer partly contribute to the results. We will

discuss the difference based on the X-ray magnetic circular dichroism (XMCD) results of Co.

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[1] T. Ashida et al., Appl. Phys. Lett., 104 (2014) 152409.

[2] T. Ashida et al., Appl. Phys. Lett., 106 (2015) 132407.

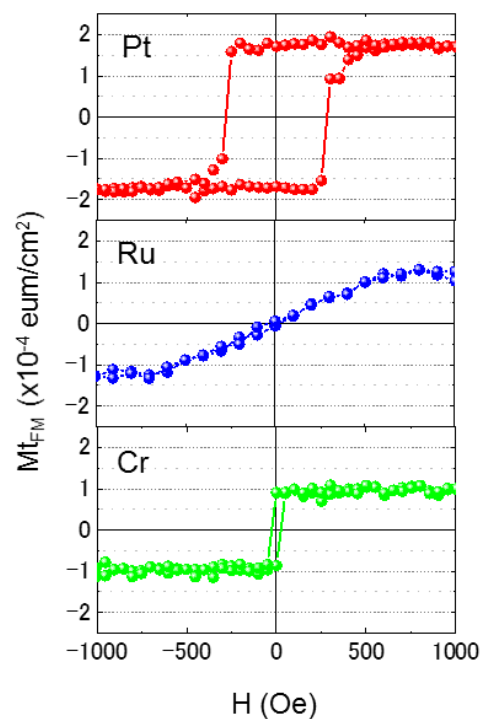


Fig. 1 Typical magnetization curve of Pt, Ru, and Cr spacer samples at room temperature.