# 重金属/秩序化した $Mn_3Ir$ 中の磁気抵抗効果

## Magnetoresistance in bilayers of heavy metal and non-collinear antiferromagnet

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Antiferromagnetic spintronics is an emerging field which utilizes antiferromagnets(AFM) as active components in spintronic applications. However, the difficulty of the electrical detection of the antiferromagnetic moments obstructed its experimental advances. Recent studies have overcome this fact by using anisotropic magnetoresistance (AMR) and the spin Hall magnetoresistance (SMR). More intriguing magnetoresistive effect in AFMs is the giant anomalous Hall effect due to the chiral magnetic structure in $L1_2$-ordered $Mn_3Ir$. Thus, it is important to investigate the MR in antiferromagnetic multilayer systems with $Mn_3Ir$. In this work, we examined the MR in Pt/$Mn_3Ir$ and W/$Mn_3Ir$ bilayers.

W 6 nm/$Mn_3Ir$ 10 nm/MgO 2nm/W 2 nm and Pt 6 nm/$Mn_3Ir$ 10 nm/MgO 2 nm/W 2 nm were deposited on a $SiO_2$ substrate by magnetron sputtering. The films were annealed at 220ºC for 30 min. Figs. (a) and (b) show the X-ray diffraction of the films before and after the annealing. A distinct difference between the W/$Mn_3Ir$ and the Pt/$Mn_3Ir$ multilayers can be found in the evolution of the (110) superlattice peak which indicates the $L1_2$-ordered $Mn_3Ir$ in W/$Mn_3Ir$. Then, the films were patterned into a 120-µm-long and 30-µm-wide Hall bar structure by a conventional photolithography and Ar ion milling process. The longitudinal $R_{xx}$ resistances were measured under the current of 1 mA in a rotating magnetic field with 9 T (Figs. (c)-(e)). Figures (f) and (g) show the magnetoresistance ratio $\Delta R_{xx}/R_{xx}$ as functions of α, β, and γ before and after annealing. Both W/$Mn_3Ir$ and Pt/$Mn_3Ir$ samples did not show α–dependent magnetoresistive behaviors before annealing. On the other hand, after annealing, appreciable MRs were observed but the behaviors with respect to the rotating angles differ for the two samples. Further investigation on W/$Mn_3Ir$ revealed that there is an additional component of the MR, which cannot be accounted for conventional AMR and SMR, presumably derived from the non-collinear magnetic structure associated with the $L1_2$-ordered $Mn_3Ir$[1].

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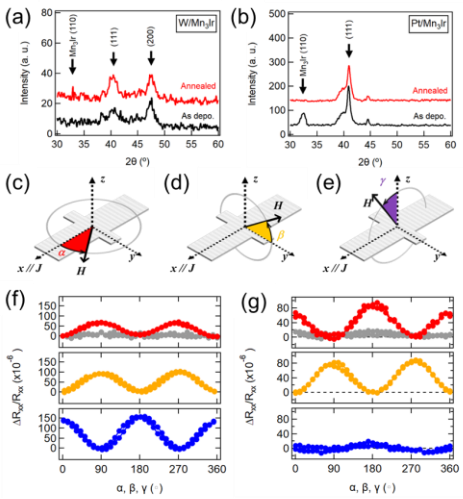


**Figure** XRD patterns for (a)W 6 nm/Mn3Ir 30 nm/MgO 2 nm/W 2 nm and (b)Pt 6 nm/Mn3Ir 30 nm/MgO 2 nm/W 2 nm. (c-e) Experimental setup of the electrical transport property measurement and the definition of the coordinate system. *H* denotes the magnetic field and *J* denotes the d.c. current density. Angular dependence of the longitudinal magnetoresistance ($\Delta R_{xx}/R_{xx}$) under the field of 9 T at 300 K for the as-deposited (gray) and annealed (otherwise) W/$Mn_3Ir$ and (g) for the as-deposited (gray) and annealed (other plots) Pt/$Mn_3Ir$.