AgSn/InZnO スペーサーCPP-GMR スピンバルブの磁気抵抗特性

CPP-GMR spin-valves with AgSn/InZnO spacers

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Current-perpendicular-to-plane giant magnetoresistance (CPP-GMR) devices with Heusler alloy ferromagnetic layers and a hybrid spacer structure composed of non-magnet/conductive oxide composite exhibit large magnetoresistive (MR) outputs at resistance-area product (RA) ~0.1 Ω μm^2, [1] therefore promising for nano-scale magnetic sensor applications such as read sensors for hard disk drives. Here, we report the MR properties of polycrystalline spin-valve devices with $Co_2(Mn_{0.6}Fe_{0.4})Ge$ Heusler alloy ferromagnetic layers and a AgSn/InZnO (IZO) bilayer spacer. [2]

Polycrystalline bottom-pinned spin-valves were deposited by magnetron sputtering on thermally oxidized Si substrates coated with a Cu (100 nm)-based bottom electrode. The layer structure is shown in Fig. 1(a). A $Ag_{90}Sn_{10}$(0.4 nm)/IZO(1.4-1.85 nm) bilayer spacer was used. After annealing at 280 °C for 3 h, the films were pattered to circular pillars with a 120 nm-diameter.

Fig. 1(b) shows the MR ratio ($\Delta R/R$) *vs*. RA of the devices with a variation of the IZO thickness. The RA value increased with increasing IZO thickness. The largest $\Delta R/R$ of ~30% was obtained at RA ~0.1 Ω μm^2, much larger than that of the conventional all-metallic CPP-GMR spin-valves with a AgSn(3.5 nm) spacer ($\Delta R/R$ = 14% at RA = 0.04 Ω μm^2). Note that the $\Delta R/R$ enhancement by the AgSn/IZO spacer was realized even at lower RA range of ~0.05 Ω μm^2. As shown in Fig. 1(c), the device resistance in the parallel magnetization configuration (R_P) showed a monotonous decrease as temperature was decreased, indicating a metallic conduction in the AgSn/IZO spacer. The large increment of $\Delta R/R$ with decreasing temperature ($\Delta R/R$ = 95% at 5 K) suggests a large increase of the spin polarization of the CMFG Heusler alloy layers at low temperatures.

References [1] Nakatani *et al*. Appl. Phys. Express **8**, 093003 (2015). [2] Nakatani *et al*. IEEE Trans. Magn., in press (DOI: 10.1109/TMAG.2017.2753221)

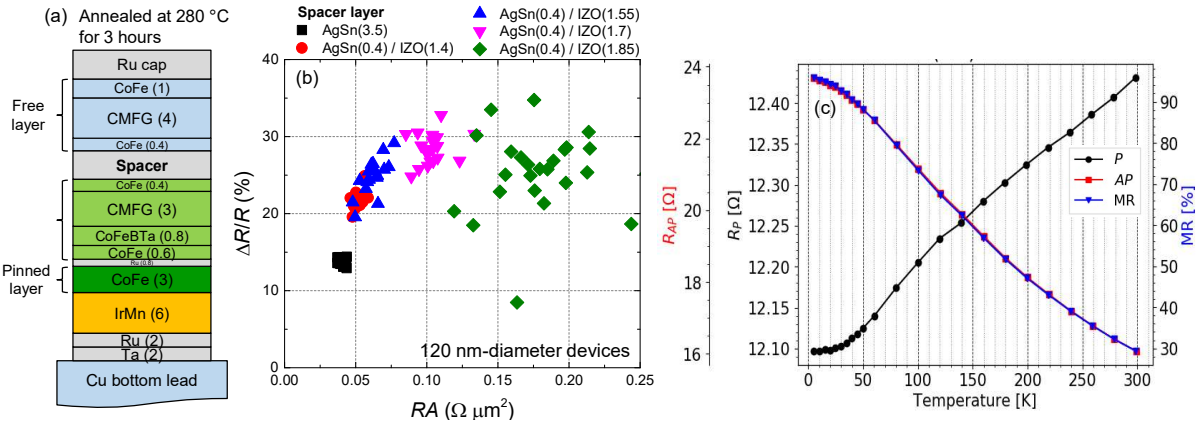

Fig. 1(a) Spin-valve film structure, (b) $\Delta R/R$ *vs*. RA for the AgSn(3.5) and AgSn(0.4)/IZO(t) spacers, (c) temperature dependences of R_P, R_{AP} and $\Delta R/R$ for AgSn(0.4)/IZO(1.7) (RA = 0.1 Ω μm^2, $\Delta R/R$ = 30%).