Ag-In-Zn-O スペーサー前駆体による CPP-GMR 比の増大

Enhancement of CPP-GMR ratio by Ag-In-Zn-O precursor for spacer layer

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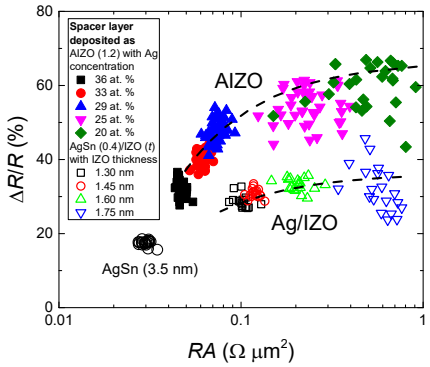
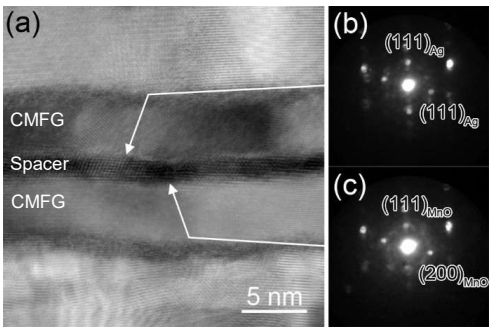
Enhancing the output of current-perpendicular-to-plane giant magnetoresistance (CPP-GMR) devices is the critical issue for the nano-scale magnetic sensor applications such as read sensors of hard disk drives. The selection of the material for the non-magnetic spacer layer is important for improving CPP-GMR ratio. We recently reported MR ratios ($\Delta R/R$) up to 30% with spin-valve devices by using Ag/In-Zn-O (IZO)/(Zn) bi- or tri-layer as spacer, which works as a precursor to form heterogeneous Ag-In:Mn-Zn-O nanocomposite spacer layer. [1] In this presentation, we report improved CPP-GMR ratios by using Ag-In-Zn-O (AIZO) as the spacer layer of the CPP-GMR devices with polycrystalline $Co_2(Mn_{0.6}Fe_{0.4})Ge$ (CMFG) Heusler alloy ferromagnetic layers.

Pseudo spin-valve stacks of Ta(2)/Ru(2)/CoFe(0.5)/CoFeBTa(1.5)/CMFG(5)/CoFe(0.4) /spacer/CoFe(0.4)/CMFG(5)/CoFeBTa(1.5)/Ru(8) (in nm) were sputter-deposited on Cu bottom-lead fabricated on thermally oxidized Si substrate. AgSn(3.5 m), Ag(0.4 nm)/IZO(1.30-1.75 nm), and AIZO(1.2 nm) with nominal Ag concentrations of 20-36 at. % were used for the spacer layer. The films were annealed at 280 °C for 3 h and patterned to CPP-pillar devices.

Figure 1 shows RA and $\Delta R/R$ of the devices. A large $\Delta R/R$ up to 54% at RA ~0.075 Ω μm^2 was obtained by using the AIZO with Ag 29 at. % spacer precursor, which is much larger than those by the Ag/IZO spacer precursor (up to 35%). Scanning transmission electron microcopy revealed that the actual spacer layer by the AIZO precursor was a Ag-In:Mn-Zn-O nanocomposite, similar to that by the Ag/IZO/Zn precursor. [1] Thus, the mechanism of the RA and $\Delta R/R$ enhancements by the AIZO spacer precurso is thought to be current-confinement effect by the Ag-In metallic paths in the spacer layer. The larger $\Delta R/R$ by the AIZO precursor than those by the Ag/IZO precursor could be understood by assuming a formation of Ag-In metallic paths with a lower resistivity.

References [1] Nakatani *et al*. IEEE Trans. Magn. 54, 3300211 (2018), J. Appl. Phys. 124, 223904 (2018).





(Left) Fig. 1 RA-$\Delta R/R$ of the devices with various kinds of spacer layer. (Right) Fig. 2 (a) High-angle annular dark-field image of the film with the AIZO (Ag 29 at. %) precursor, (b) and (c) nano-beam electron diffraction patterns from fcc Ag-In metallic path and rock-salt Mn-Zn-O matrix, respectively.