TaFeB spacer for soft magnetic composite free layer in CoFeB/MgO/CoFeB-based magnetic tunnel junction

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CoFeB/MgO/CoFeB-based magnetic tunnel junctions (MTJs) with a soft magnetic composite free layer have been developed for magnetic sensor applications.[1-4] Tunnel magnetoresistance (TMR) ratios in the sensor-type MTJs have reached a ceiling due to a trade-off between the TMR ratio and interlayer exchange coupling (IEC) depending on the spacer thickness of the composite free layer. In this study, we developed a paramagnetic amorphous TaFeB-alloy spacer to replace the conventional Ta spacer and solve this trade-off.

Figure 1 shows magnetization curves of the following multilayer: Si/SiO_2 subs./underlayers/IrMn (10)/CoFe (2.5)/Ta or TaFeB spacer (*t*)/CoFeB (3)/MgO/Ta (2) (thicknesses in nm). The magnetic field was applied parallel to the exchange-bias. The IEC strength across the spacer was evaluated by a loop shift of the CoFeB layer. The TaFeB spacer showed a wider thickness window for a sufficient IEC, resulting in IEC energy values of 0.18–0.19 erg/cm^2 at t = 1.0 nm. In addition, we confirmed that the TaFeB film had an ability to function as a boron sink comparable to that of pure Ta. Figure 2 shows spacer thickness dependence of TMR ratios in the following sensor-type MTJ: Si/SiO_2 subs./underlayers/CoFeSiB (100)/Ta or TaFeB spacer (*t*)/CoFeB (2)/CoFe (1)/MgO/pinned layers/capping layers. The above characteristics allowed us to thicken the TaFeB spacer up to 1.0 nm and attain an enhanced TMR ratio of up to 234%, which is the highest compared with cases using the Ta counterpart reported to date. These findings demonstrate that TaFeB alloy is a promising material for breaking the ceiling of sensor-type MTJs and increasing sensitivity.

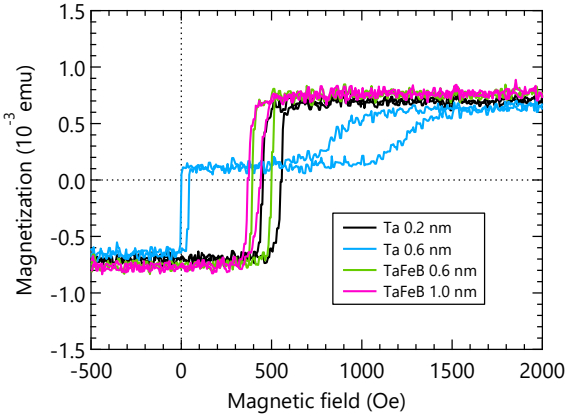

Fig. 1. Magnetization curves of multilayer with Ta or TaFeB spacer for IEC evaluation.

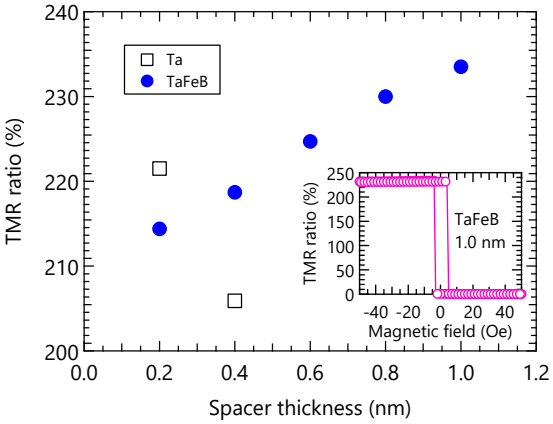

Fig. 2. Thickness dependence of TMR ratios in sensor-type MTJs with Ta or TaFeB spacer. Inset shows TMR curve for TaFeB of 1.0 nm.

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