超磁歪 $SmFe_2$/CoFeB/MgO/CoFeB-磁気トンネル接合構造の結晶構造解析

Crystallographic analysis of $SmFe_2$/CoFeB/MgO/CoFeB magnetic tunnel junctions

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Piezo-electronic magnetic tunnel junctions (PE-MTJ)[1] consisting of an MTJ using a magnetostrictive material for the free layer are a promising MTJ which can overcome a trade-off relationship between the critical current density for magnetization reversal and thermal stability of the magnetization of the free layer for magnetoresistive random access memories. To realize PE-MTJs, we have been studied MTJs using a $SmFe_2$ free layer as a giant negative magnetostriction. The magnetizations of the MTJ showed both parallel and antiparallel states, however, tunneling mantetoresistance (TMR) signals have not been observed yet. In this study, a CoFeB/MgO/CoFeB multilayer was formed on an amorphous $SmFe_2$ layer and investigated the crystalline properties of this multilayer to achieve MgO(001)-based spin filter PE-MTJs.

A stack of Ta (5 nm) / $SmFe_2$ (10 nm) / CoFeB (3 nm) / MgO (~2 nm) / CoFeB (4 nm) / Ta (5 nm) was deposited on a thermally oxidized Si(100) substrate using a facing targets sputtering system at RT. The MgO layer was formed by oxidation process of Mg layers under a pure oxygen atmosphere of 1 Pa for 3 minutes. After the deposition, the sample was annealed at 300 ℃ in a vacuum for 1 hour.

Figure 1 shows a cross-sectional transmission electron microscopy (TEM) image of the MTJ. Most areas of MgO and the lower CoFeB layers had (001) texture, which could be formed by the pseudo epitaxial growth from MgO(001). On the other hand, the upper CoFeB layer on crystallized (amorphous) MgO layer showed (110) ((001)) orientation. Improving the surface morphology of the MgO layer may be necessary to induce epitaxy growth of (001)-oriented upper CoFeB layer on MgO(001) layer to achieve spin filter structure on a $SmFe_2$ layer.

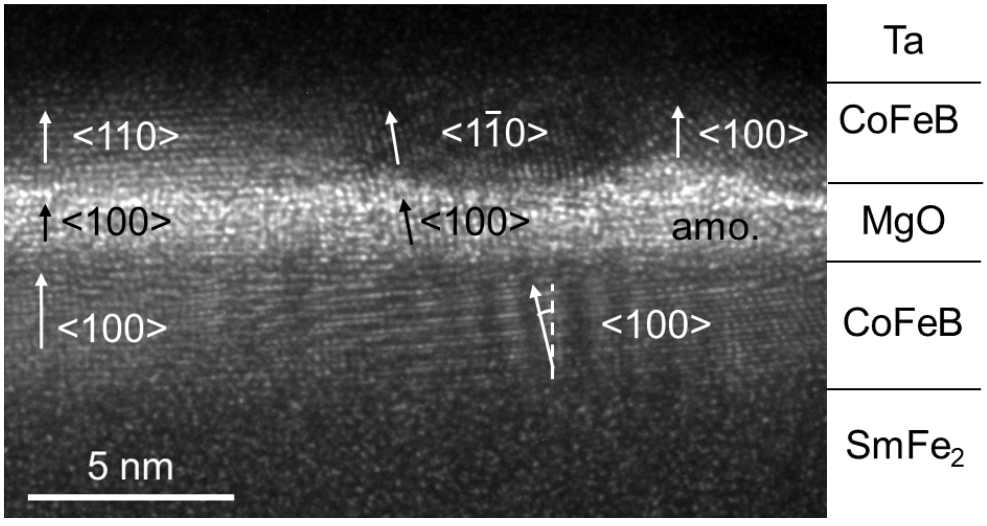

Fig. 1 Cross-sectional TEM image of the MTJ

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