

Applications of high-k dielectric materials to magnetic tunnel junctions

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Tunnel magneto-resistance(TMR) phenomena have been much interested since high magneto-resistance(MR) over 20% had been observed at the room temperature[1]. For the applications of TMR read sensor to high density magnetic recording system over 100G/in², low resistance area product(RA) below 10 Ω cm² are required in order to obtain reasonable ratio of signal to noise(S/N). RA has reached a limiting value of around 10 in TMR devices, where, mostly, Al₂O₃ as insulating barrier material had been formed by natural oxidation method[2]. When Al thickness becomes below 7Å, defects such as pinholes sharply reduce MR into below 10%. One breakthrough is using several high-k dielectric materials. In recent years, Wang et al. presented that TMR with low RA (about 2) showed stable MR values of around 14%, where HfAlOx was used as dielectric material[3].

In this study, we fabricated patterned TMR devices using photo (and electron beam) lithography, reactive ion etching, and ion-milling. Various high-k dielectric materials were applied to TMR insulating barriers, where source materials such as HfAl, ZrAl, RuTi, TiAl, and TaAl were formed by sputter deposition and oxidized by natural oxidation method. For TMR read sensors with low RA and high MR, it is important to form amorphous phase without pinholes, maintaining a good smooth surface. We examined MR and RA in above TMR devices with top-type, or bottom-type pinned structure, respectively.

References

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