Magneto-resistance Properties in Magnetic Tunnel Junctions with Amorphous CoFeSiB Electrode at Low Magnetic Field

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The discovery of the large tunnel magneto-resistance (TMR) effect in magnetic tunnel junctions (MTJs) enables us to design highly sensitive magnetic field sensors such as bio-magnetic field sensors. MTJs with a large sensitivity (=TMR/2Hk, Hk is magnetic anisotropy field) and linear resistance responses are required in such applications. We have to develop MTJs with high sensitivity of over 100 %/Oe in order to detect a small bio-magnetic field (ca. 10⁻⁹ Oe). We achieved a high sensitivity of 115%/Oe in MTJs with free layers of CoFeSiB(100)/Ru(0.4)/CoFeB(3)¹. However, sensor properties at low magnetic field were not investigated. In this study, we have investigated the magneto-resistance properties in MTJs using amorphous CoFeSiB electrode at low magnetic field.

The films were deposited onto thermally oxidized Si wafers using an ultrahigh vacuum magnetron sputtering system (Pbase < 3.0 x 10⁻⁶ Pa). The stacking structures of the MTJ films were Si/SiO₂/Ta(5)/Ru(10)/Ta(5)/CoFeSiB(100)/Ru(0.4)/Co₄₀Fe₄₀B₂₀(3)/MgO(2.5)/Co₄₀Fe₄₀B₂₀(3)/Ru(0.9)/Co₇₅Fe₂₅(5)/Ir₂₂Mn₇₈(10)/Ta(5) (in nm). The magneto-resistance properties were measured by the DC four-probe method at RT in magnetic shield room.

Fig. 1 shows the typical magneto-resistance curve in magnetic field range of ±10 Oe. We observed the linear TMR response to the external magnetic field and a high sensitivity of 65%/Oe. Fig. 2 shows the applied magnetic field dependence of the sensitivity. The sensitivity dropped to ca. 55%/Oe below 20 mOe. We will discuss the origin of reduction of sensitivity at low field and the linearity and the noise properties in MTJs with CoFeSiB electrode. This work was supported by the S-Innovation program, Japan Science and Technology Agency (JST), Center of Innovative Integrated Electronic Systems, and Grant-in-Aid for JSPS Fellows 15J02067. ¹) D. Kato et al., 62nd JSAP spring meeting, 11p-P1-5

Fig. 1 Typical magneto-resistance curve in the MTJ with CoFeSiB electrode applying magnetic field of ±10 Oe

Fig. 2 Applied magnetic field dependence of sensitivity in the MTJ with CoFeSiB electrode