BC04

Room-temperature ferromagnetism of nanosized one-dimensional $ZnO/Zn_{1-x}Mn_xO$ heterstructure

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In recent years, since the prediction on possible ferromagnetic properties of transition-metal doped ZnO with a Curie temperature (Tc) above room temperature [1], studies on these materials have attracted lots of attention for the application to the spintronic device. Up to now, room-temperature ferromagnetism has been reported for Co-doped and Mn-doped ZnO films [2,3]. Nevertheless, the reproducible synthesis of nanosized transition-metal doped ZnO with a high Tc, which is more important than the bulk or the film for the spintronic applications, still remains a challenge.

In the present work, nanosized one-dimensional $ZnO/Zn_{1-x}Mn_xO$ heterstructures wereprepared in two steps: ZnO nanowire was synthesised by the standard vapor-solid technique, followed by depositing $Zn_{1-x}Mn_xO$ onto the surface of ZnO nanowireusing radio-frequency magnetron sputtering. The samples werecharacterized by scanning elctron microscopy, x-ray diffraction, Rutherford backscattering, and by using a superconducting quantum interference device magnetometer. The XRD patterns reveal that Mn is incorporated into the wurtzite structure without forming the Mn oxide. The magnetic measurement shows that the nanosized $ZnO/Zn_{1-x}Mn_xO$ heterstructures exhibit the ferromagnetic behavior at room temperature. The coercive field turns out to be 109 and 153 Oe at 300 and 10 K, respectively. Most importantly, good reproducibility was achieved.

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BC05

Correlation between crystallographic structure and magnetoresistance in CoFeB/MgO/CoFeB magnetic tunnel junctions

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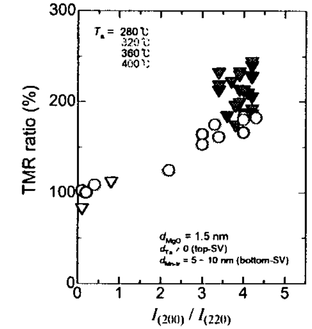
The (001) orientation of MgO barrier layer on amorphous CoFeB layers by sputtering depositionand the giant tunnel magnetoresistance (TMR) ratio exceeding 200% for high temperature annealed CoFeB/MgO/CoFeB magnetic tunnel junctions (MTJs) have been reported [1]. Extensive studies have been done for the CoFeB/MgO/CoFeB-MTJ, since it is a promisingcandidate for magnetic random access memory (MRAM) cells and high sensitive reproducing head element in hard disk drives (HDDs). However, it is generally known that the giant TMR effect of the CoFeB/MgO/CoFeB-MTJ is quite sensitive to the deposition apparatus, fabrication conditions, and stacking structure of the MTJ films. In order to clarify the dominant factors affecting on the giant TMR effect, we investigated the crystallographic orientation of the MgO barrier layer fabricated on the CoFeB layer with changing the stacking structure and the correlation between the MgO-orientation and the TMR ratio.

wo sets of samples, either bottom-pinned spin valve type MTJs or top-pinned spin valve type MTJs were fabricated on thermally oxidized Si wafers with an ultra-high vacuum magnetron sputtering system, in a deposition sequence of sub./Ta/Ru/MnIr/CoFe/Ru/CoFeB/MgO/CoFeB/Ta/Ru (bottom-SV) or sub./Ta/Ru/Ta/CoFeB/MgO/CoFeB/Ru/CoFe/MnIr/Ta/Ru (top-SV). The crystallographic orientation of the MgO layer was estimated from the integral intensity ratio of MgO(200) and MgO(220) diffraction lines, observed with grazing incident x-ray diffraction method. When the MgO layer has (001) and (111) orientations, the intensity ratio comes to be about 4 and 0, respectively. The TMR ratio was mostly measured with current-in-plane tunneling (CIPT) apparatus.



The figure shows an achievable TMR ratio of the MTJs, having different crystallographic orientation of theMgO layer, after thermal annealing from 280°C to 400°C. Only the MTJs having MgO(001) orientation ($I_{(200)}/I_{(220)} \sim 4$) show giant (>200%) TMR ratio. This result means that the MgO(001)-followed crystallization of CoFeB [2] is essential for the giant TMR effect. The important point to be noticed here is that the TMR ratio disperses from 160% to 250% even at I(200)/I(220) ~ 4. The bottom-SV structured MTJs (circle marks) show lower TMR ratio than the top-SV MTJs (reversed-triangle marks). The reason of this dispersion and methods to improve the achievable TMR ratio in bottom-SV will be discussed in the conference.

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