

Tunnel magnetoresistance in magnetic tunnel junctions with a metastable cubic GaN barrier

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Magnetic tunnel junctions (MTJs) exhibit tunnel magnetoresistance (TMR), which are applied for HDD reading heads, memories, and sensors. Current standard materials are FeCoB and MgO, whereas various materials are being explored for advanced MTJs [1-4]. One of the demands is new barrier materials exhibiting both large TMR and low resistance, and good candidates would be cubic wide-bandgap oxide semiconductors crystallizing on a (001) plane of magnetic electrode [3,4]. In this study, we explored a

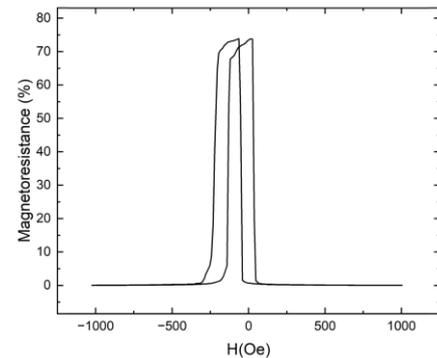


Fig. 1 The TMR curves in the MTJs with the 0.9-nm-thick GaN layer in the barrier.

metastable cubic nitride wide-bandgap semiconductor c-GaN (001) with a bandgap of approximately 3 eV for a tunnel barrier in MTJs. Films were deposited on MgO (001) single crystal substrates using an ultra-high vacuum magnetron sputtering. Multilayer stacking structure was Cr(40)/ CoMnFe(10)/ Mg(0.5)/ MgO(0.6)/ GaN($d=0.4-1.2$)/ MgO(0.6)/ CoMnFe(8)/ IrMn(10)/ Ru(10) (thickness in nm). MTJs were annealed in a vacuum furnace, and the film structures were analyzed by X-ray diffraction (XRD). TMR effects were evaluated using the current-in-plane tunneling (CIPT) measurements and a standard four probe method in patterned MTJs. The XRD measurements confirmed the epitaxial relationship of the buffer Cr(001)||CoMnFe(001)||IrMn(001). Notably, the texture of the IrMn (001) indicates the formation of the metastable cubic GaN (001) which is promoted by MgO(001). Fig. 1 shows the TMR curve for the MTJ with the 0.9-nm-thick GaN layer annealed at 300°C, we observed the relatively high TMR ratio of about 75%. We will present the GaN thickness dependence of the TMR ratio and the resistance area product in the presentation and discuss the effect of GaN layer in detail. This work was supported by JST CREST (JPMJCR17J5), KAKENHI (21H05000), and X-NICS of MEXT (JPJ011438). S.M and M.S thank Spin-RNJ. H.K thanks GP-Spin at Tohoku Univ.

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