Fabrication of fully epitaxial magnetic tunnel junctions with rock-salt type ZnO/MgO bilayer tunnel barrier

°H. Saito[1], S, Kon[1,2], N. Sai Krishna[3], N. Matsuo[1,2], N. Doko[1,2], Y. Yasukawa[2] and S. Yuasa[1]

Spintronics Research Center AIST [1], Chiba Institute of Technology [2], Research Center for Magnetic and Spintronic Materials NIMS[3]

E-mail: h-saitoh@aist.go.jp

Fully epitaxial ferromagnet/semiconductor/ferromagnet heterojunctions is one of the fundamental building blocks of a vertical-type spin metal-oxide-semiconductor field-effect transistor [1,2]. ZnO is a typical oxide semiconductor and has a wurtzite type crystal structure. It has been recently demonstrated that a thin ZnO film with a rock-salt (RS) crystal structure can be epitaxial grown on MgO(001) [3,4]. In this study, we examined to grow fully epitaxial Fe/RS-ZnO/MgO/Fe structure and conducted a detailed investigation on its structural properties.

Films were prepared by molecular beam epitaxy. The structure of the MTJ was Au (10 nm) cap layer / Co (10 nm) pinned layer / Fe (5 nm) top electrode / ZnO (1.2 nm) tunnel barrier/ MgO (1 nm) tunnel barrier / Fe (30 nm) bottom electrode / MgO (10 nm) buffer layer on MgO(001) substrates. The ZnO layer was deposited under an O_2 pressure of 1×10^{-6} Torr.

Figures 1 show reflection high-energy electron diffraction (RHEED) images of the ZnO layer grown at various temperatures T_g. Streaky patterns, similar to the MgO(001) seed layer, were observed for the samples with T_g = 100°C, 170°C and 230°C, indicating the formation of the single-crystalline RS-ZnO(001) layer. We also confirmed by the RHEED observation that the Fe top electrodes grown on the single-crystalline RS-ZnO tunnel barrier are single-crystalline, resulting in a fully epitaxial Fe(001)/RS-ZnO(001)/MgO(001)/Fe(001) structure.

This work was supported by KAKENHI “Nano Spin Conversion Science” (Grant No. 26103003)

Reference

[1] T. Kanaki, *et al*, Appl. Phys. Lett. **107**, 242401 (2015). [2] N. Matsuo, *et al*., Phys. Rev. Applied **6**, 034011 (2016). [3] Y. Uehara *et al*, J. Magn. Soc. Jpn. 34, 311 (2010). [4] C. Y. James,*et al*., Chem. Phys. **144**, 214704 (2016).

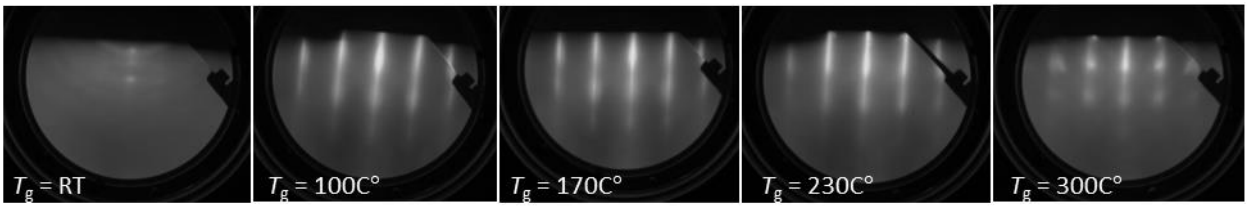

Fig. 1. RHEED images of ZnO barrier layer grown at various temperatures T_g.