

Fabrication of Tunnel Junction with the BiFeO₃ Barrier and the La_{0.6}Sr_{0.4}MnO₃ Electrode

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1. Introduction

BiFeO₃ (BFO) is the promised multiferroic material possesses antiferromagnetism ($T_N=643$ K) and ferroelectricity ($T_C=1103$ K), simultaneously. The interfacial ferromagnetism appeared in BFO-La_{1-x}Sr_xMnO₃ (LSMO) interface, [1] and its modulation by polarization switching is expected. Because spin-dependent transport is dominated by interfacial magnetic structure, electric control of tunnel magnetoresistance is anticipated in the BFO-LSMO junctions. However, there are few reports related to the magnetic tunnel junction with BFO-LSMO. In this study, junctions with the BFO-LSMO were fabricated and its structural property was investigated.

2. Experimental Procedure

50-nm-thick La_{0.6}Sr_{0.4}MnO₃ films were deposited on SrTiO₃ (STO)(001) substrates by reactive r.f. magnetron sputtering. Post-annealing was carried out for two hours in air at 650-950°C to reduce the oxygen vacancies. The 5-nm-thick BFO films were deposited on STO(001)/LSMO to confirm the surface roughness. STO(001)/LSMO(70 nm)/BFO(4 nm)/CoFe(4 nm)/Ru(5 nm) junction was fabricated by photolithography and Ar ion milling. The structural property was measured with TEM, and composition of the films was evaluated with EDX. Surface morphology was observed with AFM. The resistance of junctions was measured by d.c. four-terminal method.

3. Experimental Results

The cross-sectional TEM image for LSMO-BFO interface in STO(001)/LSMO(50 nm)/BFO(50 nm) indicated the epitaxial growth of BFO and LSMO (fig. 1). The electron diffraction revealed that there were two regions in the BFO layer, i.e., cubic-like region near interface and tetragonal-like region. Since the thickness of cubic-like BFO was 7 nm, the structure of BFO might be cubic-like when BFO was used as barrier. Although the structure of BFO changed over the 7-nm-thick, it was confirmed that the average surface roughness R_a was 0.3 nm with AFM in the 5-nm-thick BFO on STO(001)/LSMO. Therefore the BFO films were flat enough to use as barrier of tunnel junctions. The resistance measurement of the junctions in magnetic field indicated the magnetoresistance of 4% at room temperature.

[1] P. Yu *et al.*, Phys. Rev. Lett. **105**, 027201 (2010).

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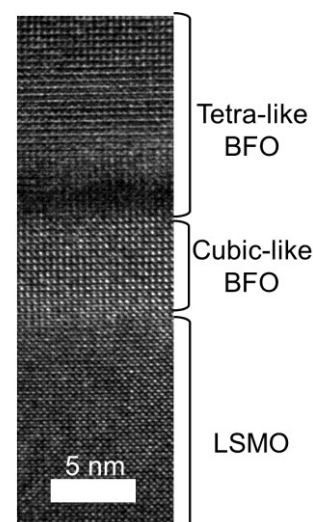


Fig. 1 The TEM image for the BFO-LSMO interface