Structure and magnetic properties in $Bi_2Fe_4O_9/Fe_3O_4$ nanocomposite thin film on $LaAlO_3$ substrate

Duong Anh Tuan[2*], Yooleemi Shin[1], Nguyen Van Quang[1], Jeongyong Choi[1], and Sunglae Cho[1†]

[1]Department of Physics and Energy Harvest-Storage Research Center, University of Ulsan, Ulsan 680-749, Republic of Korea
[2]Department of General Sciences, Quang Ninh University of Industry, Quang Ninh, Viet Nam

The mullite-type orthorhombic $Bi_2Fe_4O_9$ is a well known multiferroic material, which is ferroelectric and antiferromagnetic with T_N = 260K.[1] Magnetite Fe_3O_4 was known as one of the important ferromagnetic oxides for spintronic devices due to its high spin-polarization at room temperature, high Curie temperature (T_C = 860 K) and high room temperature magnetoresistance (MR).[2,3] The combination of ferroelectric phase and ferromagnetic phase in nanostructure composite enables us to control electrical polarization by magnetic field and vice versa. Recently, there are some interesting reports in nanocomposite systems. For example, E. Weal *et al* reported the large saturation magnetization (M_S), 900 emu/cm^3, in $BiFeO_3$–Fe_3O_4 nanocomposite.[4] L. Yan *et al* reported that, $BiFeO_3$–$CoFeO_4$ nanocomposite possessed the saturation polarization of 60 ❍V/cm^2 and magnetization of 410 emu/cm^3.[5] S. N. Babu *et al* reported that $BiFe_{0.5}Cr_{0.5}O_3$–$NiFe_2O_3$ composite has a larger magnetization and dielectric constant than those of both parent compounds.[6] Here we report on the structural and magnetic properties of $Bi_2Fe_4O_9$-Fe_3O_4 nanocomposite thin films grown on $LaAlO_3$ substrate by MBE. X-ray diffraction and FE-SEM image revealed the epitaxial nanocomposites consisting of two single crystal phases; orthorhombic $Bi_2Fe_4O_9$ and fcc Fe_3O_4. The temperature dependent resistivity showed the Verwey transition temperature (T_V, a first order metal-insulator transition of Fe_3O_4) of 100 K. The 1.4% MR in 7.5 kOe was observed at 150 K. The saturation magnetization at room temperature is 140emu/cm^3. The temperature dependent magnetization in 0.5T showed the Néel temperature (T_N) of $Bi_2Fe_4O_9$ is about 260K.

†Corresponding author: slcho@ulsan.ac.kr

1. Z. M. Tian, *et al*.J. Appl. Phys. 106 103912 (2009).
2. S. Tiwari, *et al*. J. Phys. D: Appl. Phys. 40, 4943 (2007).
3. A. V. Ramos, *et al*. J. Appl. Phys. 100, 103902 (2006).
4. E. Weal, *et al*. Appl. Phys. Lett. 97, 153121 (2010).
5. L. Yan, *et al*. Appl. Phys. Lett. 94, 192902 (2009).
6. S. N. Babu, *et al*. J. Appl. Phys. 107, 09D919 (2010).