Growth and Characterization of Epitaxial Co-Substituted Bismuth Ferrite Thin Film on Silicon Substrate

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Abstract

The Co-substituted bismuth ferrite thin films grown on perovskite substrates have demonstrated promise as a multiferroic material for nonvolatile magnetic memory devices with low power consumption [1-2]. For further device integration, it is essential to select a substrate compatible with silicon-CMOS processing. In this presentation, we will show our recent progress in growing epitaxial thin film of $BiFe_{0.9}Co_{0.1}O_3$ (BFCO) on the silicon substrate and the investigation of the crystal structure, ferroelectric and ferromagnetic domain structures, and magnetic properties of the thin film.

Experimetal methods

BFCO thin films were prepared on (001)-oriented Si substrate with $SrRuO_3/Pt/ZrO_2$ coated wafer (KRYSTAL Wafer, I-PEX Inc.) by using pulsed laser deposition with a KrF excimer laser (λ = 248 nm). A pulsed laser was focused on stoichiometric target of BFCO with a fluence of 1.1 J/cm^2 and a repetition rate of 4 Hz. The substrate was kept at 660 °C in an oxygen partial pressure of 15 Pa during the deposition. The crystal structure of the thin film was investigated by X-ray diffraction (XRD) measurements. Ferroelectric and ferromagnetic domains were observed by piezoresponse force microscope (PFM) and magnetic force microscope (MFM), respectively.

Results

The out-of-plane 2θ-ω XRD profile of BFCO thin film, compared with the profile of Si substrate, is shown in Figure 1 (a). The BFCO thin film exhibits 00*h* reflections of pseudocubic perovskite notation (denoted by “pc”) without any impurity phases. The reciprocal space maps (RSMs) around 203_{pc} and 113_{pc} are shown in Figure 1 (b), which is an indicative of a M_A phase of BFCO [3]. The smooth surface was obtained as shown in Figure 1 (c). The successful growth of M_A-phase BFCO thin film on the Si substrate provided us the opportunity to investigate ferroelectric and ferromagnetic domain structures of the thin film, the results of which will be presented.

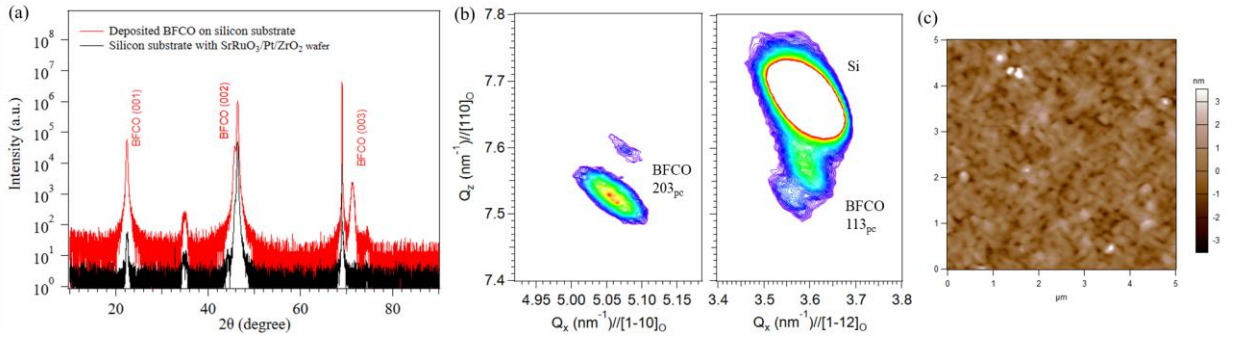

Figure 1 (a) The XRD 2θ-ω profile of the BFCO thin film and silicon substrate with $SrRuO_3/Pt/ZrO_2$ wafer. (b) Reciprocal space maps of the BFCO thin film around 203_{pc} and 113_{pc} reflections of BFCO thin film [3]. (c) AFM image of BFCO thin film on Si substrate.

Reference

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