Supplementary Information

Enhanced optical and piezoelectric characteristics of transparent Ni-doped $BiFeO_3$ thin films on glass substrate

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I. Effect of film thickness on the degree of crystallinity in Ni-substituted $BiFeO_3$ films

Additionally, 0.5 mol% Ni-substituted $BiFeO_3$ thin films were investigated by changing film thickness from 50 nm to 200 nm with regard to phase evolution, optical transmittance and band gap. Figure S1 shows XRD patterns of the films with film thickness of 50 nm to 200 nm. Higher crystallinity was observed with thicker thickness. All films demonstrate the random orientation of film growth even though the (012) preferred growth becomes more evident with the progress of film growth. The increasing tendency in lattice parameters and unit cell volume with film thickness, as represented in Table S1, indicates that the values are getting close to the reported bulk values.

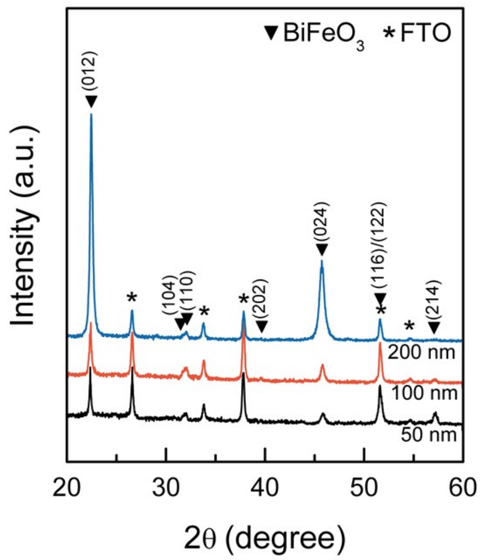

Figure S1. XRD patterns of 0.5 mol% Ni-doped $BiFeO_3$ thin films with different film thickness

Table S1. Lattice parameters of 0.5 mol% Ni-doped $BiFeO_3$ thin films with different thickness.

Thickness	a (Å)	c (Å)	Volume of cell (Å^3)
50 nm	5.10	12.7	286.1
100 nm	5.33	13.5	332.2
200 nm	5.59	13.6	368.0

II. Effect of film thickness on the optical properties of Ni-substituted $BiFeO_3$ films

Figure 2S shows the results of UV-Vis spectroscopy evaluation for the 0.5 mol% Ni-substituted $BiFeO_3$ films with different thickness. All films exhibited highly transparent nature in the visible range. At 700 nm, the 50 nm thickness shows nearly 95% transparency although the transparency becomes reduced with a thicker thickness. Optical band gap was substantially reduced from 3.07 eV to 2.83 eV as the film thickness decreased from 50 nm to 200 nm.

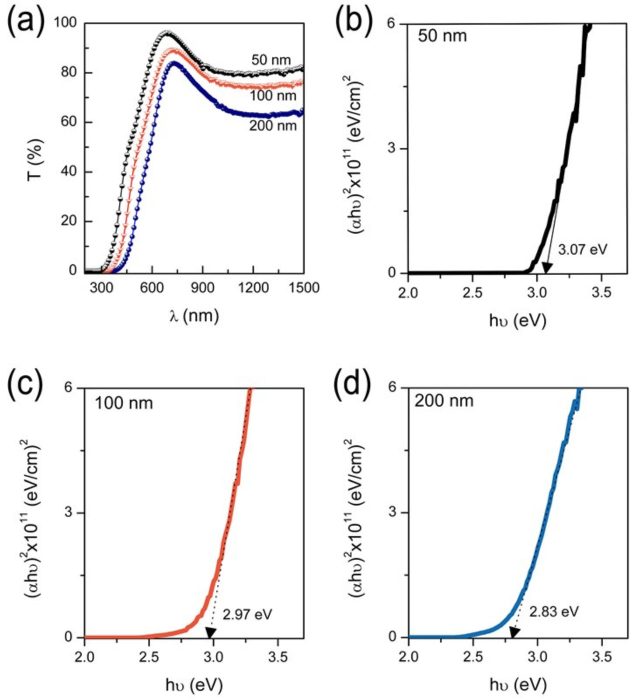

Figure S2. (a) UV-visible transmittance spectra of 0.5 mol% Ni-doped $BiFeO_3$ thin films and $(\alpha h\upsilon)^2$ vs. $h\upsilon$ curves with different thickness of (b) 50 nm, (c) 100 nm and (d) 200 nm.