Supporting Information

Effect of Tetragonal to Cubic Phase Transition on the Upconversion Luminescence Properties of A/B site Erbium-doped Perovskite BaTiO$_3$

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Figure S1. IR spectrum of B-BT (Ti-O vibration is the maximum phonon energy of BT).
Figure S2. Upconversion emission spectrum of A-BT with different concentrations of Er$^{3+}$ ions (green: doped with 1% Er$^{3+}$ ion, pink: doped with 2% Er$^{3+}$ ion, blue: doped with 3% Er$^{3+}$ ion).
Figure S3. Log(I) versus log(P) diagram of each emission of A-BT: (a) $^2\text{H}_{11/2} \rightarrow ^4\text{I}_{15/2}$, (b) $^4\text{S}_{3/2} \rightarrow ^4\text{I}_{15/2}$, (c) $^4\text{F}_{9/2} \rightarrow ^4\text{I}_{15/2}$; (a) slope = 2.03225, (b) slope = 1.92454, (c) slope = 1.98517; and log(I) versus log(P) diagram of each emission of B-BT: (d) $^3\text{H}_{11/2} \rightarrow ^4\text{I}_{15/2}$, (e) $^4\text{S}_{3/2} \rightarrow ^4\text{I}_{15/2}$, (f) $^4\text{F}_{9/2} \rightarrow ^4\text{I}_{15/2}$; (d) slope = 2.07297, (e) slope = 1.86522, (f) slope = 1.9305.
Figure S4. Schematic energy level diagram of erbium ions (Er$^{3+}$) (GSA: ground-state absorption, ESA: excited-state absorption).
Figure S5. Optical setup for temperature-dependent upconversion spectrum measurement.
Figure S6. Optical setup reliability test. (a) Upconversion luminescence spectrum of A-BT. (b) Mean intensities of the respective luminescent points (green: $^2\text{H}_{11/2}\rightarrow^4\text{I}_{15/2}$, green 2: $^4\text{S}_{3/2}\rightarrow^4\text{I}_{15/2}$, red: $^4\text{F}_{9/2}\rightarrow^4\text{I}_{15/2}$), where error bars represent standard deviation (N=40).
Figure S7. Normalized intensity versus cycles diagrams that show the reversibility of the B-BT intensity temperature from 105 °C to 135 °C (green: 105 °C, yellow: 115 °C, pink: 125 °C, red: 135 °C).