Supporting information

Transformation of thermal expansion from Large Volume Contraction to Nonlinear Strong Negative Thermal Expansion in $PbTiO_3$-$Bi(Co_{1-x}Fe_x)O_3$ Perovskites

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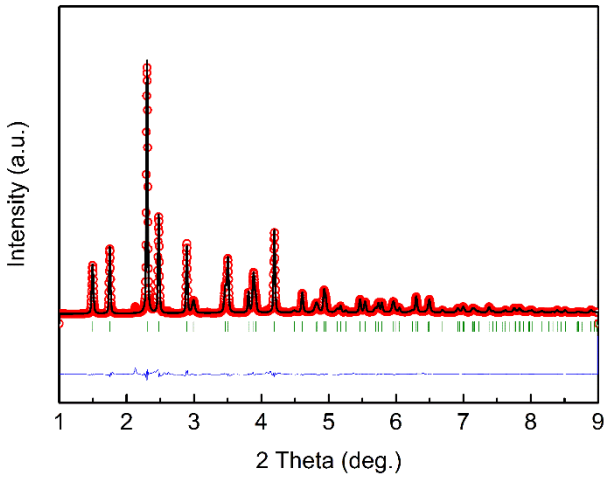

Figure S1. Rietveld refinement of SXRD patterns of tetragonal $0.5PbTiO_3$-$0.5BiCoO_3$ at room temperature. Observed (red, circles), calculated (black line), and their difference profiles (bottom line) are shown. The Bragg reflection positions are indicated by the green ticks (λ = 0.117418 Å).

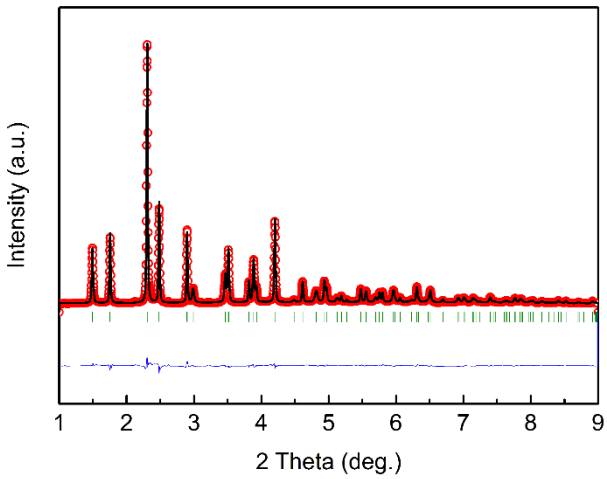

Figure S2. Rietveld refinement of SXRD patterns of tetragonal $0.5PbTiO_3$-$0.5BiCo_{0.8}Fe_{0.2}O_3$ at room temperature. Observed (red, circles), calculated (black line), and their difference profiles (bottom line) are shown. The Bragg reflection positions are indicated by the green ticks (λ = 0.117418 Å).

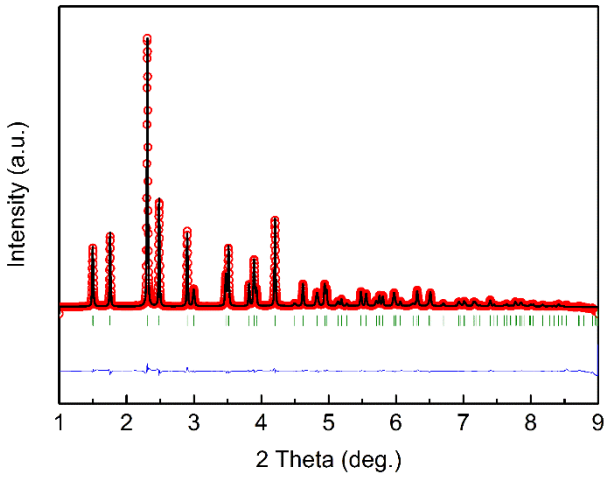

Figure S3. Rietveld refinement of SXRD patterns of tetragonal $0.5PbTiO_3$-$0.5BiCo_{0.6}Fe_{0.4}O_3$ at room temperature. Observed (red, circles), calculated (black line), and their difference profiles (bottom line) are shown. The Bragg reflection positions are indicated by the green ticks (λ = 0.117418 Å).

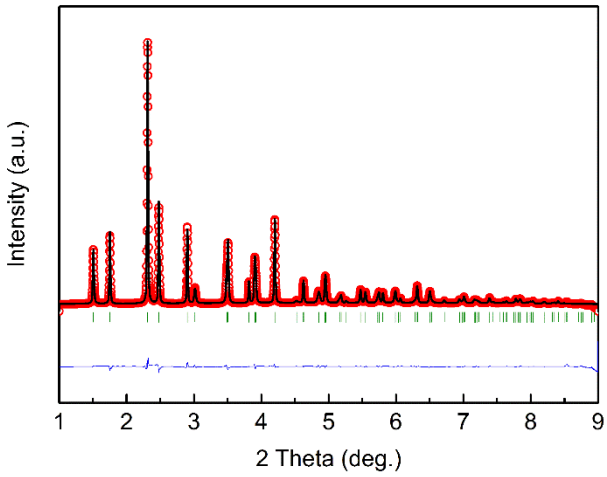

Figure S4. Rietveld refinement of SXRD patterns of tetragonal $0.5PbTiO_3$-$0.5BiCo_{0.4}Fe_{0.6}O_3$ at room temperature. Observed (red, circles), calculated (black line), and their difference profiles (bottom line) are shown. The Bragg reflection positions are indicated by the green ticks (λ = 0.117418 Å).

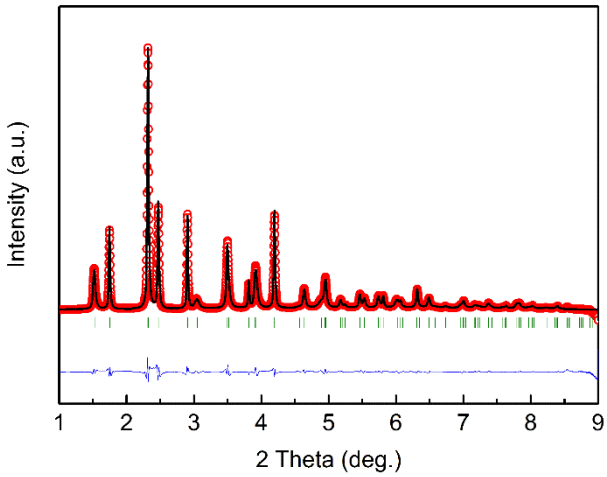

Figure S5. Rietveld refinement of SXRD patterns of tetragonal $0.5PbTiO_3$-$0.5BiCo_{0.2}Fe_{0.8}O_3$ at room temperature. Observed (red, circles), calculated (black line), and their difference profiles (bottom line) are shown. The Bragg reflection positions are indicated by the green ticks (λ = 0.117418 Å).

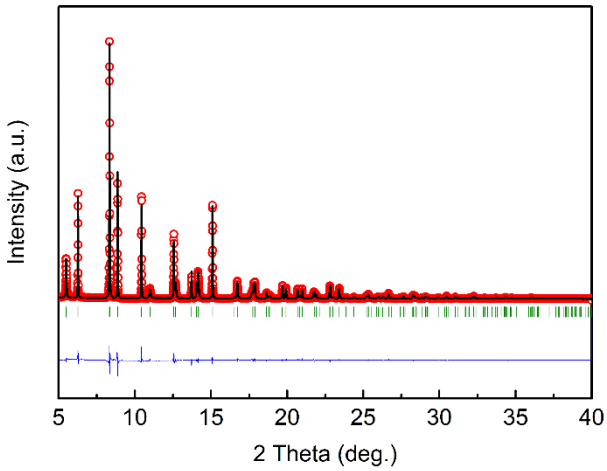

Figure S6. Rietveld refinement of SXRD patterns of tetragonal $0.5PbTiO_3$-$0.5BiFeO_3$ at room temperature. Observed (red, circles), calculated (black line), and their difference profiles (bottom line) are shown. The Bragg reflection positions are indicated by the green ticks (λ = 0.421026 Å).