SUPPLEMENTARY DATA

Electrocaloric effect in different oriented $BaZr_{0.15}Ti_{0.85}O_3$ single crystals

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The thermodynamic potential energy density of the (001)-oriented bulk ferroelectric is expressed as:

$$G_{(001)}(\mathbf{E},T) = \alpha_1(P_1^2+P_2^2+P_3^2) + \alpha_{11}(P_1^4+P_2^4+P_3^4) + \alpha_{12}(P_1^2P_2^2+P_2^2P_3^2+P_1^2P_3^2) + \alpha_{111}(P_1^6+P_2^6+P_3^6) + \alpha_{112}[P_1^2(P_2^4+P_3^4)+P_2^2(P_1^4+P_3^4)+P_3^2(P_1^4+P_2^4)] + \alpha_{123}P_1^2P_2^2P_3^2 + \alpha_{1111}(P_1^8+P_2^8+P_3^8) + \alpha_{1122}(P_1^4P_2^4+P_2^4P_3^4+P_1^4P_3^4) + \alpha_{1112}[P_1^6(P_2^2+P_3^2)+P_2^6(P_1^2+P_3^2)+P_3^6(P_1^2+P_2^2)] + \alpha_{1123}(P_1^4P_2^2P_3^2+P_1^2P_2^4P_3^2+P_1^2P_2^2P_3^4) - P_1E_1 - P_2E_2 - P_3E_3, \quad \text{(S1)}$$

The thermodynamic potential energy density of the (110)-oriented bulk ferroelectric is expressed as:

$$G_{(110)}(\mathbf{E},T) = \alpha_1(P_1^2+P_2^2+P_3^2) + \frac{1}{2}\alpha_{11}(2P_1^4+P_2^4+6P_2^2P_3^2+P_3^4) + \frac{1}{4}\alpha_{12}(4P_1^2P_2^2+P_2^4+4P_1^2P_3^2-2P_2^2P_3^2+P_3^4) + \frac{1}{4}\alpha_{111}(4P_1^6+P_2^6+15P_2^4P_3^2+15P_2^2P_3^4+P_3^6) + \frac{1}{4}\alpha_{112}(4P_1^4P_2^2+2P_1^2P_2^4+P_2^6+4P_1^4P_3^2+12P_1^2P_2^2P_3^2-P_2^4P_3^2+2P_1^2P_3^4-P_2^2P_3^4+P_3^6) + \frac{1}{4}\alpha_{123}(P_1^2P_2^4-2P_1^2P_2^2P_3^2+P_1^2P_3^4) + \frac{1}{16}[\alpha_{1111}(16P_1^8+2P_2^8+56P_2^6P_3^2+140P_2^4P_3^4+56P_2^2P_3^6+2P_3^8) + \alpha_{1112}(16P_1^6P_2^2+4P_1^2P_2^6+2P_2^8+16P_1^6P_3^2+60P_1^2P_2^4P_3^2+8P_2^6P_3^2+60P_1^2P_2^2P_3^4-20P_2^4P_3^4+4P_1^2P_3^6+8P_2^2P_3^6+2P_3^8) + \alpha_{1122}(8P_1^4P_2^4+$$

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$P_2^8 + 48P_1^4P_2^2P_3^2 - 4P_2^6P_3^2 + 8P_1^4P_3^4 + 6P_2^4P_3^4 - 4P_2^2P_3^6 + P_3^8) + \alpha_{1123}(4P_1^4P_2^4 + 4P_1^2P_2^6 - 8P_1^4P_2^2P_3^2 - 4P_1^2P_2^4P_3^2 + 4P_1^4P_3^4 - 4P_1^2P_2^2P_3^4 + 4P_1^2P_3^6)] - P_1E_1 - P_2E_2 - P_3E_3,$ (S2)

The thermodynamic potential energy density of the (111)-oriented bulk ferroelectric is expressed as:

$$G_{(111)}(\mathbf{E},T) = \alpha_1(P_1^2 + P_2^2 + P_3^2) + \frac{1}{6}\alpha_{11}\left(3P_1^4 + 6P_1^2P_2^2 + 3P_2^4 + 12\sqrt{2}P_1^2P_2P_3 - 4\sqrt{2}P_2^3P_3 + 12P_1^2P_3^2 + 12P_2^2P_3^2 + 2P_3^4\right) + \frac{1}{12}\alpha_{12}\left(3P_1^4 + 6P_1^2P_2^2 + 3P_2^4 - 12\sqrt{2}P_1^2P_2P_3 + 4\sqrt{2}P_2^3P_3 + 4P_3^4\right) + \frac{1}{36}\alpha_{111}\left(9P_1^6 + 45P_1^4P_2^2 + 15P_1^2P_2^4 + 11P_2^6 + 90\sqrt{2}P_1^4P_2P_3 + 60\sqrt{2}P_1^2P_2^3P_3 - 30\sqrt{2}P_2^5P_3 + 90P_1^4P_2^2 + 180P_1^2P_2^2P_3^2 + 90P_2^4P_3^2 + 120\sqrt{2}P_1^2P_2P_3^3 - 40\sqrt{2}P_2^3P_3^3 + 60P_1^2P_3^4 + 60P_2^2P_3^4 + 4P_3^6\right) + \frac{1}{36}\alpha_{112}(9P_1^6 + 9P_1^4P_2^2 + 39P_1^2P_2^4 + 7P_2^6 - 18\sqrt{2}P_1^4P_2P_3 - 12\sqrt{2}P_1^2P_2^3P_3 + 6\sqrt{2}P_2^5P_3 - 48\sqrt{2}P_1^2P_2P_3^3 + 16\sqrt{2}P_2^3P_3^3 + 24P_1^2P_3^4 + 24P_2^2P_3^4 + 8P_3^6) + \frac{1}{108}\alpha_{123}(18P_1^4P_2^2 - 12P_1^2P_2^4 + 2P_2^6 - 18\sqrt{2}P_1^4P_2P_3 - 12\sqrt{2}P_1^2P_2^3P_3 + 6\sqrt{2}P_2^5P_3 + 9P_1^4P_2^2 + 18P_1^2P_2^2P_3^2 + 9P_2^4P_3^2 + 12\sqrt{2}P_1^2P_2P_3^3 - 4\sqrt{2}P_2^3P_3^3 - 12P_1^2P_3^4 - 12P_2^2P_3^4 + 4P_3^6) + \frac{1}{216}\alpha_{1111}\left(27P_1^8 + 252P_1^6P_2^2 + 210P_1^4P_2^4 + 28P_1^2P_2^6 + 43P_2^8 + 504\sqrt{2}P_1^6P_2P_3 + 840\sqrt{2}P_1^4P_2^3P_3 + 168\sqrt{2}P_1^2P_2^5P_3 - 168\sqrt{2}P_2^7P_3 + 504P_1^6P_3^2 + 2520P_1^4P_2^2P_3^2 + 840P_1^2P_2^4P_3^2 + 616P_2^6P_3^2 + 1680\sqrt{2}P_1^4P_2P_3^3 + 1120\sqrt{2}P_1^2P_2^3P_3^3 - 560\sqrt{2}P_2^5P_3^3 + 840P_1^4P_3^4 + 1680P_1^2P_2^2P_3^4 + 840P_2^4P_3^4 + 672\sqrt{2}P_1^2P_2P_3^5 - 224\sqrt{2}P_2^3P_3^5 + 224P_1^2P_3^6 + 224P_2^2P_3^6 + 8P_3^8\right) + \frac{1}{216}\alpha_{1112}(27P_1^8 + 72P_1^6P_2^2 + 150P_1^4P_2^4 + 128P_1^2P_2^6 + 23P_2^8 + 36\sqrt{2}P_1^6P_2P_3 + 60\sqrt{2}P_1^4P_2^3P_3 + 12\sqrt{2}P_1^2P_2^5P_3 - 12\sqrt{2}P_2^7P_3 + 90P_1^6P_3^2 - 630P_1^4P_2^2P_3^2 + 870P_1^2P_2^4P_3^2 - 10P_2^6P_3^2 - 420\sqrt{2}P_1^4P_2P_3^3 - 280\sqrt{2}P_1^2P_2^3P_3^3 + 140\sqrt{2}P_2^5P_3^3 + 60P_1^4P_3^4 + 120P_1^2P_2^2P_3^4 + 60P_2^4P_3^4 + 48\sqrt{2}P_1^2P_2P_3^5 - 16\sqrt{2}P_2^3P_3^5 + 160P_1^2P_3^6 + 160P_2^2P_3^6 + 16P_3^8) + \frac{1}{432}\alpha_{1122}\left(27P_1^8 - 36P_1^6P_2^2 + 114P_1^4P_2^4 + 188P_1^2P_2^6 + 11P_2^8 - 72\sqrt{2}P_1^6P_2P_3 - 120\sqrt{2}P_1^4P_2^3P_3 - 24\sqrt{2}P_1^2P_2^5P_3 + 24\sqrt{2}P_2^7P_3 - 72P_1^6P_3^2 + 504P_1^4P_2^2P_3^2 - 696P_1^2P_2^4P_3^2 + 8P_2^6P_3^2 + 48\sqrt{2}P_1^4P_2P_3^3 + 32\sqrt{2}P_1^2P_2^3P_3^3 - 16\sqrt{2}P_2^5P_3^3 + 96P_1^4P_3^4 + 192P_1^2P_2^2P_3^4 + 96P_2^4P_3^4 - 384\sqrt{2}P_1^2P_2P_3^5 - 128\sqrt{2}P_2^3P_3^5 + 64P_1^2P_3^6 + 64P_2^2P_3^6 + 16P_3^8\right) + \frac{1}{108}\alpha_{1123}\left(18P_1^6P_2^2 + 6P_1^4P_2^4 - 10P_1^2P_2^6 + 2P_2^8 - 18\sqrt{2}P_1^6P_2P_3 - 30\sqrt{2}P_1^4P_2^3P_3 - 6\sqrt{2}P_1^2P_2^5P_3 + 6\sqrt{2}P_2^7P_3 + 9P_1^6P_3^2 + 45P_1^4P_2^2P_3^2 + 15P_1^2P_2^4P_3^2 + 11P_2^6P_3^2 - 6\sqrt{2}P_1^4P_2P_3^3 - 4\sqrt{2}P_1^2P_2^3P_3^3 + 2\sqrt{2}P_2^5P_3^3 - 3P_1^4P_3^4 - 6P_1^2P_2^2P_3^4 - 3P_2^4P_3^4 + 12\sqrt{2}P_1^2P_2P_3^5 - 4\sqrt{2}P_2^3P_3^5 - 8P_1^2P_3^6 - 8P_2^2P_3^6 + 4P_3^8\right) - P_1E_1 - P_2E_2 - P_3E_3 \quad \text{(S3)}$$