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$BaTiO_3$系、PLZT セラミックスの焦電特性と電気熱量効果

Pyropelectric properties and electrocaloric effects of $BaTiO_3$-based and PLZT ceramics

湘南工大工[1]　○眞岩 宏司[1]

Shonan Inst. Tech.[1]　°Hiroshi Maiwa[1]

E-mail: maiwa@mate.shonan-it.acjp

Thermal energy harvesting using non-linear pyroelectric effects in PLZT ceramics, $Ba(Zr_{0.2}Ti_{0.8})O_3$ and $(Ba_{0.8}Sr_{0.2})TiO_3$, PMN-PT crystals were investigated. PLZT ceramics with Tc of 140°C exhibited large energy generation of 54.8 J/L/cycle with temperature variations from 30°C to 200°C and field variations from 0 to 20kV/cm. $Ba(Zr_{0.2}Ti_{0.8})O_3$ ceramics with Tc of 40°C exhibited energy generation of 58.6 J/L/cycle with temperature variations from 30°C to 125°C and field variations from 0 to 20kV/cm. The generated energies of the samples are shown in Fig. 1.

The electrocaloric effect is a phenomenon in which a material shows a reversible temperature change under an applied electric field. In order to create ECE cooling devices, materials with large ECEs are required. The electrocaloric temperature change ΔT due to applied ΔE is calculated from the following equation. Here, C and ρ are the specific heat and the density, respectively.

$$\Delta T = -\frac{1}{C\rho}\int_{E1}^{E2} T\left(\frac{\partial P}{\partial T}\right)_E dE \qquad (1)$$

The electrocaloric temperature changes ΔT due to applied ΔE were measured. PLZT ceramics exhibited relatively large change of polarizations with temperature, as shown in Fig. 2, and ΔT of 0.2K at room temperature under a bipolar switching field of 20kV/cm.

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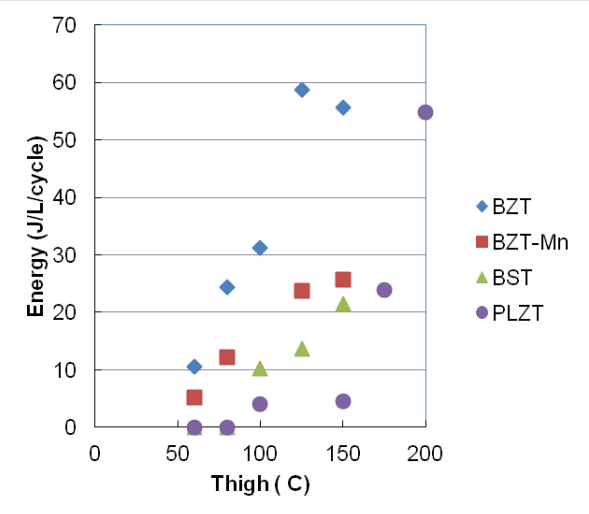

Fig. 1 Non-linear pyroelectric effect of $BaTiO_3$-based and PLZT ceramics.

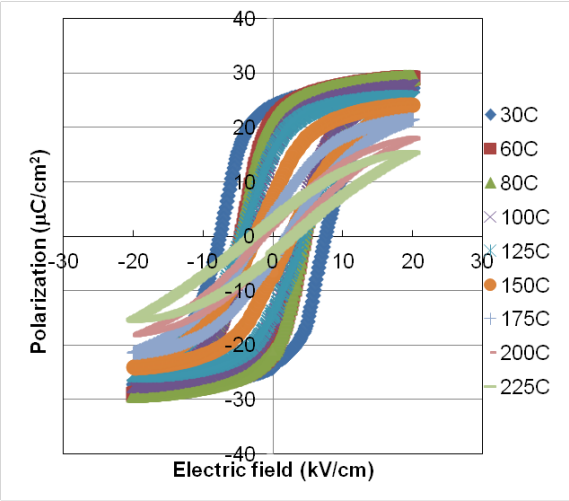

Fig. 2 P-E loops of PLZT ceramics at various temperatures.