Electrocaloric Effects and Temperature Distribution Analysis of $BaTiO_3$-based Ceramics and Multi-layer Capacitor

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The electrocaloric effect (ECE) is a phenomenon in which a material shows a reversible temperature change under an applied electric field. There has been some problem in the conventional refrigerator. Since the conventional refrigerator operates by using a compressor, vibration generation is inevitable. The other disadvantage includes the difficulty in down-scaling. Thermoelectric cooling using the Peltier device has been considered as a solid state cooling device; however, low efficiency has been a hindrance to the wide applications. From the viewpoint of the refrigerator innovation, new refrigerators based on the new mechanism are expected. ECE is considered to be one of the new cooling mechanisms. By using ECE, the application to compact a high energy-effective, inexpensive, and safe refrigerator would be considered. In order to create ECE cooling devices, materials with large ECEs are required. For direct measurement of the ΔT, there are some difficulties. Most probably due to these difficulties, the reports on the direct measurement of ΔT are limited thus far.

In this study, the electrocaloric temperature change, ΔT, due to applied ΔE, of the $BaTiO_3$-based ceramics is estimated and directly measured. Figure 1 shows temperature-electric field (T-E) loops of the $Ba(Zr,Ti)O_3$ ceramics and $BaTiO_3$-based multi-layer capacitor. The comparison with the estimations from indirect approach based on Maxwell's equation will be discussed. And temperature distribution analysis of the $BaTiO_3$-based multi-layer capacitor will be discussed for the realization of the cooling devices.

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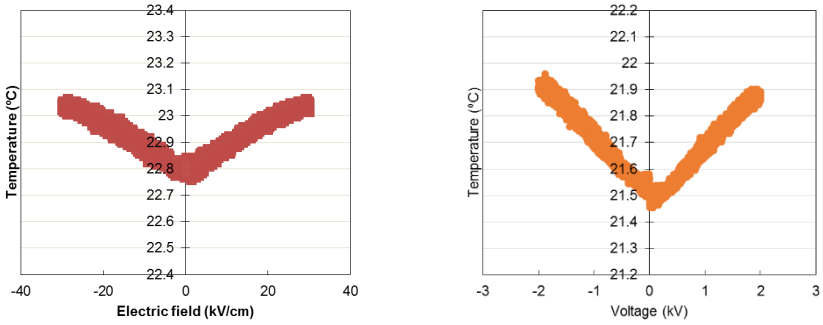

Fig. 1. Temperature-electric field (T-E) loops of the $Ba(Zr,Ti)O_3$ ceramics and $BaTiO_3$-based multi-layer capacitor

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