The electrocaloric effect (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 $\Delta T$, there are some difficulties. Most temperature changes are less than 1K. And heat dissipation from ferroelectric materials through electrode, wire, and/or the supporting jig for field application occurs. Most probably due to these difficulties, the reports on the direct measurement of $\Delta T$ are limited thus far. In this study, the electrocaloric temperature change, $\Delta T$, due to applied $\Delta E$, of the $\text{BaTiO}_3$ ceramics is estimated and directly measured. Electrocaloric properties were investigated by indirect estimation and direct measurement of temperature–electric field ($T$–$E$) hysteresis loops. The measured $T$-$E$ loops showed a similar shape to strain–electric field ($s$–$E$) loops. The measured temperature changes $\Delta T$ of the $(\text{Ba},\text{Sr})\text{TiO}_3$ ceramics sintered at 1600°C upon the release of the electric field from 30 kV/cm to zero was 0.57K at 30°C. The temperature dependences of the electromechanical and electrocaloric properties were investigated. Fig. 1 shows $T$–$E$ loops from the $(\text{Ba},\text{Sr})\text{TiO}_3$ ceramics. BST is more temperature dependent compared with $\text{Ba(Zr,Ti)}_3\text{O}_9$ (BZT). BST ceramics sintered at 1600°C exhibited the largest the electromechanical and electrocaloric properties at around 30°C. This temperature corresponds to the temperature around 10°C higher than the phase transition temperature. This study is partly supported by grant from KAKENHI #26420684, from the Ministry of Education, Culture, Sports, Science and Technology.

References