Electrocaloric multilayer capacitors on the base of lead magnesium niobate–lead scandium niobate

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ABSTRACT

Electrocaloric and pyroelectric effects of the relaxor 0.55Pb-Mg1/3Nb2/3O3–0.45PbSc1/2Nb1/2O3 (PMN–PSN) bulk and multilayer ceramic (MLC) structures in their connection with the microstructure are reported. The electrocaloric measurements were performed using the mid-infrared radiation (MIR) technique developed and introduced by the authors. The comparison of the electrocaloric temperature change δT and pyroelectric coefficient p vs temperature dependences of bulk and MLC samples shows a large difference in their temperature behavior. It is shown that significant smearing of these dependences is determined by the microstructure (grain size and grain size distribution) of both bulk and MLC samples. The predicted cooling power of the PMN–PSN MLC can reach Qmax = 1370 mW with reasonable MLC geometry (the number of layers n = 200, the effective length of L = 3.3 mm) and taking into account experimentally obtained δT = 1.2 °C at a relatively low electric field of 68 kV/cm. Both large values for δT at ambient temperatures and the estimated cooling power characterize the PMN–PSN MLC as a promising unit for electrocaloric cooling devices.