Electrocaloric Ceramic Multilayer Modules – A Critical Step In Realizing High Performance Electrocaloric Cooling Devices

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A critical step in transitioning the electrocaloric (EC) materials with large EC response invented recently to the electrocaloric cooling devices of high performance is to develop EC multilayer (ML) modules which can be operated at high electric field with high reliability. This talk will present a recent work in developing electrocaloric ceramics multilayer modules, employing the commercial multilayer ceramic capacitor (MLCC) fabrication technology.

We first investigate the electrocaloric ceramics based on $Ba(Zr_xTi_{1-x})O_3$, which are ceramic compositions suitable for fabricating EC ceramic multilayers using MLCC technology. $Ba(Zr_xTi_{1-x})O_3$ (BZT) exhibits an invariant critical point at $x \sim 0.2$, generating a large ECE due to multi-polar state coexistence and near critical transition behavior. We show that the ECE can be further enhanced, where an adiabatic temperature change of near 7 K can be induced under 20 MV/m near room temperature over a broad temperature range, by employing suitable sintering aides which reduce the sintering temperature, which makes it easier for EC multilayer fabrication with MLCC technology. EC ML modules with modified BZT were fabricated utilizing the commercial MLCC technology. The EC MLs thus fabricated can be operated at high electric field and consequently generate a large EC response.