Cubic Pyrochlore Bismuth Zinc Niobate Thin Films for High-Temperature Dielectric Energy Storage

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Thin films of cubic pyrochlore bismuth zinc niobate, a lead-free dielectric, were fabricated using a solution chemistry based upon the Pechini method. Scanning electron microscopy confirmed that the films are smooth and mostly dense. The films exhibit a dielectric constant of 145 ± 5, a low dielectric loss of 0.00065 ± 0.0001, and a room temperature, 1 kHz maximum field of approximately 4.7 MV/cm. At frequencies of 100 Hz and 10 kHz, the maximum field sustained by the material increased to 5.0 MV/cm and 5.1 MV/cm, although the dielectric loss increased to 0.0065 ± 0.001. At a measurement frequency of 10 kHz, the maximum energy storage density was ~60.8 ± 2.0 J/cm^3, while at a measurement frequency of 100 Hz, the maximum energy storage was ~46.7 ± 1.7 J/cm^3. As the temperature was increased to 200°C, the breakdown strength of the films decreased, while the loss tangent remained modest. At 200°C and a measurement frequency of 100 Hz, the maximum energy storage density was ~23.1 ± 0.8 J/cm^3, and at 10 kHz, the maximum energy storage density was ~27.3 ± 1.0 J/cm^3.