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BaTiO₃ Glass-Ceramics Composites For High Energy Storage Capacitors

Abstract:

Renewable energy sources require large-scale power storage so that their inherently intermittent supply of power can meet demand. For capacitive energy to have the necessary high volumetric and gravimetric energy storage density this will require the dielectric layer to simultaneously possess a high dielectric constant and a high breakdown strength, e.g., in excess of 10,000 and 1 MV/cm, respectively. To be a realistic solution for renewable energy storage, it must also be low cost and scalable, i.e., no roadblocks from the laboratory prototype to large scale production, and to achieve the all of the aforementioned requirements we have exploited a glass-ceramic phase. It is expected that glass-ceramics composites will have higher breakdown strength than that of a sintered ceramic alone, because the glass would displace the air-filled voids. Due to the dielectric mixing rule, the dielectric constant of the composite mixture will then be limited by the low permittivity of the glass phase in comparison to the ceramic phase. In our work, we use a glass phase that can undergo a phase transformation into BaTiO₃-precipitating glass-ceramic by controlled crystallization (annealing temperature). The benefit of doing this is that we achieve a higher dielectric constant of composite mixture, due to the additional high dielectric constant BaTiO₃ phase, while also improving the high breakdown strength. It was demonstrated that this BaTiO₃-precipitating glass-ceramic and BaTiO₃ ceramic composite are promising for improved dielectric properties for high-density energy storage capacitors.

Bio:

Professor Douglas B. Chrisey is a Professor of Materials Science and Biomedical Engineering at Rensselaer Polytechnic Institute. After receiving his Ph.D. in Engineering Physics from the University of Virginia in 1987 he spent the next 17 years at the U.S. Naval Research Laboratory. He joined RPI in 2006 after spending 2005 as the Deputy Director of the North Dakota State University Center for Nanoscale Science and Engineering. His current research interests include the laser fabrication of thin films for advanced electronics, sensors, biomaterials, and energy storage. These materials are used as prototypes in disparate device configurations for testing and typically have an improved figure-of-merit. His research has resulted in more than 400 citable publications and nearly 8,000 citations and he has an h-index of 48 and 18 granted patents.