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Dielectric Bilayer Films Comprising Polar Cyanolated Silica Sol-Gel and Nanoscale Blocking Layer for Energy Storage Applications MOHANALINGAM KATHAPERUMAL, YUNSANG KIM, O'NEIL SMITH, School of Chem and Biochem, Georgia Inst Tech, AMIR DINDAR, CANEK FUENTES-HERNANDEZ, DO-KYUNG HWANG, School of Electrical and Computer Engineering, Georgia Inst Tech, MING-JEN PAN, Naval Research Laboratory, BERNARD KIPPELEN, School of Electrical and Computer Engineering, Georgia Inst Tech, JOSEPH PERRY, School of Chem and Biochem, Georgia Inst Tech — Organic-inorganic hybrid sol-gel containing polar groups, which can undergo orientational polarization under the influence of an electric field, provide a potential route to processable and rational design of materials for energy storage applications. However, the porous nature of sol-gel films, which significantly lowers breakdown strength, limits the potential of this material for energy storage particularly in high-field applications. In this work, we fabricate and characterize dielectric bilayer films comprising cyanolated silica sol-gel film prepared from 2-cyanoethyltrimethoxysilane (CNETMS) precursor and nanoscale blocking layers, which include amorphous fluoropolymer, SiO_2, Al_2O_3 and ZrO_2 deposited by spin casting, electron beam evaporation or atomic layer deposition (ALD). CNETMS films with 50 nm ZrO_2 blocking layer exhibit an extractable energy density of 13 J/cm^3, which is about a twofold enhancement compared to CNETMS films without blocking layer. The effect of the blocking layer will be discussed in terms of surface morphology, dielectric contrast, i.e. the ratio of relative permittivity between oxide layer and sol-gel film, electric field distribution, breakdown strength and statistics, bias polarity, and loss of the bilayer films.

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