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Authors: Minh D. Nguyen, Chi T.Q. Nguyen, Hung N. Vu, Guus Rijnders

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Controlling microstructure and film growth of relaxor-ferroelectric thin films for high break-down strength and energy-storage performance

Minh D. Nguyen[1,2,*], Chi T. Q. Nguyen[2,3], Hung N. Vu[2], and Guus Rijnders[1]

[1]MESA+ Institute for Nanotechnology, University of Twente, P.O. Box 217, 7500AE Enschede, The Netherlands

[2]International Training Institute for Materials Science (ITIMS), Hanoi University of Science and Technology, No. 1 Dai Co Viet road, Hanoi 10000, Vietnam

[3]Vietnam National University of Forestry, Chuong My district, Hanoi 10000, Vietnam

* E-mail: d.m.nguyen@utwente.nl

Abstract:

The relaxor ferroelectric $Pb_{0.9}La_{0.1}(Zr_{0.52}Ti_{0.48})O_3$ (PLZT) thin films were deposited using pulsed laser deposition, and their microstructures, break-down field strengths and energy storage performances were investigated as a function of the buffer layer and electrode. A large recoverable energy-storage density (U_{reco}) of 23.2 J/cm^3 and high energy-storage efficiency (η) of 91.6% obtained in the epitaxial PLZT film grown on $SrRuO_3/SrTiO_3/Si$ are much higher than those in the textured PLZT film (U_{reco} = 21.9 J/cm^3, η = 87.8%) on $SrRuO_3/Ca_2Nb_3O_{10}$-nanosheet/Si and the polycrystalline PLZT film (U_{reco} = 17.6 J/cm^3, η = 82.6%) on $Pt/Ti/SiO_2/Si$, under the same condition of 1500 kV/cm and 1 kHz, due to the slim polarization loop and significant antiferroelectric-like behavior. Owing to the high break-down strength (BDS) of 2500 kV/cm, a giant U_{reco} value of 40.2 J/cm^3 was obtained for the epitaxial PLZT film, in which U_{reco} values of 28.4 J/cm^3 (at BDS of 2000 kV/cm) and 20.2 J/cm^3 (at BDS of 1700 kV/cm), respectively, were obtained in the textured and polycrystalline