Depolarizing Field and “Real” Hysteresis Loops in Nanometer Scale Ferroelectric Films

A.M. BRATKOVSKY, Hewlett-Packard Laboratories, Palo Alto, A.P. LEVANYUK, U Autonoma, Madrid — We give detailed analysis of the effect of depolarizing field in nanometer-size ferroelectric capacitors studied by Kim et al. [Phys. Rev. Lett. 95, 237602 (2005)]. We calculate a critical thickness of the homogeneous state and its stability with respect to domain formation for strained thin films of BaTiO$_3$ on SrRuO$_3$/SrTiO$_3$ substrate within the Landau theory. While the former (2.5nm) is the same as given by ab-initio calculations, the actual critical thickness is set by the domains at 1.6nm [1]. There is a large Merz’s activation field for polarization relaxation. Remarkably, the results show a negative slope of the “actual” hysteresis loops, a hallmark of the domain structures in ideal thin films with imperfect screening[2].