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Switching behavior and scaling effects in ferroelectric capacitors

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In this presentation, we discuss the results of direct time-space resolved studies of domain switching behavior in micrometer capacitors by means of piezoresponse force microscopy (PFM). The PFM approach allows an insight in the mechanism of polarization reversal and its change as a function of the capacitor size and microstructure. Simultaneous visualization of the instantaneous domain configurations arising during polarization reversal and sub-ms transient current measurements allow us to establish direct relationship between the electrically measured polarization reversal signal and domain switching kinetics and determine the relative contribution of nucleation and wall motion mechanisms into polarization reversal as a function of capacitor size. Effect of microstructure on domain switching kinetics has been studied by comparing the switching behavior of polycrystalline and epitaxial capacitors. It is shown that in epitaxial capacitors the domain kinetics can be described by the classic nucleation model. In the polycrystalline capacitors, interaction of moving domain walls with microstructural defects gives rise to a completely different time dependence of polarization due to a wide distribution of local switching times. In this case the domain kinetics can be fitted by nucleation-limited switching model.