Ferroelectric memories have traditionally been limited in their density by the number of states in which the electric polarization vector can be oriented. The number of states is defined by the symmetry of the material. By decoupling the polarization from the symmetry on a mesoscopic scale, we show that we can create a switched spectrum of states, and that the polarization can be oriented at any in-plane angle through controlled writing by an atomic force microscope tip in a composite Bi$_5$Ti$_3$FeO$_{15}$-CoFe$_2$O$_4$ ferroelectric film. Through high resolution piezoresponse force microscopy imaging, it is found that the surface consists of a wealth of sub-50nm nanodomains, which could facilitate this rotation on the mesoscopic scale. The cause of disorder appears to be the CoFe$_2$O$_4$ inclusions, with electron microscopy showing very large stresses imparted on the Bi$_5$Ti$_3$FeO$_{15}$ matrix resulting in characteristic strain undulations through the matrix, and dislocations at the interface. In addition to opening the possibility for larger densities of ferroelectric memories, these studies give more understanding pertaining to theories of large electromechanical response in particular classes of ferroelectrics materials, such as those near morphotropic phase boundaries, and relaxor ferroics.

Reference

“Deterministic arbitrary switching of polarization in a ferroelectric thin film”
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Nature Communications 5, 4971 (2014). DOI: 10.1038/ncomms5971

Acknowledgment of Support
This research was sponsored by the Division of Materials Sciences and Engineering (R.K.V., S.V.K.) of BES, DOE. A portion of this research was conducted at the Center for Nanophase Materials Sciences, which is sponsored at Oak Ridge National Laboratory by the Scientific User Facilities Division, Office of Basic Energy Sciences, U.S. Department of Energy. V.N., X.C. and A.I. thank the Australian Research Council Discovery and LIEF projects. We also acknowledge funding partly by Industrial Technology Research Grant Program in 2007 from New Energy and Industrial Technology Development Organization (NEDO) of Japan, the Integrated Doctoral Education Program at Tokyo Tech, and Sumitomo Foundation. Image processing made use of capabilities at the Center for Functional Nanomaterials, Brookhaven National Laboratory, which is supported by the U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. DE-AC02-98CH10886.