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Equilateral triangular ferroelectric closure domains in (111)-oriented epitaxial Pb(Zr,Ti)O_3 thin films SANG MO YANG, Y.J. SHIN, T.W. NOH, CFI-CES, Institute for Basic Science, and Dept. of Physics & Astronomy, Seoul Nat'l Univ., Seoul, Korea, Y. EHARA, H. FUNAKUBO, Dept. of Innovative and Engineered Material, Tokyo Institute of Technology, Yokohama, Japan, J.-G. YOON, Dept. of Physics, Univ. of Suwon, Hwaseong, Gyunggi-do, Korea, J.F. SCOTT, Dept. of Physics, Cavendish Laboratory, Univ. of Cambridge, Cambridge, UK — Over 60 years ago, Charles Kittel predicted that intriguing quadrant flux-closure domains could spontaneously form in small ferromagnetic platelets [1]. Such quadrant flux-closure domains are considered as a precursor for the true vortex states, having attracted particular interest for storing memory devices. Although the vortex states are now ubiquitous and rather well understood in ferromagnets, even the flux-closure domains as their precursors are much less established in ferroelectrics (FEs) [2]. Here we report the generation of novel equilateral triangular FE closure domains. We generated such intriguing states by using the high crystalline anisotropy energy of a (111)-oriented epitaxial $PbZr_{0.35}Ti_{0.65}O_3$ thin film. Vector piezoresponse force microscopy analysis showed clearly the equilateral triangular closure states, consisting of three stripe domain bundles with three 120 degree orientation differences. Interestingly, the observed two closure states had the different rotation direction around the core, i.e., clockwise and anti-clockwise.

[1] C. Kittel, Rev. Mod. Phys. 21, 541 (1949);
[2] G. Catalan et al., Rev. Mod. Phys. 84, 119 (2012)

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