Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Vortex Ferroelectric Domains, Large-loop Weak Ferromagnetic Domains, and Their Decoupling in Hexagonal LuFeO3[1] KAI DU, BIN GAO, YAZHONG WANG, RONGWEI HU, FEI-TING HUANG, SANG-WOOK CHEONG, Rutgers Univ — The direct domain coupling of spontaneous ferroelectric polarization and magnetic moment can result in giant magnetoelectric coupling, which is essential to achieve mutual controls and real applications of multiferroics. Recently, the possible bulk domain coupling of ferroelectricity(FE) and weak ferromagnetism(WFM) has been theoretically predicted in hexagonal LuFeO3(h-LuFeO3). Thus, it is important to experimentally study the possibility of this effect. Here, we report the successful growth of Sc-stabilized h-LuFeO3 single crystals, as well as the first time visualization of their cloverleaf pattern of vortex FE domains and large-loop WFM domains. FE and WFM domains are distinct regarding the size and shape. There exists no interlocking of FE and WFM domain walls. These demonstrate the decoupling between FE and WFM in h-LuFeO3, which is in contrast to the theoretical prediction. This domain decoupling can be explained as the consequence of the structure-mediated coupling between polarization and in-plane antiferromagnetic spins. Our results indicate the magnetic topological charge tends to be identical with structural topological charge. These discoveries could provide new insights into inducing direct domain coupling between FE and WFM mediated through structural distortion.

[1]This work was supported by the Gordon and Betty Moore Foundations EPiQS Initiative through Grant GBMF4413 to the Rutgers Center for Emergent Materials.

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Date submitted: 11 Nov 2016 Electronic form version 1.4