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**Low-energy Structural Dynamics of Multiferroic Domain Walls in Hexagonal Rare-earth Manganites** XIAOYU WU, University of Texas at Austin, URKO PETRALANDA, Istituto Italiano di Tecnologia, LU ZHENG, YUAN REN, University of Texas at Austin, RONGWEI HU, SANG-WOOK CHEONG, Rutgers University, SERGEY ARTYUKHIN, Istituto Italiano di Tecnologia, KEJI LAI, University of Texas at Austin — Multiferroic domain walls (DWs), the natural interfaces between domains with different order parameters, usually exhibit unconventional functionalities. For instance, recent discovery of the ferroelectric DW conduction highlights its extraordinary electronic structure that is absent in bulk domains. The structural dynamics of individual DWs in the microwave regime, however, have not been fully explored due to the lack of spatially resolved studies. Here, we report the broadband ($10^6$–$10^{10}$ Hz) scanning impedance microscopy results on the interlocked anti-phase boundaries and ferroelectric DWs in hexagonal rare-earth manganites. Surprisingly, the effective conductivity of the (001) DWs displays a $10^6$-fold increase from dc to GHz frequencies, while the effect is absent on surfaces with in-plane polarized domains. First-principles and model calculations indicate that the frequency range and selection rules are consistent with the periodic sliding of the DW around its equilibrium position. This DW acoustic-wave-like mode, which is associated with the synchronized oscillation of local polarization and apical oxygen atoms, is localized perpendicular to the DW but free to propagate along the DW plane. Our results break the ground to understand structural DW dynamics and exploit new interfacial phenomena for novel devices.

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