KFM 19: Ferroics – Domains and Domain Walls 2

Chair: Dr. Jan Schultheiß (Augsburg University, NTNU Trondheim)

Time: Wednesday 15:00–16:00 Location: H7

KFM 19.1 Wed 15:00 H7

Phase Field Simulations of the Dipolar Interaction in Hexagonal Manganites — •Aaron Merlin Müller, Amadé Bortis, Manfred Fiebig, and Thomas Lottermoser — Department of Materials, ETH Zurich, 8093 Zurich, Switzerland

We introduce a phase-field method that allows simulation of dipolar interaction in thin-film hexagonal manganites and investigate its effect on the unconventional ferroelectric vortex domain pattern of the material. Dipolar interactions are assumed to have negligible influence because of the improper nature of the ferroelectric order. Hence, dipolar interactions are commonly neglected when modeling such systems. Efficiently incorporating dipolar interactions of out-of-plane-oriented dipoles in phase-field methods is challenging as they represent a nonlocal Coulomb contribution to the free energy. In addition, the Coulomb interaction of a polarization field diverges at zero distance, unlike for atomistic dipole models. In our work, we show that including the dipolar interaction in the phase-field method results in more regular shaped domains in comparison to simulations that ignore the dipolar interaction, with lower variance in domain size. The ferroelectric domains of our revised approach resemble the experimentally observed patterns more closely. Hence, our work gives insights on the often neglected effects of dipolar interaction and the resulting depolarizing field on ferroelectric domains in an important class of improper ferroelectric materials.

KFM 19.2 Wed 15:20 H7

Dynamics of the electrocaloric effect in ferroelectric materials — •Jan Fischer, Daniel Hägele, and Jörg Rudolph — Ruhr-Universität Bochum, Faculty of Physics and Astronomy, Experimental Physics VI (AG), Germany

The electrocaloric effect (ECE) in ferroelectrics is a promising candidate for energy efficient cooling technologies. The ECE leads to a reversible adiabatic temperature change ΔT of a ferroelectric material upon a change of an external electric field. The reliable determination of the adiabatic ΔT is, however, experimentally challenging and most studies use either indirect methods which are prone to artifacts, or comparably slow direct methods. The dynamics of the ECE has therefore not been systematically studied so far. Here, we introduce a direct and contactless method to study the full dynamics $\Delta T(t)$ of the ECE with μK temperature resolution and μs temporal resolution via the infrared emission of the sample. The simultaneous recording of transients for $\Delta T(t)$, applied electric field $E(t)$, and induced polarization $P(t)$ gives the opportunity to correlate the caloric properties with the dielectric properties thus opening perspectives for a fundamental understanding of the ECE also in complex materials like relaxor ferroelectrics. Our techniques allows also for high-frequency measurements as needed for adiabatic measurements in thin films.[1,2] We will discuss several examples ranging from bulk materials to thin films.

[1] J., Döntgen, *et al.*, Applied Physics Letters 106, 3 (2015)
[2] J., Döntgen, *et al.*, Energy Technology 6, 8 (2018)

KFM 19.3 Wed 15:40 H7

Interfacial Stabilization of Homochiral Ferroelectric Domain Walls in $BiFeO_3$ — •Elzbieta Gradauskaite[1], Quintin N. Meier[2], Natascha Gray[1], Marco Campanini[3], Marta D. Rossell[3], Manfred Fiebig[1], and Morgan Trassin[1] — [1]Department of Materials, ETH Zurich, Switzerland — [2]CEA Grenoble, LITEN, Grenoble, France — [3]Electron Microscopy Center, Empa, Switzerland

Chirality is a concept central to all molecular interactions in biological systems. In the last decade its importance was also highlighted in condensed-matter physics, where spin textures at the homochiral ferromagnetic domain walls were shown to enable their deterministic current-driven motion. Nevertheless, only a few reports on polar chirality exist to this date, prompting increased research efforts on this important issue. Here, we report the stabilization of net chirality in $BiFeO_3$ ferroelectric films grown on a fully in-plane-polarized ferroelectric layer of the Aurivillius phase. By introducing an in-plane-polarized epitaxial buffer we create polarization continuity and provide a symmetry breaking at the interface with the out-of-plane polarized $BiFeO_3$. Scanning probe microscopy uncovers the stabilization of conceptually novel 251° domain walls in $BiFeO_3$. Their unusual chirality is likely associated with the ferroelectric analog to the Dzyaloshinskii-Moriya interaction in magnets. Thus, we demonstrate a simple design combining perpendicular polar anisotropies for the effective stabilization of homochiral textures in ferroelectric thin films.