KFM 7: Dielectric, Elastic and Electromechanical Properties

Chairman: Stephan Krohns (University of Augsburg)

Time: Wednesday 10:00–10:45 Location: H1

KFM 7.1 Wed 10:00 H1

Tunable Graphene Phononic Crystal — •Jan Niklas Kirchhof[1], Kristina Weinel[1,2], Sebastian Heeg[1], Victor Deinhart[2,3], Sviatoslav Kovalchuk[1], Katja Höflich[2,3], and Kirill I. Bolotin[1] — [1]Department of Physics, Freie Universität Berlin, Germany — [2]Ferdinand-Braun-Institut, Berlin, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany,

In the field of phononics, periodic patterning controls vibrations and thereby the flow of heat and sound in matter. Bandgaps arising in such phononic crystals (PnCs) realize low-dissipation vibrational modes and enable applications towards mechanical qubits, efficient waveguides, and state-of-the-art sensing. Here, we combine phononics and two-dimensional materials and explore tuning of PnCs via applied mechanical pressure. To this end, we fabricate the thinnest possible PnC from monolayer graphene and simulate its vibrational properties. We find a bandgap in the MHz regime, within which we localize a defect mode with a small effective mass of 0.72 ag = 0.002 $m_{physical}$. We exploit graphene's flexibility and simulate mechanical tuning of a finite size PnC. Under electrostatic pressure up to 30 kPa, we observe an upshift in frequency of the entire phononic system by $\sim$ 350%. At the same time, the defect mode stays within the bandgap and remains localized, suggesting a high-quality, dynamically tunable mechanical system.

KFM 7.2 Wed 10:15 H1

Multi-step stochastic polarization reversal in orthorhombic ferroelectrics — Yuri Genenko[1], Maohua Zhang[1], •Ivan Vorotiahin[1], Ruben Khachaturyan[2], Yi-Xuan Liu[3], Ke Wang[3], and Jurij Koruza[1] — [1]Institute für Materialwissenschaft, Technische Universität Darmstadt, Darmstadt, Germany — [2]Interdisciplinary Center for Advanced Materials Simulation, Ruhr-Universität Bochum, Bochum, Germany — [3]State Key Laboratory of New Ceramics and Fine Processing, School of Materials Science and Engineering, Tsinghua University, Beijing, China

Polarization switching under applied electric fields is an important property of ferroelectrics, being crucial for the operation of the data storage FeRAM-devices and for setting up properties of piezoelectric films. Mathematical models such as KAI, NLS and IFM help understand underlying mechanisms and parameters of switching processes. Moving to structures with lower symmetries, there is a need for more complex models to describe the switching events.

A stochastic model has been developed to describe the multistep switching behaviour of a potassium sodium niobate (KNN)-based orthorhombic ceramic sample. The polarization and strain changes were measured over a large time scale and a wide range of applied electric fields. The switching paths for one-, two- and three-step processes were isolated, and the existence of coherent switching events over the multidomain structures was confirmed. The predicted and detected parameters of the processes give us a glimpse into the properties of the orthorhombic KNN materials family.

KFM 7.3 Wed 10:30 H1

Symmetry breaking by 4f-electron ordering in $NdGaO_3$ — •Lea Forster[1], Katrin Fürsich[2], Eva Benckiser[2], Thomas Lottermoser[1], Manfred Fiebig[1], and Mads C. Weber[1] — [1]ETH Zurich, Switzerland — [2]MPI Stuttgart, Germany

Despite intense investigations, the low temperature behavior of 4f electrons in neodymium gallate, $NdGaO_3$, is not fully understood. Several studies suggest that the 4f electrons affect the physical properties of $NdGaO_3$ at low temperature, and even a potential structural phase transition has been discussed in light of Raman measurements [1]. In this study, we shed light on these anomalies. We applied optical second harmonic generation (SHG), a highly symmetry-sensitive technique. Furthermore, SHG spectroscopy also gives us an insight into the physical origin of the anomalies. We reveal a strong SHG signal of $NdGaO_3$ characterized by many spectrally sharp features with increasing intensity toward low temperatures. While the spectral signature identifies the features as 4f transitions, our symmetry analysis reveals a lower symmetry with respect to the expected *Pbnm* phase of $NdGaO_3$. We therefore conclude that an orbital ordering of the 4f electrons gives rise to a symmetry breaking in $NdGaO_3$. This result raises the question whether a similar effect could also appear in other rare-earth compounds.

[1] B. K. De *et al.*, PRB **103**, 054106 (2021).