# New approaches to understand conductive and polar domain walls by Raman spectroscopy and low energy electron microscopy

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**Abstract**

We investigate the structural and electronic properties of domain walls to achieve a better understanding of the conduction mechanisms in domain walls of lithium niobate and the polarity of domain walls in calcium titanate.

In a first part, we discuss the interaction between defects and domain walls in lithium niobate. A dielectric resonance with a low activation energy is observed, which vanishes under thermal annealing in monodomain samples while it remains stable in periodically poled samples. Therefore we propose that domain walls stabilize polaronic states. We also report the evolution of Raman modes with increasing amount of magnesium in congruent lithium niobate. We identified specific frequency shifts of the modes at the domain walls. The domains walls appear then as spaces where polar defects are stabilized.

In a second step, we use mirror electron microscopy (MEM) and low energy electron microscopy (LEEM) to characterize the domains and domain walls at the surface of magnesium-doped lithium niobate. We demonstrate that out of focus settings can be used to determine the domain polarization. At domain walls, a local stray, lateral electric field arising from different surface charge states is observed.

In a second part, we investigate the polarity of domain walls in calcium titanate. We use resonant piezoelectric spectroscopy to detect elastic resonances induced by an electric field, which is interpreted as a piezoelectric response of the walls. A direct image of the domain walls in calcium titanate is also obtained by LEEM, showing a clear contrast in surface potential between domains and walls. This contrast is observed to change reversibly upon electron irradiation due to the screening of polarization charges at domain walls.