Manipulating the DWC in Bulk $LiNbO_3$

C. Razzaghi , M. Becker, and E. Soergel *
University of Bonn
Nussallee 12, Bonn, Germany, 53115
*Elisabeth Soergel: soergel@uni-bonn.de

Lithium niobate ($LiNbO_3$), as well as its crystallographic isomorph confrère Lithium tantalate ($LiTaO_3$), possess a unique combination of electro-optical, acoustic, ferroelectric, piezoelectric, pyroelectric and non-linear optical properties. Both materials enjoy great popularity in applications such as surface acoustic wave devices or pyroelectric sensors for motion detectors. But also domain-engineered crystals have found their way into relevant applications – the most prominent example being PPLN (periodically poled lithium niobate) which is used for efficient frequency conversion thereby taking advantage of quasi-phase-matching.
Unsurprisingly, both, $LiNbO_3$ and $LiTaO_3$ are mass-produced and are thus commercially available in constant quality, both as single-domain wafers but also with periodic poling (periodicities in the µm-range). Since LN and LT basically allow only for 180° domains, the domain-walls in these materials are best defined, the only uncertain parameter being a possible slight inclination (of few degrees at most) with respect to the preferred crystallographic z-axis. Surprisingly, research on domain wall conductivity (DWC) in $LiNbO_3$ and $LiTaO_3$ lives a shadowy existence – the exponentially exploding research on DWC seems having circumvented the most obvious materials, namely those exhibiting commercially engineered domain walls. Indeed, it is about time to investigate DWC in these materials!

Actually, recording DWC using today's standard tool, namely c-AFM, it becomes plausible why the above-mentioned crystals have been put in second place: the amplitudes of the currents measured in commercially available domain-engineered crystals are extremely small. A first approach for obtaining an increased DWC is thus the fabrication of crystals with a larger inclination of the domain walls with respect to the crystallographic z-axis, the charging of the domain walls being assumed to be the crucial parameter for DWC. Upon a series of drawbacks followed by a wealth interesting findings, we are now able to create domain-walls which show a highly increased conductivity paving the way towards realistic applications.