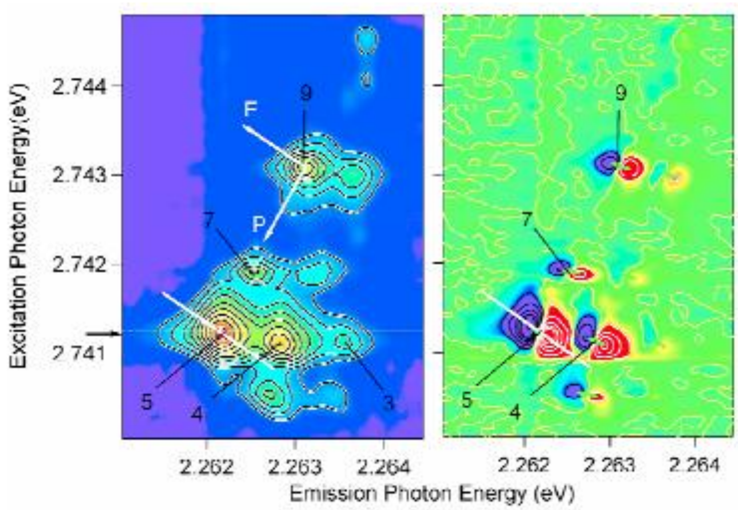
Submicron Ferroelectric Domain Patterning with Real-Time Feedback (DoD, ARL-ARO)

Controlling domain structures in ferroelectric materials is key to many practical uses of this class of materials. Although ferroelectrics such as $LiNbO_3$ and $LiTaO_3$ are critical components in a wide range of current and future technological applications, such as wavelength converters, laser scanners, all optical switches, and non-linear photonic band-gap devices, current understanding is quite limited, especially concerning the role of defects in domain reversals and their dramatic influence on coercive fields. The goal of the research is to develop real time diagnostic tools to monitor the creation of fine (submicron size) domain patterns and to advance fundamental understanding of the static and dynamic interaction between atomic size defects and the interface between domains of opposite orientations. For that purpose, a new method that uses the atomic–scale sensitivity of intentionally doped probe ions, such as rare earth ions has been developed. Real-time diagnostic tools to monitor the creation of fine (submicron size) domain patterns in ferroelectrics such as lithium niobate and tantalate are being developed to advance fundamental understanding of the static and dynamic interaction between atomic size defects and the interface between domains of opposite orientations. The spatial resolution of the rare earth based imaging technique has been reduced to the nanoscale (100nm). Another unique capability, domain imaging using confocal Raman spectroscopy was demonstrated. To further the goal of obtaining real-time feedback in electron beam writing of domain patterns, the cathodoluminescence of a wide range of rare earth ions was measured and clarified the origin of a pronounced saturation process occurring under intense electron beam irradiation.



Contour/Image plot of combined excitation emission data for Er in nearly stoichiometric LiNbO at 4K.

V. Dierolf, C. Sandmann, and P. Capek, “Defect Based Real-Time Diagnostics of Ferroelectric Domain Wall Motion,” Phys. Stat. Sol. (a) 204, 690-94. (2007).