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**Luminescence and Raman based real time imaging of ferroelectric domain walls<sup>1</sup>**

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Novel methods for real-time imaging of ferroelectric domain walls open up new possibilities for advancing physical understanding of domain wall structure, properties, and defect interactions. Instead of destructive chemical etching and subsequent optical or electron microscopy, domain walls are imaged nondestructively in real-time by photoluminescence microscopy using dilute doping by rare earth ions as designer defects whose luminescence is affected by the domain walls. Using a combination of high spatial and spectral site-selectivity in laser confocal and near field optical microscopy, domain structure changes on a 100 nm length scale can be observed with a temporal resolution of 5ms, as demonstrated in  $\text{LiNbO}_3$  and  $\text{LiTaO}_3$ . Imaging using Raman spectroscopy (that does not require rare earth doping) will also be described. These new imaging methods reveal that domain wall widths and structures are velocity-dependent, and they provide active, real time feedback needed for precise laser-writing of ferroelectric domain patterns.

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