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Probing bias-strain coupling on the nanoscale by Piezoresponse Force Microscopy: from ferroelectric and multiferroics to energy storage materials[1]

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Coupling between the electric fields and strains is ubiquitous on the nanoscale, ranging from piezoelectricity and electrostriction in piezo- and ferroelectrics to complex phenomena mediated by the changes in mobile ion concentration in intercalation compounds and collective Jahn-Teller distortions coupled to oxidation states in correlated oxides. In this presentation, I will summarize recent advances in Piezoresponse Force Microscopy applied for studies of bias-induced phase transitions in ferroelectrics and multiferroics, and demonstrate potential for mapping polarization switching on a single defect level. Phase-field modeling allows the corresponding mesoscopic mechanisms to be deciphered, and further suggests strategies for (symmetry forbidden) manipulation of in-plane polarization component. Controlled creation of ferroelectric closure domains is demonstrated. In the second part of the talk, I will demonstrate applications of spectroscopic PFM for mapping Li-ion dynamics and diffusion in energy storage materials and devices, potentially extending PFM for studies of nanoscale phenomena in an extremely broad range of materials beyond ferroelectrics.

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