Poster Presentations

[MS1-P02] Submicrosecond X-ray Crystallography: New Technique, Challenges and Opportunities

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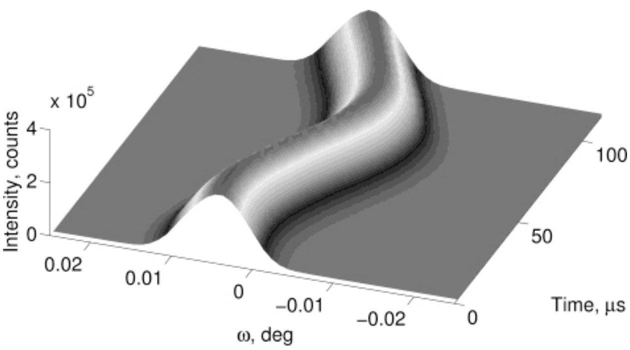
Investigation of structural dynamics of crystals under external perturbation is one of the major challenges for modern X-ray structure analysis. This interest is motivated by both fundamental and material sciences, since sensitivity of a structure to a perturbation predefines numerous macroscopic physical properties. In this work we show recent achievments using a new data-aquisition system (DAQ) for a broad range of time-resolved diffraction experiment with a point detector [1]. It applies to probe the reversible submicro-, micro- or millisecond dynamics under periodically modulated external electric field such as a) dynamics of domains in ferroelectrics and multiferroic; b) piezoelectrically induced elastic vibrations; c) dynamics of field induced phase transitions, etc. The DAQ is constructed on the basis of a Field Programmable Gate Array (FPGA-board), which distributes the point detector signals in 10000 time channels, synchronized with an applied electric perturbation. It allows for a flexible change of the channel width (> 100 ns), i.e. the time resolution of the experiment.



We will demonstrate in-situ X-ray diffraction study of resonance-enhanced vibrations of -quartz (the figure above shows the example: -3 2 0 Bragg rocking curve collected while the crystal was vibrating at the resonance frequency). The position, width and integrated intensity of the rocking curve can be extracted, thus the dynamics of elastic deformation, mosaicity and atomic position can be analyzed as a function of time and applied electric field. We will also present the time-resolved diffraction study of domain switching in uniaxial (Sr0.5Ba0.5Nb2O6) ferroelectric under alternating electric field. The dynamics of field induced Bragg peak splitting and dispalcements quantifies lattice and domains contribution into the piezoelectric deformation in ferroelectris. Finally, we used the DAQ to reveal the ferroelectric switching in magnetite below the Verwey transition temperature. We applied 1 kHz periodic electric field field: the single period included two 10 s switching pulses and longer periods without voltage. The small intensity contrast (the contrast between the Friedel pairs) between the two zero-field periods (straight after positive and after negative pulses) was observed.

[1] Gorfman, S., Schmidt, O., Ziolkowski, M., Kozierowski, M., & Pietsch, U. (2010). J. Appl. Phys. 108, 064911.

Keywords: time-resolved X-ray diffraction; Piezoelectricity; Ferroelectricity