MS40. X-ray diffraction from microsecond to femtosecond time range (including FELs)

Chairs: Christian Betzel, Anton Barty

MS40-P1 Time-resolved X-ray diffraction study of inhomogeneous deformations in piezoelectric single crystals, induced by a nanosecond electric pulse

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Electromechanical coupling (piezoelectric effect) is the physical property describing the ability of some materials to convert electrical energy to mechanical energy or vice versa. Despite the great technological importance of piezoelectric materials, many fundamental aspects of piezoelectricity are still quite poorly understood. For instance, very little are known about a reaction of piezoelectric crystals to ultra-short (e.g. nanosecond) and strong electric pulses on the microscopic and mesoscopic length scales. The aim of this work is to investigate the reaction of lithium niobate ($LiNbO_3$) and α-quartz (α-SiO_2) single crystals to a nanosecond electric pulse by time-resolved X-ray diffraction.

We report on the measurement of time-dependent rocking curves of selected Bragg reflections from the ~0.05mm thin single crystal plates. We applied 2ns electric pulse reaching the maximum amplitude of 30kV/mm and collected diffraction intensity as a function of time delay after the applied pulse. The measurement was performed using the specially developed stroboscopic data-acquisition system [1-3]. Figure1 shows dynamics of 0 0 12 Bragg rocking curve of $LiNbO_3$ as a function of time (passed after the pulse). We observed the range of phenomena, corresponding to the changes on different time and length scales, including: (1) the change of integrated intensity, and (2) change of full width half maxima. The change of integrated intensity can be caused by both, the rearrangement within the unit cell (change of the structure factors) or alternatively by the change induced of the mosaicity (change of the extinction parameter).

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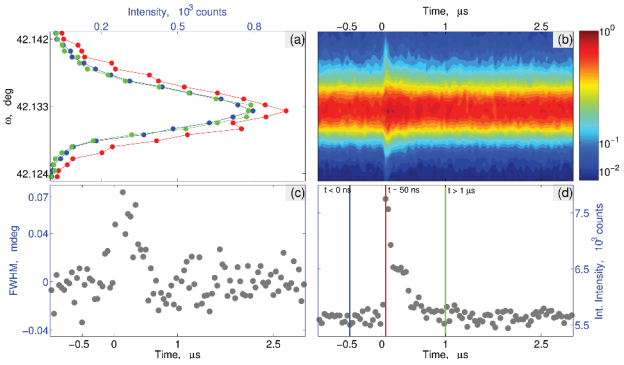

Figure 1. Time-resolved X-ray diffraction of $LiNbO_3$ single crystal, impacted by nanosecond high electric pulse: (a) dynamics of 0 0 12 Bragg rocking curves as selected time ranges, (b) time-resolved intensity map, (c) change of peak width, and (d) change of integrated intensity after applied electric pulse

Keywords: time-resolved X-ray diffraction, piezoelectric materials, nanosecond electric pulse