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X 線自由電子レーザーによる $Pr_{0.5}Ca_{0.5}MnO_3$ 薄膜の時間分解 X 線回折

Time-resolved x-ray diffraction study of $Pr_{0.5}Ca_{0.5}MnO_3$ thin films by XFEL

Univ. of Tokyo[1], SLS[2], SwissFEL[3], ETH[4], LCLS[5], RIKEN CEMS[6] ○H. Wadati[1], P. Beaud[2,3], A. Caviezel[2], S. O. Mariager[2], L. Rettig[2], G. Ingold[3], C. Dornes[4], S.-W. Huang[2], J. A. Johnson[2], M. Radovic[2], T. Huber[4], T. Kubacka[4], A. Ferrer[2,4], H. T. Lemke[5], M. Chollet[5], D. Zhu[5], J. M. Glownia[5], M. Sikorski[5], A. Robert[5], M. Nakamura[6], M. Kawasaki[1,6], Y. Tokura[1,6], S. L. Johnson[4], U. Staub[2]

E-mail: wadati@issp.u-tokyo.ac.jp

X-rays from synchrotron radiation (SR) have time structures related to the SR pulse width of several 10 ps. By using the slicing technique, weak fs pulses can be created and were used to study dynamics in manganites [1]. We recently performed a time-resolved x-ray diffraction study in a pump-probe setup by using XFEL in LCLS (USA). Using intense ultra-short x-ray pulses of XFEL allows a much more detailed understanding of the dynamics. The sample is a $Pr_{0.5}Ca_{0.5}MnO_3$ thin film, which shows charge and orbital ordering. The pump light is Ti:sapphire laser (800 nm), and the probe is XFEL.

Figure 1 shows the time evolution of the normalized diffracted x-ray intensity of three superlattice reflections. Panel (a) shows the (2 1/2 0) reflection at 6.53 keV (off resonance), which is sensitive to the structural atomic motion. One can see clear oscillations, which correspond to the frequency of phonons. At higher pump fluences (> 12 μJ), higher-frequency structure, which is double the frequency of phonons, appears. Panel (b) shows the (0 5/2 0) reflection measured at resonance (6.553 keV) and mainly sensitive to the Jahn-Teller distortion, whereas panel (c) shows the (0 3 0) reflection measured at resonance (6.555 keV) and mainly sensitive to the electronic order. Both of these two reflections also show oscillations similar to the (2 1/2 0) reflection. The frequency of this oscillation is 2.45 THz. This is the slowest of a series of coherent optical phonon modes and can be assigned as the motion of the Pr/Ca cations.

In this talk, we will further discuss the origin of the time evolution and the theoretical analyses.

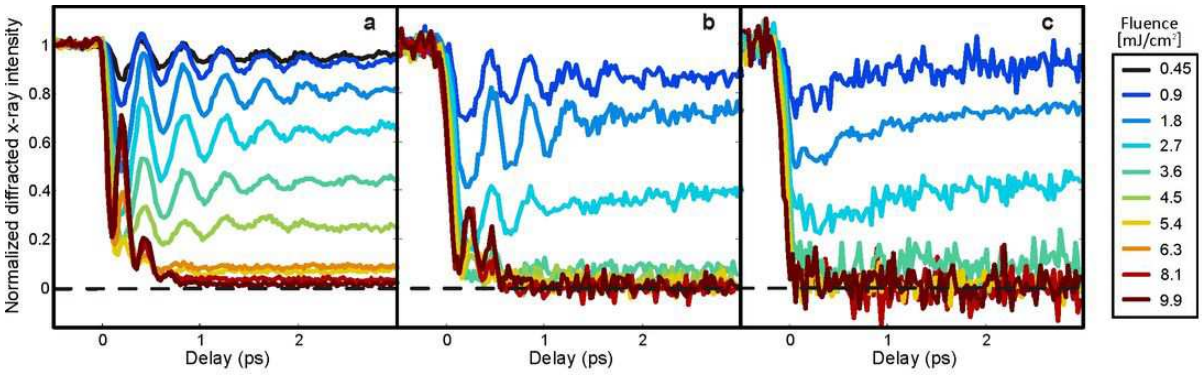

Fig 1: Time evolution of the normalized diffracted x-ray intensity of three superlattice reflections: (2 1/2 0) (a), (0 5/2 0) (b), and (0 3 0) (c) reflections.

[1] P. Beaud *et al.*, Phys. Rev. Lett. **103**, 155702 (2009).