Nanosecond time-resolved X-ray diffraction of laser-shocked YSZ

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Time-resolved X-ray diffraction using short puled X rays makes it possible to monitor a transient structure during phase transitions and chemical reactions. In the present work, we report nanosecond time-resolved X-ray diffraction measurements of the phase transition of yittoria stabilized zirconia (YSZ) ceramics under laser shock compression.

The experiment was performed using the beamline NW14A at PF-AR, KEK[1]. A single-shot laser pump-X-ray probe scheme was applied to capture the structural change of laser-shocked YSZ ceramics as a function of the pump-probe delay Δt. The peak energy and bandwidth of probe X-ray pulse are 15.6 keV and $\Delta E/E$=4.6 %. The 10-ns laser pulse from Nd:YAG laser was used to generated shock compression. The used target assembly had the plasma confinement geometry and made the shock duration longer than the laser pulse width. The experimental details are described elsewhere[2].

The Debye-Scherrer ring patterns of YSZ show peaks of the tetragonal structure before the laser irradiation. New peaks from the monoclinic structure appeared during the laser shock compression (Δt=10 ns) and disappeared after the shock wave passed away (Δt=1000 ns). This fact indicates that the reversible phase transition (tetragonal-monoclinic) occurs under the shock compression, although the estimated shock pressure (5 GPa) is much lower than the reported phase transition pressure (16 GPa). This phase transition is believed to be martensitic, generated by shear stress accompanied by compression.

[1] S. Nozawa, S. Adachi, J. Takahashi, *et al.*, *J. Synchrotron Rad.*, **14**, 313-319 (2007)
[2] K. Ichiyanagi, S. Adachi, S. Nozawa, *et al.*, *Appl. Phys. Lett.*, **91**, 231918 (2007)