

## High-speed x-ray diffraction for studying irreversible materials structure dynamics

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At the 32-ID beamline of the Advanced Photon Source, we recently developed the high-speed x-ray diffraction technique for studying highly dynamic materials behaviors. Different from conventional pump-probe type of ultrafast diffraction techniques, our technique uses high-flux white or pink undulator x-ray beams, and diffraction movies of single material events are recorded by a high-speed multiframe detection system. In another word, each diffraction pattern is generated with single exposure without repeatedly pumping and probing the sample. By taking advantage of the time structure of the filling pattern in the storage ring, single x-ray pulse diffraction can achieve with an exposure time set by the natural width of the pulse (down to 100 ps) and a frame rate set by the bunch repetition frequency (up to 6.5 MHz). Therefore, our high-speed diffraction technique is particularly suitable for real-time probing those transient processes which are non-repeatable and/or irreversible, such as grain refinement or phase transformation induced by high-rate loading, rapid material reactions, laser additive manufacturing, etc. In this contribution, I will present the beamline instrument and software we developed, and also some scientific cases which well highlight the unique capabilities of our high-speed hard x-ray diffraction technique.