Fast and bright scintillators for ultrafast materials dynamics using 4th generation synchrotron

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Abstract: We present the latest results on searching for fast and bright scintillators for ultrafast dynamic materials experiments using the Argonne APS-U, a 4th generation synchrotron. One of the new APS-U capabilities is for hard X-ray movies at a rate of at least 13 MHz (77 ns or shorter intervals). The need for faster and brighter scintillators than lutetium–yttrium oxyorthosilicate (LYSO) is urgent for indirect modes of imaging and diffraction using ultrafast cameras. Commercial Lanthanum Bromide ($LaBr_3$) and Cerium Bromide ($CeBr_3$) are among the leading candidates for the ultrafast hard X-ray movies. These commercial inorganic scintillators have a decay time about half or less than that of LYSO (~ 40 ns) and LSO, with a comparable light yield per X-ray photon. Deployment of these scintillators to APS-U needs to overcome the following challenges: scintillator lifetime affected by hygroscopicity, efficient light collection and coupling to imaging lenses and detectors, and high quantum efficiency for scintillator-light-to-electron conversion, corresponding to wavelengths < 400 nm. The results on scintillator materials studies, packaging, and X-ray beam-line characterization and testing will be presented. A few other options, such as perovskites and high-entropy scintillators, will also be discussed as potential alternatives. *This work is supported in part by the LANL Office of Experimental Sciences (Dynamic Materials) and is based upon work performed at the Dynamic Compression Sector, which is operated by Washington State University under the U.S. Department of Energy (DOE)/National Nuclear Security Administration award no. DE-NA0003957. This research used resources of the Advanced Photon Source, a DOE Office of Science User Facility operated for the DOE Office of Science by Argonne National Laboratory under contract no. DE-AC02-06CH11357*.