Contribution ID: **69** Type: **Oral presentation**

Ultrafast Scintillator for Dynamic Compression Studies

Friday, 22 September 2017 10:45 (15 minutes)

The Dynamic Compression Sector (DCS) at the Advanced Photon Source (APS) links a high-energy, tunable X-ray beamline to state-of-the-art dynamic compression plat-forms. This novel development will permit real-time X-ray measurements (diffraction, imaging, scattering) in dynamically compressed materials (peak stresses to over 350 GPa, and time duration ranging from ~5 ns to microseconds). Thus, the advent of the DCS will enable understanding of the dynamics of materials response to intense shock waves, geomaterials and other materials under extreme stress. High-speed X-ray imaging, however, is inherently photon starved. Even though the beam flux at synchrotron facilities is extremely high (~10^20 X-ray photons/mm^2/s) the number of X-rays available for imaging (100 ps pulse duration) may be limited due to weak reflections and/or attenuation in the material under test. Consequently the burden of maintaining high signal-to-noise ratio (SNR) in the image is shifted to the scintillator used in high speed imaging systems. We manufactured scintillator screens of cerium-doped lutetium iodide (LuI3:Ce). This material is well-suited for large-area coatings using vacuum-based physical vapor deposition methods. With its high density (~5.6 g/cm^3'), high effective Z (59.7), bright (exceeding 115,000 ph/MeV) green emission (540 nm range) well matched to commercial optics and CCD sensors, and rapid, afterglow-free decay (~28 ns in crystals), this scintillation material is arguably the best suited material candidate for the dynamic compression and alternative high-speed imaging applications. In its film format, a primary decay time component of 12.6 ns has been demonstrated. This, combined with the low afterglow, made it possible to resolve the 153 ns synchrotron bunch structure demonstrating the high speed imaging ability of this materials.

Our lutetium-iodide film provides us with about 8 μm resolution at 70 keV which energy is necessary to penetrate metallic structural materials. Also, superior performance in imaging and diffraction mode at DCS have been demonstrated.

LuI3:Ce is highly hygroscopic. Given the deleterious and effect of moisture, it is of critical importance that the coating and our novel dust-free, hermetic packaging steps be carried out in a climate controlled, dry environment. In order to address this challenge, and realizing the tremendous commercial potential of the ultrafast LuI3:Ce, we have acquired a unique tool called the "Glove-box-enabled Evaporator"(GBE). The GBE features a vacuum evaporator fully integrated in a glovebox and enables commercial grade manufacturing of high efficiency but moisture sensitive scintillating materials, such as LuI3:Ce scintillators while preventing exposure to moisture during the process.

Here, we report on the scintillation properties of films and those for corresponding crystalline material. The vapor grown films were integrated into a high-speed CMOS imager to demonstrate high-speed radiography capability. The films were also tested at the DCS of the Advanced Photon Source at Argonne National Laboratory under X-ray irradiation. The data show a high image quality and the sufficient temporal resolution for the recent bunch mode.

Has accepted

Primary authors: Dr MARTON, Zsolt (Radiation Monitoring Devices, Inc.); Mr SINCLAIR, Nicholas (Washington State University, The Dynamic Compression Sector); Dr GUPTA, Yogendra (Washington State University); Dr SINGH, Bipin (Radiation Monitoring Devices, Inc.); Dr NAGARKAR, Vivek (Radiation Monitoring Devices, Inc.)

Presenter: Dr NAGARKAR, Vivek (Radiation Monitoring Devices, Inc.)

Session Classification: Applications

Track Classification: S15_applications 3 (Orals)