High-Speed Imaging for Additive Manufacturing of Titanium Alloys at SSRL

A. M. Kiss[1], A. Y. Fong[1], V. Thampy[1], K. H. Stone[1], C. J. Tassone[1], N. P. Calta[2], P. Depond[2], J. Wang[2], A. Martin[2], R. T. Ott[3], M. J. Matthews[2], T. W. van Buuren[2], M. F. Toney[1], and J. Nelson Weker[1]

[1] SLAC National Accelerator Laboratory, Menlo Park, CA, USA
[2] Lawrence Livermore National Laboratory, Livermore, CA, USA
[3] Ames Laboratory, Ames, IA, USA

Additive manufacturing (AM) has several advantages and capabilities over traditional methods by decreasing costs, increasing energy efficiency, enabling new component design motifs, and providing a manufacturing pathway for novel materials which cannot be processed by traditional means. This has initiated a renaissance in American manufacturing; however, much is still unknown about the starting material properties and the processing parameters on how they relate to the final printed part. The final properties of the printed parts is dependent on these parameters and an experimental study of the building process is necessary to fully understand part performance. By utilizing the high brilliance X-ray source at the Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory, a high-speed imaging system was developed for observing the additive manufacturing process. This imaging system is capable of high-speed imaging, demonstrating 4 kHz frame rates, during the build process in a selective laser melting fusion powder bed AM chamber while the laser is melting the powder. The recorded X-ray images provide valuable information about the process by nondestructively transmitting through the sample so that void formation, keyholes, and melt pool are visible during the build. The images are analyzed to assist modeling and simulation efforts to better understand how the build process affects material properties.