In situ synchrotron x-ray study of additive manufacturing processes and materials

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Metal additive manufacturing (AM) refers to a suite of disruptive technologies that build metallic three-dimensional objects by adding materials layer by layer based on digital designs. AM holds the promise for completely revolutionizing the way we make things. However, fabrication of defect-free products with precisely controlled microstructures remains challenging. Indeed, many fundamental issues in AM need to be addressed, and many new directions need to explored. Synchrotron x-ray techniques are among the most versatile and effective techniques for characterizing materials microstructures and their evolution in various conditions. At the Advanced Photon Source, we recently applied high-speed x-ray imaging and diffraction techniques for *in situ/operando* characterization of various metal AM processes. The high penetration power of hard x-rays makes it possible to look through dense metallic materials and watch their dynamic structural evolution during AM processes in real time. Many highly transient processes involved in metal AM were quantitatively measured with unprecedented spatial and temporal resolutions, and the mechanisms responsible for different types of defects in AM materials were identified. Here, I will introduce the new understanding gained from our synchrotron x-ray experiments, as well as their broad impact on the development of AM materials, processes, and numerical models.

Biography

Dr. Tao Sun is a staff scientist at Argonne National Laboratory, and also a fellow of Northwestern-Argonne Institute of Science and Engineering. Sun obtained his Bachelor and Master degrees in Materials Science and Engineering (MSE) from Tsinghua University, and his Ph.D. in MSE from Northwestern University. Sun's doctoral research at Northwestern was focused on fabrication and characterization of nanostructured oxides. In 2010, Sun joined the X-ray Science Division at Argonne as a postdoc. During this period, Sun developed correlograph electron analysis technique for characterizing the atomic structures of amorphous materials, and coherent x-ray surface scattering imaging technique for resolving sample surface structures. Sun became an Assistant Physicist at Argonne in 2012, and was promoted to Physicist in 2017. Sun's current research program is focused on addressing the critical issues in additive manufacturing through *in situ/operando* characterization of build processes and material microstructures using advanced synchrotron x-ray techniques.