Abstract/Bio for Keynote Address at APICAM 2019

Using High Energy X-Ray Diffraction to Probe Additively Manufactured Metals over a Range of Length and Time Scales

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The last decade has seen tremendous advances in the ability of X-rays at large scale facilities to probe microstructure at unprecedented length and time scales under unique environments that simulate manufacturing conditions. Concurrently, manufacturing is undergoing a revolution as investments are made in advanced manufacturing techniques, such as additive manufacturing. It is natural that advanced manufacturing techniques should couple with advanced in-situ characterization techniques in order to accelerate the process of qualification of products for critical applications.

This talk will present our efforts to characterize the processing / microstructure / properties / performance relationship of additively manufactured materials across many length and time scales utilizing high-energy x-ray scattering techniques at the Advanced Photon Source. As an example of studying the effect of processing on microstructure, high energy x-ray diffraction has been used to monitor microstructural evolution in-situ during additive manufacture of 304L stainless steel and Ti-6Al-4V with sub-second time resolution and sub 0.1mm spatial resolution. Both material feedstocks are wire and deposited using a metal inert gas welding set-up. The intent is to study this additive technique as it pertains to the repair of existing objects. Specifically, the evolution of phase fractions, liquid and multiple solid phases, is monitored immediately following deposition, during solidification, and during cooling. This information can be utilized in current process – microstructure models in order to inform and validate the appropriate kinetics which lead to the resultant microstructure after deposition.