On the Possibility of Real-Time Techniques to Enable Property Prediction in Additive Manufactured Materials

T.K. Ales[1], M. Clark[2], and P.C. Collins[1]
1: Materials Science and Engineering
Iowa State University
2: Optics and Photonics Research Group
The University of Nottingham (UK)
E-mail: pcollins@iastate.edu

A recently completed 6-year program has resulted in the demonstration of an integrated computational materials engineering (ICME) framework that has resulted in the prediction of design allowables for large-scale, electron-beam additive manufacturing (EBAM) of Ti-6Al-4V. The scale of the depositions is quite large (>650 kg), pushing the research into the realm of large structures for aerospace applications. While the ICME approach incorporates modules to predict the composition and microstructure of EBAM Ti-6Al-4V, and thus its properties, the results point to the possibility to collect relevant sensor information to predict the properties in a near-real time manner. Should such sensors be possible, it would be possible to additively manufacture a component with a "digital twin" consisting of microstructural, chemical, and defect information, along with expected performance probability distribution functions. To be successful, any sensors must collect information at a scale and rate commensurate with the additive manufacturing process. One promising technique is spatially resolved acoustic spectroscopy (SRAS) and its rough-surface equivalent. SRAS uses accurate measurements of the surface acoustic waves to characterize the local orientation of the grains and phases, providing critical microstructural information at a part length-scale. In this talk, the ICME framework will be presented, along with the emergence of the SRAS method. Possibilities and limitations of both the framework and existing sensors will be discussed. Finally, the possibility of digital twins will be discussed.