

Investigating Defect Formation Mechanisms in Powder-bed Metal Additive Manufacturing

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ABSTRACT

Metal Additive Manufacturing (AM) provides the means to fabricate complex metallic parts with reduced time to market and material waste. However, significant materials-related challenges impede the widespread adoption of these technologies for critical components. In particular, fatigue resistance in as-built parts has proven to be inferior and unpredictable due to the large and variable presence of porosity. This presents a challenge for the qualification of any load bearing part without extensive post-processing (HIP) and inspection. Further understanding of the underlying mechanisms behind defect formation will assist in designing process improvements to minimize or eliminate defects without relying entirely on post-processing. In this presentation, the effects of powder, processing parameters, and post-processing on porosity formation in powder-bed metal AM processes are investigated using X-ray microtomography and a newly developed in-situ high speed radiography technique, Dynamic X-ray Radiography (DXR), at Argonne National Lab's Advanced Photon Source 3rd generation synchrotron. DXR enables the direct visualization of defect formation in the melt pool via X-ray radiographs at frame rates up 400,000 Hz.

BIOGRAPHY

Ross Cunningham is a 4th year Ph.D. candidate in the Materials Science and Engineering department at Carnegie Mellon University working under Dr. Anthony Rollett. His thesis research focuses on metallurgical challenges related to powder-bed metal additive manufacturing, with a focus on understanding defect formation mechanisms. Ross earned Bachelor's degrees in Materials Science and Engineering and Integrated Business and Engineering from Lehigh University in 2014. During this time, he worked on developing polymer-ceramic nanocomposite powder for 3D printing applications under Drs. Martin Harmer and Raymond Pearson. He earned his Master's degree in Materials Science and Engineering from Carnegie Mellon University in 2016. The following summer Ross interned in the Materials Processing and Engineering department at Pratt & Whitney under Iuliana Cernatescu. He is the author of six publications related to metal additive manufacturing. Ross is also involved in the Crosslink graduate student networking group at CMU that focuses on connecting graduate students to local companies and bringing in industry representatives for professional development discussions.

