Predicting Failure of Additively Manufactured Parts: The Effect of Defects

Christopher M. Peitsch, Steven M. Storck, Ian D. McCue, Timothy J. Montalbano, Salahudin M. Nimer, Douglas B. Trigg, Nathan G. Drenkow, Joseph Sopcisak, Ryan H. Carter, and Morgana M. Trexler

ABSTRACT

While the use of metal additive manufacturing (AM) has grown immensely over the past decade, there still exists a gap in understanding of process defects in AM, which often inhibit its use in critical applications such as flight hardware. The Johns Hopkins University Applied Physics Laboratory (APL) is developing novel techniques to replicate authentic surrogate defects in AM parts and characterize their effect on mechanical response. Advanced data processing methods, such as machine learning, are being leveraged to develop predictive failure models, which will help enhance our understanding of the effects of defects.

The effects of defects and ultimate prediction of when defects become critical failure points is an ongoing challenge in the selection and qualification of emerging materials. The rapid growth of metal additive manufacturing (AM) processes in recent years has led to a renewed interest in modeling and understanding of defect networks. However, analytical approaches to predictive failure caused by embedded defect networks were originucleation and growth processes have proven difficult to implement and control. The underlying goal of this research is to produce a predictive failure modeling technique that leverages large amounts of real-world empirical data to better inform qualification standards in AM.

The first problem to solve is how to create authentic surrogate defects in AM parts on demand using laser powder bed fusion. A [illegible]

[illegible]