On the Criticality of Defect Features in Failure of Additively Manufactured Components

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Porosity and other defects resultant by additive manufacturing processes are well-known to affect mechanical properties. However, there remains limited understanding regarding how the internal defect structure influences the evolution of the local strain field, as experimental investigations have not presented direct measurements of the evolving internal strain field in the presence of defects. Further, the criticality of specific defect characteristics on failure of additive manufacture components is not well understood. In this presentation, we will discuss results from interrupted in-situ tensile tests in X-ray computed tomography environments that were used to investigate the evolution of the strain field around internal defects via digital volume correlation. The evolution of the internal strain field facilitated examination of the role of specific defects in the macroscopic deformation of additive manufactured components. Characteristics of the porosity distribution, including presence of porosity at the surface or near-surface of components, as well as the local proximity of pores were found to influence the evolution of failure. Early onset of failure was found to be associated with the availability of neighboring porosity that allowed for rapid progression of the fracture path. Complementary to these high fidelity in situ evaluations of defect-driven failure, we also will detail similar results from statistical and machine learning based approaches from pre-mortem structure measurements that highlight the importance of similar defect characteristics in driving failure for additive manufactured components.

Dr. Christopher Saldaña is the Ring Family Professor and an associate professor of mechanical engineering at Georgia Tech. He previously held the Harold and Inge Marcus Career Development Professorship at the Department of Industrial and Manufacturing Engineering at Penn State. Dr. Saldana's research has focused on developing integrated frameworks for describing relationships between processing, structure and properties for advanced manufacturing operations. He is an expert on materials processing and nondestructive evaluation with 15 years of experience in the precision manufacturing sector and a focus on multi-scale materials and metrology characterization for supporting new product development and realization of next generation manufacturing processes. His current work is focused on developing process qualification and process design tools for hybrid additive/subtractive manufacturing and digitally-enabled manufacturing. He earned his graduate and undergraduate degrees from Purdue and Virginia Tech, respectively, and has been recognized with several awards, including an NSF CAREER award, the Robert J. Hocken SME Outstanding Young Manufacturing Engineer award and an R&D100 Technology Award.

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