Fatigue behavior of additive manufactured materials: an investigation into feedstock-process-structure-property-performance relationships

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Abstract:

The booming interest in additive manufacturing (AM) and its great potential has spurred industry to adopt this advanced technology. AM can produce net-shaped parts with complex geometries that are often impossible to fabricate through traditional subtractive methods. Additionally, AM has introduced the ability to fabricate internal geometries, functionally graded materials, and can generate assembled moving parts in one step. However, for these additively manufactured parts to be trusted in load-bearing and/or safety-critical applications, their structural integrity must be well understood, especially under cyclic loading. Bridging this gap is a complex undertaking, as there are many challenges specific to characterizing the behavior of additively manufactured parts. For example, the mechanical properties of AM laboratory specimens may not be representative of those associated with service parts; this is primarily due to differences in geometry/size, which can affect the thermal histories experienced during fabrication. The variation in thermal history affects the defects inherent to additively manufactured parts such as surface roughness, porosity, and lack of fusion between subsequent layers that can negatively impact the fatigue resistance. Because of these AM-specific challenges, the current global standards for mechanical testing methods, specimen design procedures, post-manufacturing treatments, etc., may need to be revised for additively manufactured parts. This presentation will provide an overview of the challenges facing the scientific community with regards to producing trustworthy additively manufactured service parts and demonstrate the need for establishing AM feedstock-process-structure-property-performance relationships.

Key words:

Fatigue behavior, additive manufacturing