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ADVANCED CHARACTERIZATION METHODS FOR VALIDATION AND VERIFICATION

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ABSTRACT

Additive manufacturing (AM) is a powerful technology that enables the production of geometrically complex structural components with ease. However, the mechanical properties of AM parts can differ significantly from those produced using standard subtractive manufacturing processes. These differences arise due to microstructural modifications induced by the layer-by-layer building strategies, which involve various parameters such as heat source settings, scanning paths, and building directions. As a result, AM parts often exhibit material inhomogeneities, anisotropies, and lack of fusion defects. Consequently, standard testing methodologies used for the mechanical characterization of materials may fail to accurately predict the mechanical properties of AM materials and parts. To address this challenge, special methods need to be developed to predict the effective response of AM parts at different scales, ranging from microstructural analyses to the engineering scale. These methods may include i) Micro-Scale Measurements, utilizing instrumented indentation to gather detailed data on the material properties at the micro-scale, ii) Meso-Scale Analyses, employing full-field measurement methods to analyze material behavior at an intermediate scale, iii) Engineering-Scale Evaluations, assessing the mechanical properties of the entire component. Furthermore, high-resolution image analysis through computed tomography (CT) is crucial for capturing both the real as-built geometry of AM parts and detecting internal defects. These defects play a fundamental role in determining the overall mechanical response of the parts, especially under fatigue loading conditions. Understanding the mechanical properties of AM parts is essential for calibrating and validating simulation models. This session aims to collect scientific and technical contributions that analyze the complex mechanical response of AM parts, by advancing the understanding and testing methodologies, to better predict and optimize the performance of AM components across various applications.