Metal Additive Manufacturing Process Selection and Development for Propulsion Components

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Metal additive manufacturing (AM) is a generic term that captures a variety of fabrication processes. Each of these manufacturing process has unique advantages and challenges for use in aerospace propulsion applications. The most commonly used AM processes include Powder Bed Fusion (PBF), Directed Energy Deposition (DED), and solid-state processes as in Cold Spray, Ultrasonic Additive Manufacturing, and Additive Friction Stir Deposition. While detailed research has been conducted among many of the AM processes to mature processing parameters and material properties, navigating which processes are best to select is difficult as it is based on specific component requirements. The focus of this presentation is to provide an overview of considerations for each of metal AM process selection for aerospace components based on various key attributes. These key attributes include geometric considerations, metallurgical characteristics, cost basis, post-processing and maturity of the processes. The data for these trade selections are based on studies that NASA as performed internally and with academic and industry partners. These studies include multiple AM build experiments to evaluate (1) geometric variations and constraints within the processes, (2) alloy characterization and mechanical testing, (3) pathfinder component development and hot-fire evaluations, and (4) certification approaches. This presentation summarizes these results and is meant to introduce specific examples which show what to consider when designing a metal AM component for aerospace propulsion applications.