Investigation of Aero-Acoustic Noise in Cold Spray Additive Manufacturing

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Cold spray holds a significant potential to be a highly effective additive manufacturing process for developing high quality materials on target substrates. In order to achieve high-quality coatings with consistent properties, process monitoring is essential. In the current study, aero-acoustic noise characteristics of cold spray process were investigated. The goal was to develop a deeper understanding of the acoustic noise sources in the cold spray and propagation of the acoustic noise in the supersonic jet and ambient medium. Acoustic noise measurements were conducted for free jet and deposition processes. The findings of the experimental measurements give evidence that the changes in the operational parameters such as nozzle supply pressure, inlet temperature, flow rate can be detected from the frequency spectrum analyses of the acoustic noise. Acoustic noise analysis is also a useful tool for the detection of the anomalies during the cold spray process, including coating delamination, nozzle throat wear and powder feed rate variations. For the purpose of gaining insight for the observed noise characteristics in the experimental studies, CFD simulations were performed by using Large Eddy Simulation turbulence model. The CFD simulations provided valuable information on the velocity profiles, pressure fluctuations, and turbulence intensity, which were correlated with the experimental noise data. Subsequently, the insights gained from this research can be used to improve process consistency and develop real-time process monitoring techniques for cold spray additive manufacturing applications.