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Title:
Exploring Linkages between Powder Rheology, Feed Rate, and Processability in Cold Spray

Abstract:
The cold spray (CS) process heavily relies upon controllable powder injection from a powder feeder into a carrier gas stream to achieve high-fidelity material consolidations. However, most CS process parameter manipulation is associated with gas conditions, nozzle selection, and spray path planning, to name a few; as such, powder feeder parameters are often neglected from spray optimization strategies. Given the reliance of consistent powder loading upon the powder feeder configuration, a deeper understanding of the intricacies of powder feeder adjustments on powder processing in CS is necessary. Furthermore, as powders often exhibit batch-to-batch variations in particle characteristics, such as particle size distribution (PSD), their dynamic flow behaviors can change, thus affecting their rheological responses to different powder feeder configurations. In this study, the behavior and processability changes of several powder samples—Al 7050 with both broad and narrow PSDs, as well as Al 7050 blended with WC-Co-Ni—are investigated under multiple powder feeder configurations. Powder feeder angle and rotational speed were systematically adjusted to induce different powder loading conditions in the CS system, while all other parameters were held constant. Powder rheology was coupled with particle size-shape analysis, moisture content analysis, microscopy, and nano- to micro-scale mechanical characterization to identify connections between rheological characteristics and powder feeder setups, ultimately linking to deposit quality and mechanical performance. Through this research, recommendations will be provided about how to best control powder behavior and powder feeder settings for optimal process control and deposited material properties in CS.