

Design, Iteration, and Simulation of Wide High Throughput Cold Spray Nozzles for Rapidly  
Manufacturing Coatings

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Abstract: Cold Spray is a process in which a powder-based feed stock is accelerated with an inert gas through a supersonic nozzle for deposition on a substrate. The effects of nozzle elongation on spray patterns are investigated to determine if deposition rates can be increased and more uniform coatings can be applied for larger area applications. Simulations were conducted with circular nozzles of varying eccentricity (0.0, 0.2, 0.5, and 0.8) while maintaining constant exit areas and expansion ratios. Particles injected into the domain varied in size and sphericity based on measurements conducted on particles via microscopy. The simulations showed that nozzle elongation can decrease peak height up to 25% and increase spray width up to 50%. There were no major losses in deposition efficiency but particle velocity for elongated nozzles did result in decreased velocities. Losses can be attributed to an increase in the nozzle internal surface area and friction forces. The reduction in deposition peak height allows for increasing particle load rate to maintain previous coating thickness. Widening the deposition area can increase the step size between spray lines and reduce total deposition time. Based on increasing particle load rate by 25% and step size by 50%, it is estimated that deposition time can be reduced by 20%. This directly results in a reduction of labor hours and gas consumption. Small time efficiency increases would substantially benefit high volume or time-consuming projects. One high volume example could be a production line for coating high voltage cable ways.