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A Comparison of Cold Spray Technique to Single Particle Micro-Ballistic Impacts for the Deposition of Polymer Particles on Polymer Substrates

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Abstract

A laboratory-scale cold spray system with the capability of accelerating 10 – 100μm polymer particles up to Mach 2 was used to deposit polystyrene and polyamide particles on a variety of different substrates for both cases of like-on-like deposition and deposition onto a melt-cast low-density polyethylene (LDPE) substrate. By systematically varying the particle temperature and impact velocity, the deposition window was developed for each particle and substrate combination in order to understand the cold spray processing conditions necessary to form coatings. The results were compared to those of the micro-ballistic single particle impact experiments. In the latter technique, an ablation laser pulse was used to accelerate a single polymer particle to over 400m/s while being tracked during flight and rebound from the substrate using ultrafast laser photography. Single particle impact studies provide information about the particle impact dynamics including the plastic deformation of a successfully deposited particles and the coefficient of restitution of a rebounding particle that cannot be monitored during cold spray. Particles of both polyamide and polystyrene were found to deposit on a soft LDPE substrate at similar impact velocities using both deposition techniques. A number of differences between the two techniques were also observed. Like-on-like deposition was only found to be successful in cold spray. Additionally, when single particle impacts successfully deposited, the efficiency of deposition was close to 100%, while for the cold spray processes the deposition was less than 5%. These results suggest multiple particle impacts and/or surface roughness can play a major role in the effectiveness and efficiency of the cold spray deposition process for polymers.

Keywords: Window of deposition; Cold spray; Single particle impact test; Critical velocity