Influence of Carrier Gas on Microstructure and Mechanical Properties of Cold Sprayed Aluminum- Scandium Alloy

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Cold-sprayed commercial Aluminum alloys are restricted for structural load-bearing applications due to the maximum strength achievable from precipitation hardening of solute atoms such as magnesium, zinc, and silicon. Scandium-containing aluminum alloys have huge potential to achieve a higher strength due to the hardening from nanosized Al_3Sc precipitates. In this study, scalmalloy (Al-$Mg_{4.6}$-$Sc_{0.72}$-$Zr_{0.3}$ wt. %) powders are employed for cold spray deposition. Two cold-sprayed deposits of 5 mm thickness are manufactured by using helium and nitrogen as the carrier gas in a high-pressure cold spray system. Microstructural investigation showed that the flattening ratio of splats in the helium-built deposits is higher than in the nitrogen-built deposits demonstrating severe plastic deformation. The enhanced flattening ratio in the helium-built deposits resulted in a microhardness of 147 HV, 12% higher than that of the nitrogen-built deposit, 132 HV. Additionally, Profilometry-based indentation plastometry (PIP) revealed higher yield stress (σ_Y), 383 ± 11 MPa and ultimate tensile strength (UTS), 487 ± 5 MPa for helium-sprayed deposits as compared to nitrogen-built deposits (σ_Y = 325 ± 16 MPa; UTS = 450 ± 6 MPa). Together with the heat treatment of these alloys for improving the mechanical properties, this study opens a new avenue for developing state-of-the-art high strength cold-sprayed aluminum alloy deposits.