Characterization of Fundamental Building Blocks for Cold Spray Additive Manufacturing

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Abstract

Cold spray additive manufacturing is an emerging field which promises to change the way metal structures can be quickly built. Unlike traditional 3D printing methods like ABS or PLA plastic extrusion, cold spray deposits resemble a bivariate Gaussian shaped curve centered on the nozzle. Depositing multiple raster layers results in the formation of undesirable peaks caused by the non-uniform distribution of spray material – complicating the construction of regular prismatic shapes. In our research we propose a methodology to construct, regular, rectangular fundamental building blocks (FBBs) as simple shapes that can be easily compounded to form larger 3D structures while minimizing edge losses that occur from repeatedly compounding the Gaussian-shaped deposition profiles. By varying the spray angle (nozzle normal to the substrate surface) and traverse speed in raster patterns we first demonstrate how these characteristic deposits can be modeled in a discrete time MATLAB simulation. We then empirically derive a structured series of raster configurations resulting in minimal edge losses and approximate right-triangular forms. The simulation results are verified using a VRC® Gen III cold spray system depositing copper on an aluminum substrate. The depositions are measured via the use of an in-situ laser profilometer which constructs an average cross section profile for later analysis. Our results demonstrate right-angle prismatic forms can be constructed with minimal raster sprays. This work will be incorporated into further research into the decomposition of 3D models into path plans for an integrated robotic-assisted cold spray system.