In Situ Laser Profilometry for Measuring the Shape of an Evolving Cold Spray Deposit

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One of the challenges with fully commercializing cold spray as an additive manufacturing technology is enabling the production of complex-shaped parts at near net shape. Process algorithms are needed which can take the feedstock material, spray parameters, and final part geometry as inputs, and generate a nozzle trajectory that will produce a sprayed part as close to the final desired shape as possible. While several commercial entities and research groups have made progress toward this goal, there is still much work to be done. The present study analyzes the fundamental shape of the basic deposit building blocks using an innovative approach: employing laser profilometry to measure the deposit shape, in situ, as the deposit is laid down during spraying. A custom-built laser profilometry system was built at Northeastern University that mounts to the spray robot near the nozzle and scans the cross-sectional shape of the deposit, as it is laid down. Initial deposits of aluminum 6061 alloy were sprayed, using a conventional raster pattern as a starting deposit shape. Using the profilometry system, the shapes of the deposits were recorded during spraying, then post-processed using custom-written software code. A graphical user interface was developed that displays the evolving deposit, visually, allowing qualitative assessment of shape quality as the deposit grew. Metrics of the overall deposit shape and per-track cross-sections were also computed, allowing quantitative assessment of shape quality. The cross-sectional shape of the deposit tracks was shown to change as the deposit grew, and quantitative changes in the shape metrics were shown to be indicators of shape quality and degradation. The approach and its findings shed new light on the fundamental shape of cold spray building blocks, helping to bridge the gap between these and the shape of complex parts. The innovative system presented has the potential for development into a real-time shape monitoring system that can be used to adjust nozzle path, on-the-fly, as complex parts are sprayed.