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Active Cooling of Cold-Spray Nozzles by Compressed CO_2 Expansion

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Cold spray deposition is an additive manufacturing process in which metal powder particles are used to form high-quality coatings or three-dimensional parts. The metal powder particles are accelerated by injection into a supersonic stream of gas at temperatures below their melting point. This high-velocity gas stream is generated through the expansion of a pressurized, preheated gas through a converging–diverging de Laval nozzle. Upon impact, the solid particles deform and create a bond with the substrate. As the process continues, particles continue to impact the substrate and form bonds with the deposited material, resulting in a part with very little porosity and high bond strength [1].

One of the main challenges in applying this technology is the appearance of clogging in the nozzle during the deposition process, primarily during high temperature operations using low melting point metals or metal alloys powders. Water-cooled jackets have shown to modestly extend the cold spray times of powders known to clog by simply reducing the nozzle wall temperature [2].

To avoid clogging and to increase the working life of the nozzles, we report the use of a nozzle cooling system based on the Joule-Thomson effect produced by the expansion of compressed CO_2. We have designed a prototype of a cooling device that implements this idea, and its performance has been tested in several cold spray experiments running different metallic particles and a range of operating temperatures. In cold spray experiments carried out using this cooling device, we have observed a suppression of clogging even for metallic systems and temperature conditions that are known to routinely clog.

Bibliography

[1] Champagne, Victor K., The cold spray materials deposition process. Fundamentals and applications. Woodhead Publishing Limited, 2007.

[2] X. Wang, B. Zhang, J. Lv, and S. Yin. Investigation on the Clogging Behavior and Additional Wall Cooling for the Axial-Injection Cold Spray Nozzle. Journal of Thermal Spray Technology, 24 (4), 696-701, 2015.