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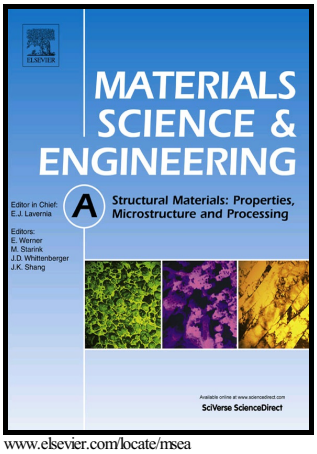

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Microstructure and mechanical anisotropy of additively manufactured cold spray copper deposits

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Abstract: In this paper, the microstructure and mechanical anisotropy of additively manufactured cold spray copper are investigated. Two nozzle scanning strategies (bidirectional and cross-hatching strategy) were employed to explore the optimum strategy for minimizing the anisotropy of cold sprayed deposits. The experimental results indicate that cold sprayed deposits showed anisotropy of microstructure and mechanical properties and that the anisotropic level can be affected by heat treatment and nozzle scanning strategy. For the microstructure, deposited copper particles exhibited an equiaxed shape through the XY plane but a lens-like shape in the XZ and YZ planes. After annealing, the microstructure anisotropy was minimised through recrystallization across the inter-particle boundaries. Both the bidirectional and cross-hatching scanning strategies appeared similar in regards to microstructure anisotropy which suggests that scanning strategies may not affect the microstructure anisotropy of the cold sprayed deposits. However, as for the mechanical properties, the scanning strategies significantly affected the mechanical anisotropy of the deposit. Mechanical anisotropy is much more prominent in the deposit produced with the bidirectional strategy when compared the deposit produced with the cross-hatching strategy. The main reason for the mechanical anisotropy is the existence of inter-track interfaces in a single-layer deposit which reduces the deposit cohesion strength (responsible for the difference between the X and Y directions) and different fracture modes during the tensile test (responsible for the difference between the XY plane and Z direction). In addition, the applied annealing treatment had no substantial effect on mechanical anisotropy.

Key words: cold spraying (CS), additive manufacturing (AM), kinetic spraying, scanning strategy, heat treatment.

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