

Novel use of nanoengineered porous powders for increased laser beam absorption in metal Additive Manufacturing

N. Kublik, S. Niauzorau, B. Azeredo

Manufacturing Engineering, Arizona State University, Mesa, AZ, 85257

natalya.kublik@asu.edu

Direct beam processes have been substantially used in metal Additive Manufacturing, predominantly in Laser Powder Bed Fusion techniques and for the fabrication of micro and nanostructures¹. Likewise, the use of nanoparticles in AM have attracted researchers due to the exceptional properties at this given scale and the macro scale properties tunability obtained by such^{2,3}. However, little has been done on the use of nanoengineered features alone in conventional scale metal 3D printing.

In this work, a novel laser beam and material interaction strategy in metal AM is proposed by the use of chemically fabricated nanoporous metal micro-scaled powders. The analysis also includes the characterization of feedstock and parts manufactured via Selective Laser Melting (SLM), based on the laser-feedstock optical interaction. Nanoporous copper (NPC) powders are fabricated by chemical etching of CuAl alloy in hundreds of grams scale. The powders are then homogeneously mixed with commercialized pure Cu in small weight percentages. Diffuse reflectance data show that NPC powders and a mix containing 5 %wt. of NPC reflect 79.2% and 34.8 % less than pure Cu powders, respectively (Figure 1). These results indicate promising improvements of Cu SLM printing culminating in higher speeds of 3000 mm/s at low power and with a trade-off of lower part density smaller than 3.5% gap (Figure 2).

¹ Vyatskikh et al., Additive manufacturing of 3D nano-architected metals, *Nature*, 2018.

² Martin et al. 3D printing of high-strength aluminum alloys, *Nature*, 2017.

³ Jadhav et al. Influence of Carbon Nanoparticle Addition (and Impurities) on Selective Laser Melting of Pure Copper

FIGURES

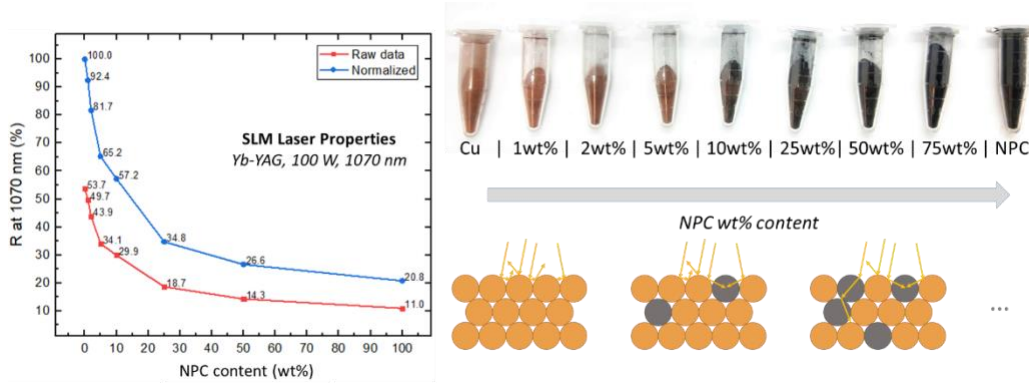


Figure 1. Powders reflectance measured by Integrating Sphere at SLM laser wavelength of 1070 nm for increasing %wt. content of NPC indicated, as obtained, and normalized by pure Cu powders reflectance value (Left). Above, pure copper powder and mixes images with increasing percentage of NPC. Below, increased laser absorption due to NPC powders is illustrated.

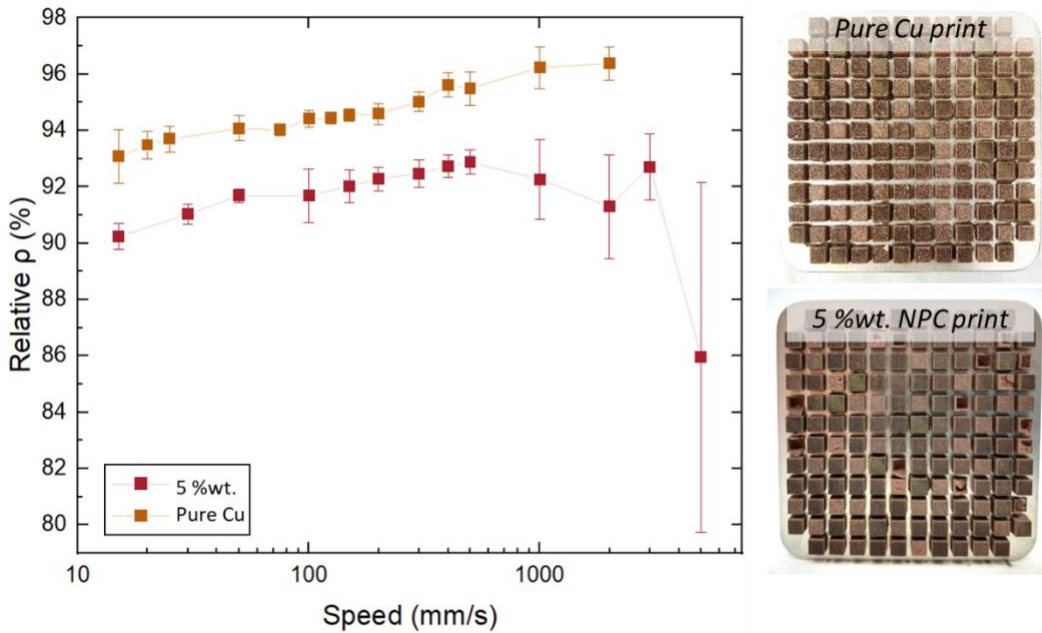


Figure 2. Relative Archimedes density of Pure Cu and 5%wt. NPC for increasing printing speed. Pure Cu and 5%wt. NPC prints. Note that Pure Cu prints at higher speeds are yet to be analyzed.