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Gas atomized versus water atomized nickel powder for the development of WC-Ni cold spray wear resistant coatings

Chingosho, Tatenda

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ABSTRACT

A research study was done to compare cold sprayed cermet coatings produced from two nickel (Ni) powders manufactured by the gas atomization and water atomization processes respectively. The aim of the research was to investigate if the Ni powders could be used to fabricate cold sprayed cermet coatings having good slurry abrasion resistance properties. The Ni powder was blended with tungsten carbide (WC) powder and deposited onto mild steel substrates using a low pressure cold spray machine to produce WC-5wt%Ni coatings. A Design of Experiments matrix was used to determine the near-optimal deposition parameters. The resulting coatings were relatively thin which exhibited mostly rebounding of feedstock powder rather than deposition. An annealing stage was introduced so as to make the Nickel powders more favourable for deposition on the mild steel substrate. The annealing caused softening of the Ni powder which led to better deformation properties upon impingement with the mild steel surface. Several materials characterization tests were conducted on the coatings to determine the microstructural and mechanical properties. Three body slurry abrasion tests were done to investigate the wear properties. Both Ni powders produced WC-5wt%Ni coatings without new phases, decarburization or oxidation. The coatings based on the annealed gas atomized Ni powder showed improved deposition, better adherence to the substrate, thicker and dense coatings whereas the coatings based on the annealed water atomized Ni powder showed little deposition improvement, the powder particles bounced off the substrate more than they adhered to the substrate. The coatings based on the annealed gas atomized Ni powder had a thickness of 255 ± 33.5 µm, a hardness of 361 ± 38 $HV_{0.3}$, WC retention of 42.9 ± 0.7 % and a percentage porosity of 0.7 ± 0.3 % whereas the coatings based on the annealed water atomized Ni powder had a thickness of 28.5 ± 1.1 µm, a hardness of 426 ± 12 $HV_{0.3}$, WC retention of 49.5 ± 2.5 % and a percentage porosity of 1.3 ± 0.8 %. The gas atomized Ni powder provided coatings with the best slurry abrasion properties.