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Multi-variable optimisation of the quality characteristics of fiber-laser cladded Inconel-625 composite coatings

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ABSTRACT:

Inappropriate choice of processing and materials parameters when re-manufacturing industrial equipment, via laser cladding (LC) technique, has adverse implications for attaining durability of equipment in terms of functional performance, efficient lead time and cost savings for equipment repairers. In an attempt to promote the adoption of LC as an efficient equipment re-manufacturing process, this study employs central composite design (CCD) and response surface modeling (RSM) to build mathematical models for optimising the quality characteristics (dilution ratio and microhardness and LC process efficiency) of a composite coating. The quality characteristics of the coating, comprising of Inconel 625 matrix reinforced with tungsten carbide (WC) particles, were optimised as functions of laser energy density, inconel content in the composite coating and shielding gas flow rates. Evidence from this study establishes that laser energy density is the dominant factor which influences all the output responses. It was also revealed that predicted values of the quality characteristics agree with the experimental results within the permissible range of the LC process and

materials variables. Consequently, dilution ratio was minimised as coating's microhardness and process efficiency were maximised with appropriate combination of laser energy density, inconel content and shielding gas flow rates. Finally, it may be inferred from this analysis that quality characteristics are optimised at 67.6 wt% inconel content, laser energy density (18.60 J/mm2) and career/shielding gas flow rates (8.86 l/min) with desirability value of 1.00.