Parametric optimization of laser deposited high entropy alloys using response surface methodology (RSM)

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ABSTRACT:

In this study, a full-factorial design of experiments was systematically structured to optimize the laser processing parameters of additively manufactured high entropy alloys by determining the impact of these parameters on the mechanical properties of the amalgams for aerospace applications. Analysis of variance (ANOVA) was employed to determine the conditions that allow the optimization process and to verify the model significance or otherwise. Laser additive manufacturing was used to fabricate the high-entropy alloys on a steel base-plate. To improve the quality of the components built and its mechanical properties, the laser process parameters must be optimized. Thus, the design of experiments was employed as a cost-effective tool for optimization with laser power and scan speed as parametric factors using a response surface methodology (RSM). These parameters were varied simultaneously over a few sets of experimental runs to determine the optimum process parameter for improving the output response. The output response was the micro-hardness properties of the HEAs after the laser deposited components were subjected to a Vickers hardness test using a Matsuzawa Seiki MMT-X series Vickers micro-hardness testing machine. The results showed that the optimum parameters were at a laser power of 1500 and 1600 W with a scan speed of 10 mm/s to give microhardness responses of 450 and 715 HV for the Ti-based and Cu-based high-entropy alloy, respectively. The model revealed that there was a strong correlation between the predicted microhardness response and the actual experimental data.