

Introduction

Laser cladding of metal powder alloys is being explored to enhance, repair, or free-form material for applications in aerospace, power generation, valve, and OEM supplied components. The LAP™ process is delivered by a 6 axis robot with two powder feed nozzle options in addition to a 2 axis tilt/turn table. The LAP™ process can offer positional accuracy while maintaining material quality and metallurgical bonding. The following study was conducted to demonstrate the LAP™ process parameters on the microstructure and properties of Stellite 6 cladding on austenitic steel. Samples produced under varying conditions were evaluated for their quality and properties aimed at improving thermal resistance, corrosion resistance and wear resistance.

Experimental

LAP™ Process

Cladding of Stellite 6 on austenitic steel carrier gas flow rate was kept constant for all trials at 8L/min using argon. Helium carrier gas was used for all trials. The following changes were effected for optimization of the cladding process: power (P, W), robot feed rate (RF, m/Min), focus diameter (FD, mm), overlay step (OS, mm), carrier gas flow rate (GFR, L/min) and powder flow rate (PFR, g/min).

Material

The composition of the base austenitic steel is given in Table 1. The powder clad material, Stellite 6, had an average particle size of 53µm, the chemical composition is given in Table 2.

Table 1 Nominal chemical composition of base material

Elements	C	Cr	Ni	Mn
Weight%	0.08	19	9	2.0

Table 2 Nominal chemical composition of Stellite 6

Elements	B	Cr	Fe	P	Si	Ni
Weight%	3.2	14.9	3.8	0.007	4.5	balance

Metallography and hardness

Samples were sectioned, cold mounted and polished using 120, 220, 320, 400, 600, 800, and 1200 grit SiC papers. Polishing was done with 1.0 and 0.3µm alumina slurry. Specimens were swabbed with Kroll's etchant for 10 to 15 seconds. The composition of the Kroll's etchant is given in Table 3.

Table 3 Nominal chemical composition of Kroll's Etchant

Elements	HF	H ₂ O	HNO ₃
Weight%	11	56	33

Evaluation of etched specimens was carried out using a low magnification optical stereo-microscope. Specimens used for metallographic examination were also tested for Vicker's hardness using a Sun-tec microhardness tester under a load of 500gf. The reported values are the averages taken from the given cladding.

Results and discussion

A full metallurgical bond with minimal dilution zone was achieved between the clad and base material as seen in Figure 1. The cladding showed an average hardness of 543.8HV (51.4HRc) while the average hardness of the base material was 243.8HV (18.5HRc).

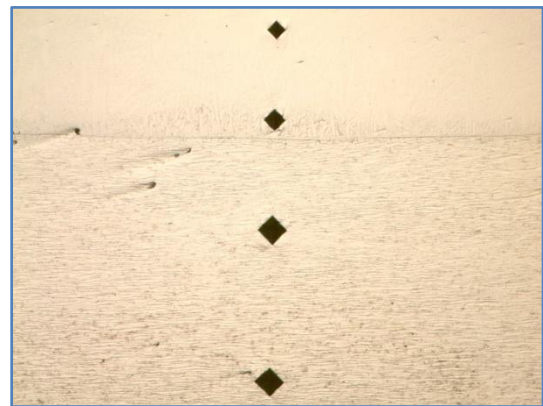


Figure 1 Specimen C interface of Stellite 6 deposit on austenitic steel 100X.

Material evaluation denoted that the slow cooling rate affected the size and shape of the dendrite, dendrite arm spacing and components formed during solidification of the laser clad layer. Carbides are contained with the

darkened eutectic regions of the clad surrounding each dendrite.

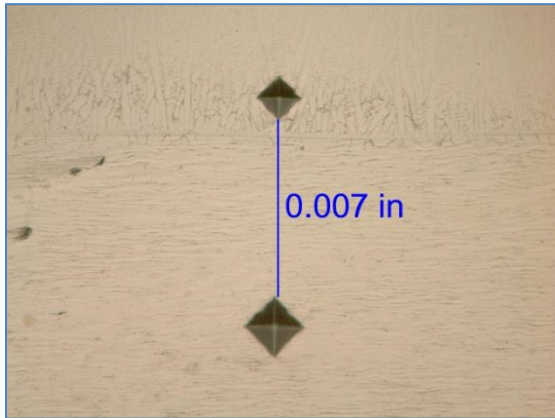


Figure 2 Specimen C interface of Stellite 6 deposit on austenitic steel 200X.

The fine, elongated grain structure of the clad predominately noted at the interface region in Figure 2 can be attributed to processing cold; non pre-heat conditions. Increased pre-heat can lead to localized and uncontrollable gradients in the material. Prolonged surfacing times can adversely affect the structure of the material and alter favorable material properties.