SUITABILITY OF LASER ENGINEERED NET SHAPING TECHNOLOGY FOR INCONEL 625 BASED PARTS REPAIR PROCESS

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1. Introduction

Nickel alloys, despite their excellent resistance to high temperature, tend to form brit- tle intermetallic phases, which decrease the mechanical properties of the material. Moreover, the high production cost of parts made of the Inconel alloys demands new techniques, that enable the fabrication of complex geometries or repair the broken part without the necessity of their replacement. Therefore, the main aim of this work was to assess the suitability of the Laser Engineering Net Shape Technology to repair parts made of the Inconel 625 nickel-based superalloy deposited using the optimized process parameters. Moreover, since the LENS technology reduces an area of heat-affected-zone and does not change the physical characteristics of the deposited material and the substrate, such aspects of this technique were also studied with regard to damaged parts re- pair.

2. Results and discussion

In this paper, the Inconel 625 laser clads characterized by microstructural homogeneity due to the application of the Laser Engineered Net Shaping (LENS, Optomec, Albuquerque, NM, USA) technology were studied in detail. The optimized LENS process parameters (laser power of 550 W, powder flow rate of 19.9 g/min, and heating of the substrate to 300 °C) enabled to deposit defect-free laser cladding. Additionally, the laser clad was applied in at least three layers on the repairing place. The deposited laser clads were characterized by slightly higher mechanical properties in comparison to the Inconel 625 substrate material. Microscopic observations and X-ray Tomography (XRT, Nikon Corporation, Tokyo, Japan) confirmed, that the substrate and cladding interface zone exhibited a defect-free structure. Moreover, the relatively thick heat-affected zone of about 35 μm was generated. It should also be highlighted, that the higher temperature of the material substrate (300°C) and relatively low power of laser reduced the significant phase transformations commonly found in the conventional repair process. Mechanical properties and flexural strength of the laser cladding were examined using microhardness and three-point bending tests. It was concluded, that the LENS technology could be successfully applied for the repair since a similar strain distribution was found after Digital Image Correlation measurements during three-point bending tests (Figure 1). Moreover, an observation of the test specimens did not reveal the surface cracks (Figure 2) [1, 2].

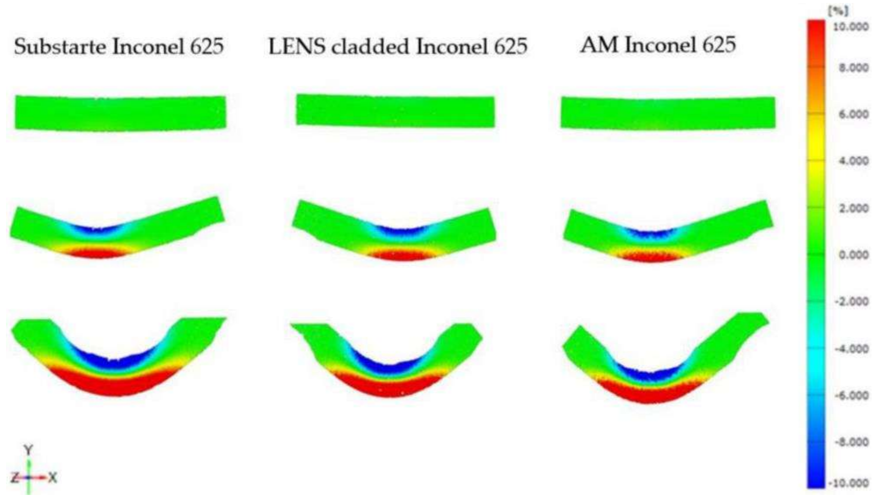

Fig. 1. DIC strain distribution maps of the Inconel 625 in the as-received state, with additional clad and additively manufactured [1]

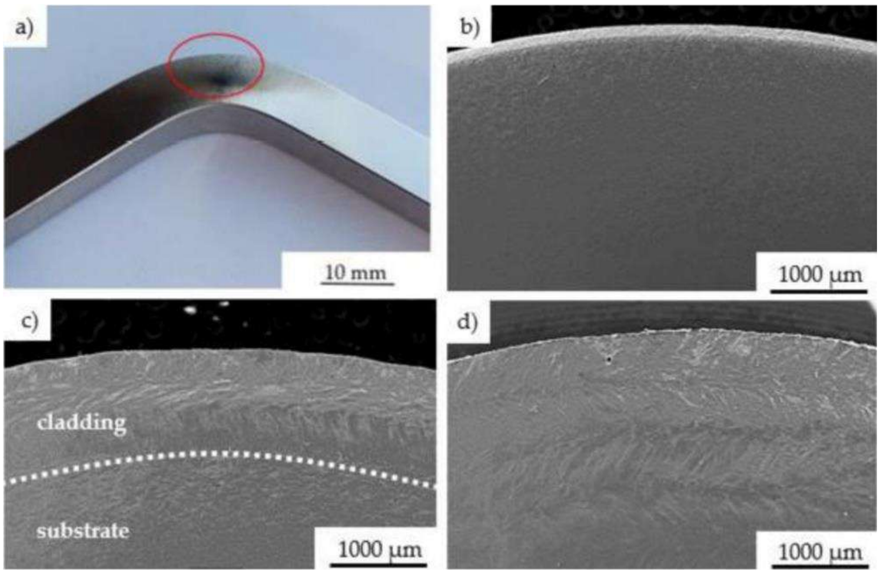

Fig. 2. Surface of the specimen after bending test: area of microscopic observations (a); substrate Inconel 625 (b), LENS cladded Inconel 625 (c), AM Inconel 625 (d) [1]

3. Conclusions

Optimization of the LENS parameters for the Inconel 625 nickel-based superalloy with respect to the repair process enabled obtaining a non-defected laser clad with the specified thickness of about 1 mm. The laser clad was characterized by a very good ad- herence to the substrate material and even improved mechanical properties.

4. References

[1] I. Barwinska, M. Kopec, M. Łazińska, A. Brodecki, T. Durejko, Z.L. Kowalewski (2021) Suitability of Laser Engineered Net Shaping Technology for Inconel 625 Based Parts Repair Process. *Materials 2021*, 14, 7302. https://doi.org/10.3390/ma14237302

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