

Electropolishing Effects on Laser-based Powder Bed Fusion 316L Stainless Steel

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Abstract

The purpose of this study is to analyze electropolishing effects on the surface roughness of a laser-based powder bed fusion (L-BPF) 316L stainless steel and develop a relationship between electropolishing (EP) and corrosion potential. Surface roughness is characterized before and after EP using different techniques. The corrosion potential is also studied before and after the EP process and its measurements are compared. This study reveals that EP results in a reduction in surface roughness and increase in corrosion resistance in L-BPF 316L stainless steel.

Introduction

Additive manufacturing is a manufacturing process that builds a part by adding material layer by layer. Various metal parts can be produced with additive manufacturing through a method called laser powder bed fusion (L-PBF). This process involves spreading a layer of metal powder and fusing it together with a laser. There are many benefits to L-PBF and other additive manufacturing processes, including the ability to create complex geometries. However, L-PBF materials have a lower surface quality due to defects like the balling effect that increase corrosion and lower performance. L-PBF parts must undergo surface treatment in order to improve the quality and thus increase the use of additively manufactured parts in industry.

Methodology

Prepare Specimen

- Clean specimen with distilled water and ultrasonic agitation bath

Optical Microscope

- capture surface morphology of the specimen

White Light Interferometer

- Capture surface topography of the specimen

Surface Roughness Tester

- Measure the Ra and Rz values 10 times
- Ra: arithmetical mean roughness value (μm)
- Rz: mean roughness depth (μm)

Corrosion Resistance Test

- Fill beaker with PBS solution
- measure potential and current

Electropolishing

- Electrolyte made up of H_3PO_4 (85%), glycerol (99%)
- run for 10 minutes

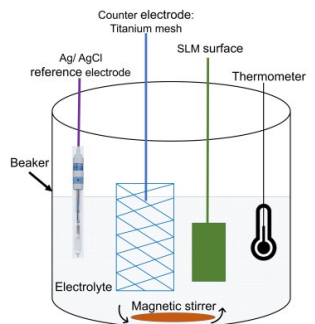


Fig. 1. Electrochemical workstation set up

Results

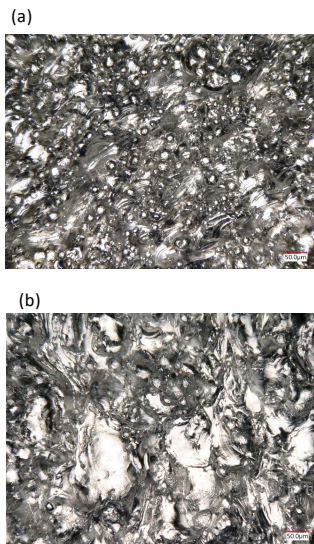


Fig. 2. optical microscope images of L-PBF surface (a) before and (b) after EP

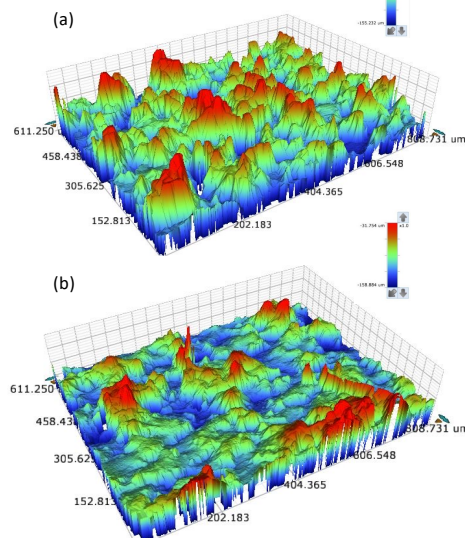


Fig. 3. white light interferometer topography of L-PBF surface (a) before and (b) after EP

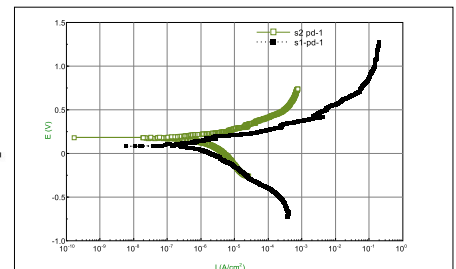


Fig. 4. Potentiodynamic polarization curves of L-PBF surface before (black) and after (green) EP

Table 1. Average of 10 measurements of Ra and Rz values before and after EP

| | Average Ra Value (μm) | Average Rz Value (μm) |
|----------|------------------------------------|------------------------------------|
| Raw | 10.9548 | 59.4688 |
| Polished | 8.2441 | 46.255 |

Conclusion

- The EP process visibly reduced surface roughness in optical microscope images, revealing a reduced number of spherical formations from the balling effect
- The topography of the white light interferometer shows a reduction in the peaks and valleys of the surface
- Decrease in overall surface roughness as seen from Ra and Rz values
- Potentiodynamic curve shows an increase in corrosion potential after EP

References

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