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Laser surface texturing to enhance adhesion bond strength of spray coatings – Cold Spraying, Wire-arc spraying, and Atmospheric Plasma Spraying

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Abstract

The aim of this study is to promote significant bond strength with laser surface texturing tools for different coating deposited by spray processes. Pulsed nanosecond laser has been used to improve the ultimate adhesion strength of thermal spray coating designed for specific applications, and the full potential of this technology must be further explored. This technology proposes several benefits such as free of grit-particle inclusions, limited affected zone and the interface contact quality. The most important improvement is the coating anchoring in the substrate by laser patterned surface. Adhesion bond strength has been improved and evaluated with the contact area. Fracture mechanic analysis has been studied and it showed that the pattern morphology has an impact on crack propagation. A mixed-mode failure has been defined and chosen to explain adhesion strength improvements for the different applications. Laser surface texturing was performed on light metal alloys substrates before cold spraying of light metal alloys powder, wire-arc metallization and atmospheric plasma spraying of thermal barrier coating without bond coat. This study has highlighted laser potential to enhance adhesion bond strength in the dry deposition field.

Keywords: laser surface texturing, thermal spraying, adhesion, in-contact area, anchoring mechanisms

Symbol list:
α and β: Dundurs parameters
ε: heterogeneous elastic coefficient
μ: Shear modulus (MPa)
ν: Poisson's ratio
E: Young modulus (GPa)
r: crack length (μm)
a, b, λ and δ: crack geometry parameters (μm)
R: pattern radius (μm)
δ_{xx}: strains (μm)
σ_{xx}: stresses (MPa)
Ki: stress intensity factor ($MPa.m^{1/2}$)
G: energy released rate ($MPa.m^{1/2}$)
P: applied forces (N)