Recent Strategies in Laser Based Machining forthe Enhanced Service Life of Nickel Based Super Alloys

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Abstract

Nickel based superalloys are well known for its superior heat resistance and corrosion resistance as well as minimal thermal expansion property. These materials are effectively used in industries where the part required retaining its stability and strong corrosion resistance properties over a wide range of temperatures. In the present study, an attempt was made to understand the various laser machining processes for the repair and renovation of nickel alloys. The motivation of present work has been received from the industrial scenario where the refurbishments of nickel based materials are still under research.

Keywords : Nickel Alloys; Superalloy; Laser Surface Treatment; Laser Surface Coating; Laser Surface Melting; XRD; Tensile; Microstructure

1.0 Introduction

Nickel-based alloys have a number of unique properties that allow them to be used in a variety of specialized applications. These are used in electric resistance heating elements as a result of their high electrical resistivity and heat resistance. These alloys have low expansion characteristics and are widely used to make frames in packaging electronic chips and in colour television tubes. Nickel copper alloys holds excellent corrosion resistance property. The monel series, nickel with ~30% copper alloy is widely recommended in valve, turbine blades and marine propeller shafts for their high fracture strength, especially in sea water applications. Nickel chromium alloys are recommended for jet engine applications. The nichrome, nickel with ~20% chromium alloys are precipitation hardened by the strengthening phases, γ' phase. However, the γ' phase change tendency at maximum operating temperature limit the usage of such alloys at high temperature applications [1,2]. Nevertheless, the development of thermal barrier coatings on high temperature turbine components increased the usage of nickel chromium alloys in gas turbine applications.

A laser beam can be positioned and controlled more accurately than any other conventional arc or flame. The laser photon absorption by various materials generate intense heat during laser processing, it is used for high precision machining, drilling and welding operations. The chances of thermal distortion is nil or very minimal in the material because laser machining produces minimum shrinkage. Thin film technology and integration of microelectronic circuits in the electronic field demanded the need of reliable high quality micro-welding without any distortion. In such cases, high precision work without any defects can be achieved by lasers. Successful laser welding of high strength alloy steels, nickel alloys, titanium alloys, etc., has been achieved with 2 to 5 kW continuous wave CO_2 laser.