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Low Power CO_2 Laser Modified Iron/Nickel Alloyed Pure Aluminum Surface: Evaluation of Structural and Mechanical Properties

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Abstract:

Surface modification of metals is demanding for high strength industrial purposes. Weak mechanical properties of aluminum (Al) are disadvantageous for several applications and needs improvement. We modify the surface of pure Al substrate by alloying it with a thick layer of Fe-Ni, where a low power (27 watt) cw CO_2 laser with varying exposure time (30, 40 and 50 s) is used. The exposure time dependent microstructure, surface morphology, and surface hardness of the achieved inter-metallic alloyed samples are determined. Microstructure analysis revealed the formation of different phases ($Al_{0.9}Ni_{1.1}$, $AlNi_3$, Al_6Fe, $AlFe_3$, Al_5Fe_2 and $Al_{76.8}Fe_{14}$, Al_5FeNi) with chemical heterogeneity. Alloyed sample displayed enhanced surface hardness (varied from 27 $HV_{0.1}$ to 53.9 $HV_{0.1}$) for extended laser radiation exposure time (from 30 to 50 s). A new inter-metallic compound aluminum-iron-nickel (Al-Fe-Ni) with considerably tougher surface is achieved. Our observations may contribute towards the development of laser assisted modification of metal surface alloying.

***Keywords*:** Al substrate; laser surface alloying; structural properties; hardness; exposure time.

1. Introduction

In recent years, the research on Al generated renewed interests due to the feasibility of achieving much harder Al surface structure modified by laser assisted multi-metals alloying. It is well known that distinctive attributes of Al including low specific weight, good formability, inexpensiveness, excellent workability, high corrosion resistance, and good thermal conductivity make it suitable for broad array of applications [1-3]. Ubiquitous metal Al is extensively utilized