A Study of LSP Technique Effect on the Wear Resistance for Aluminum and Copper Alloys

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Abstract. Laser is becoming an important surface treatment to induce a compressive residual stress field, which improves micro-hardness, wear resistance and fracture properties of components via laser shock processing (LSP) technique. This work investigates the effect of LSP technique to enhance wear resistance of 6009 Al and 70275 Cu-Ni alloys by using Nd: YAG laser (λ = 1064 nm, t = 10 ns). Four different pulse repetition rates have been used to perform hardening (2, 3, 4 and 5 Hz). A pin-on-disc technique has been used to evaluate wear rate of the specimens as-received and specimens treated by Nd: YAG laser at different applied loads with 750 rpm and 60.8 HRC of rotating disc. It is observed that LSP treatment can improve the wear resistance of both alloys, where the wear rate is reduced by 69.23% for 6009 Al and 69.11% for 70275 Cu-Ni compare to untreated LSP samples due to work hardening and compressive residual stress of LSP impact. SEM micrograph analysis of worn surface showed that the grooves and compacted debris of LSP treated sample are smaller and less than these untreated LSP samples.

INTRODUCTION

Industrial applications require parts of components with specific surface properties. Such good properties are corrosion resistance, wear resistance and hardness. Alloys with those properties are usually very expensive. There is a great interest in reducing the cost of components for fulfilling these requirements. In this sense, laser surface processing has been used as a cost-effective technique to improve the surface properties of materials. This can be achieved by using of the laser beam heat for modification of structure and its physical characteristics [1-3]. One of mechanical properties of metallic materials are improved by LSP impacts is wear resistance [4]. Wear is the progressive loss of material due to interacting surface in relative motion. It depends very markedly on surface condition, such as roughness and degree of work hardening [5]. LSP has in common the introduction of a micro-structural barrier from surface to some millimeters into the material in order to increase wear life. Among the specified boundaries the compressive lingering pressure field actuated in the material is one of the primary systems to influence the deferral in wear of metallic materials [6-8]. Gonzalez et al [9] studied the effect of laser shock processing on fatigue crack growth and fracture toughness of 6061-T6 aluminum alloy. It was observed that LSP has reduced the fatigue crack growth and increased fracture toughness in the 6061-T6 aluminum alloy. Rosas et al [10], presented a configuration and results of metal surface treatments using underwater laser irradiation at 1064 nm. They used a convergent lens to deliver 1.2 J/cm^2 at 8 ns laser FWHM pulse produced by 10 Hz Q-switched Nd: YAG. Paital et al. [11] studied the improvement of the corrosion and wear resistance of Mg alloys by using a highly intense laser beam generated from a continuous wave diode-pumped ytterbium laser. The effect of this type of coating on the corrosion and wear resistance of the Mg alloy has been investigated in the current study. Nath, Pityana, and Majumdar [12] has studied laser surface alloying of aluminum with WC + CO + NiCr for improved wear resistance. The effects of processing and materials parameters on the heat transfer and phase transformations aspects of laser hardening of plain carbon steel was analyzed by Arata, Li Ashby Easterling [13]. The peak pressure exceeds material yield strength, the transient shock pressure causes severe plastic deformation, refined grain size, compressive residual stresses, and increased hardness at the surface and in the subsurface. As a result, the mechanical properties on the work piece surface are enhanced [14]. Sanchez-Santana et al. [15] investigated the effect of LSP surface treatment on the wear

4th Electronic and Green Materials International Conference 2018 (EGM 2018)
AIP Conf. Proc. 2045, 020008-1–020008-7; https://doi.org/10.1063/1.5080821
Published by AIP Publishing. 978-0-7354-1771-7/$30.00