Abstract

Laser irradiation effects at various fluences as well as of number of laser pulses on surface, structural and mechanical properties of Al-Cu-Mg alloy (Al-2024) in different environments of vacuum, N_2 and O_2 have been investigated. In order to explore the effects of laser fluence, the first series of experiments were performed by exposing the specimens under vacuum (10^{-3} Torr), N_2 and O_2 environments at pressure of 100 torr for five different fluences ranging from 3.8 J/cm^2 to 5.5 J/cm^2 with 2250 pulses of Excimer laser (248nm, 18nsec) at fixed repetition rate of 30 Hz. The second series of experiments were performed to investigate the effect of laser pulses on surface, structural and mechanical behavior of laser irradiated Al-Cu alloy. For this purpose, laser fluence was kept constant. i.e. at 4.3 J/cm^2 and the specimens were exposed in three different environments of vacuum, N_2 and O_2 at various laser pulses ranging from 750 to 3750. The surface and structural modifications of the irradiated targets were investigated by Scanning Electron Microscope (SEM) and X-ray Diffractometer (XRD) respectively. In order to investigate the mechanical properties of the irradiated targets, Universal Tensile Testing machine and Vicker microhardness tester were employed. SEM analysis reveals the formation of micro - sized craters along the periodic surface structures under vacuum condition. In case of irradiation in N_2 environment, formation of cracks, pores and dendritic structures are observed. The growth of ripples with different periodicity has been observed under O_2 ambient environment. XRD analysis shows an anomalous trend in the peak intensity, crystallite size and in dislocation density of the irradiated specimens for various fluences and number of pulses for all three environments. XRD analysis confirms the presence of precipitates in the form of new phases after irradiation in the presence of N_2 and O_2 environment but no new phases are identified in case of irradiation in vacuum. The changes in Yield Stress (YS), Ultimate Tensile Stress (UTS) and microhardness were also found to be anomalous with increasing laser fluences as well as number of pulses in all ambient environments. The changes in the surface and structural properties of Al-Cu alloy after laser irradiation have also been correlated with the changes in mechanical properties for different fluences and number of laser pulses under vacuum, N_2 and O_2 gaseous environments. It is very important to investigate the effect of laser irradiation on Al-Cu alloy because of its many applications in automobile and aircraft industries. Al-Cu alloy is especially used for the engines of vehicles and for the wings and body structure of the aircraft.