Abstract

The present study deals with the investigation of laser assisted ablation and plasma formation of Titanium (Ti) using a Q-switched Nd: YAG laser (55 mJ, 10 Hz, 1064 nm, 10 ns). Ti was exposed to laser radiations at irradiance of 0.85 GW/cm^2 under Argon (Ar) and Neon (Ne) environment at various pressures ranging from 10 torr to 120 torr. Laser induced breakdown spectroscopy (LIBS) is used to evaluate plasma parameters, whereas, Quartz Crystal Microbalance (QCM) is used for sputtering yield measurements. The crater depth is evaluated by optical microscopy and surface features are explored by Scanning Electron Microscope (SEM) analysis. The microhardness of laser irradiated Ti is measured by Vickers hardness tester. It is observed that plasma parameters, sputtering yield, ablation depth, surface features and hardness of laser ablated Ti are strongly influenced by environmental conditions. Their values can be controlled by controlling nature and pressure of Ar and Ne. All the evaluated plasma and ablation parameters of Ti are well correlated and are higher in case of Ar than Ne. The plasma parameters, ablation yield, ablation depth and hardness increase with increasing the pressure of environmental gasses, attain their maxima at 40 torr for Ar and at 60 torr for Ne. Afterwards they show a decreasing trend up till maximum pressure of 120 torr. The maximum values of electron temperature is 3965 K, number density is 1.54×10^{18} cm^{-3}, ablation depth is 184 µm, sputtering yield is 3.9×10^{15} atom/pulse and micro hardness is 300 HV in case of Ar atmosphere. Whereas, in case of Ne their values are 3616 K, 1.46×10^{18} cm^{-3}, 137 μm, 2.38×10^{15}atom/pulse , and 232 HV respectively. SEM reveals the growth of surface features like cones, ridges and pores at inner peripheral ablated regions. The growth of these structures is attributed to temperature, pressure and density gradients of Ti plasma and are ascribed to Kelvin-Helmholtz instabilities and Raleigh-Tayler instabilities. Therefore, plasma induced plasma effects and backward flux of plasma play major role for growth of these structure. These surface features are more prominent in case of Ar than in Ne. Whereas, at the outer peripheral ablated region, grain growth is prominent feature. It is more pronounced in Ne than Ar. Rapid heating and cooling is considered a possible reason of grains growth. Hence, better control over plasma parameters and ablation yield

under various environmental conditions give us better control over growth of surface features and hardness of Ti to make it more beneficial in industrial applications.