Abstract

The present study deals with the investigation of laser assisted plasma and ablation parameters along with surface and mechanical modifications of Cu. Nd: YAG laser (1064 nm, 55 mJ, 10 ns, 10 Hz) was employed as an irradiation source at irradiance of 1.0 GW/cm^2. Laser Induced Breakdown Spectroscopy (LIBS), Quartz Crystal Microbalance (QCM), Optical Emission Microscopy (OEM), Scanning Electron Microscope (SEM), and Vicker's hardness tester are used to evaluate plasma parameters, sputtering yield, ablation depth, surface morphology, and hardness of laser irradiated Cu respectively. The effect of pressure variation ranging from 10 torr to 100 torr and nature, ablation, surface structuring, and hardness of two inert environmental gases Ar and Ne on laser assisted Cu plasma using have been investigated. It is observed that emission intensities of spectral lines of Cu, electron temperature (T_e), electron number density (n_e), sputtering yield (SY), crater depth (CD) and hardness of laser ablated Cu increase with increasing pressures of Ar and Ne, achieve their maxima at 60 torr and then decrease with further increase in pressure up to 100 torr. The initial increase from 10 torr to 60 torr increase is associated with plasma confinement effects and enhanced collisional frequency, whereas, a decrease from 60 torr to 100 torr is attributed to shielding effects or absorption of incoming laser energy by laser supported shock waves. It is also observed that all the results are well correlated and establish a strong relation that increase in T_e and n_e is attributed to increase in sputtering yield, crater depth, distinct surface morphology and surface hardness. It is also observed that all values are higher in Ar as compare to Ne. The maximum value of T_e, n_e, sputtering yield, ablation depth, and hardness of laser ablated Cu in Ar are 8998 K, 1.30x10^{18} cm^{-1}, 8.59x1015 atoms/pulse, 231 µm and 147 HV whereas, in Ne the maximum values are 8791 K, 1.27 x10^{18} cm^{-1}, 7.70x10^{15} atoms/pulse, 200 µm and 116 HV. The morphological changes on the surface of an irradiated target have been evaluated using SEM. The growth of surface structures like craters, distinct melted pools with uplifting edges, flakes and cones etc. are more prominent in Ar than Ne.