Abstract

Iron (Fe) targets are exposed to 100 pulses of Nd: YAG laser (532nm, 6 ns, 10 Hz) at various fluences ranging from 4.8 - 38.5 J/cm^2. In order to explore the effect of background environments, the targets are also laser irradiated under vacuum condition as well as under five different pressures ranging from 5 -100 torr of various background gases like Ar, Ne, O_2 and air. The sputtering yield measurements are performed by using Quartz Crystal Microbalance (QCM). The surface modifications of laser ablated Fe are observed by Scanning Electron Microscopy (SEM) analysis. QCM measurements reveal that both the deposition rate and sputtering yield of Fe are strongly effected by laser fluence, pressure and nature of environmental gas. By increasing laser fluence, the sputtering yield initially increases due to enhanced energy deposition then saturates due to self-regulating regime. However, with increasing pressures of background gases the sputtering yield of Fe initially increases and then decreases. This enhancement is attributed to confinement effects offered by background gases, whereas the decreasing trend is explainable on the basis of shielding effect. Owing to thermal conductivity, ionization potential and mass of background gas, the sputtering yield of Fe varies with type of ambient environment in accordance with the sequence vacuum > Ar > Ne > O_2 > air. The SEM analysis reveals the formation of several features identical to Laser Induced Periodic Surface Structures (LIPSS), cones, cavities, channels, multiple ablative craters and dot likes structures. With increasing laser fluence, LIPSS become more distinct and well defined. Further increase in fluence is responsible for making structures diffusive. The nature of morphological features is strongly dependent on ambient environments. The difference in the periodicity, size and shape of features is explained on the basis of confinement and shielding effects of plasma as well as on the mass and ionization potential of background gases. The amount of mass sputtered is correlated with crater depth and for this purpose surface profilometry analysis was performed. The crater depth was found to be increasing with increasing the laser fluence in all ambients. The compositional analysis has been done with the help of X Ray Diffraction (XRD) technique. An alteration in the peak intensity and d-spacing is observed but no additional phases are observed for Fe irradiation under any environment.