Abstract

The effect of laser fluence and nature of ambient gases on the sputtering yield, surface modification, crater depth, UV-visible absorption spectra and micro hardness of Zr has been investigated. Nd:YAG laser (532 nm, 10 Hz, 6 ns) at different fluences varying from 16 Jcm^{-2} to 60.8 Jcm^{-2} was employed as an irradiation source. All measurements were performed under four ambient gases of Ar, O_2, N_2 and Ne at constant pressure of 10 Torr. The sputtering yield of laser irradiated Zr was measured by QCM and it increases monotonically with increasing fluence under all environments. Scanning Electron Microscope (SEM) has been used to explore the surface morphology. SEM analysis exhibits the formation of cones and periodic ridges at the central areas in all environments. However, in case of Ar and O_2 cracks are also observed in the central areas and in case of N_2 and Ne cavities and droplets are also formed. The formation of ridges, cones and cavities are observed at inner as well as at outer boundaries of ablated regions. In case of Ar and O_2 laser-induced periodic surface structures (LIPSS) are characteristic features which are absent in case of N_2 and Ne. Additional features which are observed in case of Zr ablation in N_2 and Ne are clusters and agglomerates in the inner boundaries, whereas, grains are grown in the outer boundaries of ablated areas of Zr. The formation and growth of surface structures are firmly dependent upon laser fluence and ambient gas nature. The depth profilometry of optical microscope has been used to measure the crater depth of irradiated Zr. The Vicker Micro-hardness tester has been employed to measure the hardness. UV visible spectroscopy analysis reveals the formation of ZrO_2 in case of Zr ablation in O_2. It is true for Zr ablation in all inert (Ar and Ne) as well reactive (O_2 and N_2) environments that both crater depth and hardness of Zr show increasing trend with increasing fluences and are well correlated with sputtering yields and grown surface structures.