Abstract

Ablation mechanisms in three various metals i.e. Stainless Steel (S.S), Titanium (Ti) and Aluminum (Al) by employing nanosecond and femtosecond lasers under certain ambient conditions have been investigated. In case of nanosecond laser ablation, the experiments were performed under three environmental conditions of vacuum (10^{-3} mbar), Argon (Ar) & Oxygen (O_2) (at a pressure of 133 mbar) for 100 laser pulses. The experiments were performed for various fluences ranging from 0.72 Jcm^{-2} to 1.27 Jcm^{-2} (available range). Femtosecond laser ablation has been investigated under the ambient environments of vacuum (10^{-3} mbar) & O_2 (at a pressure of 133 mbar) for constant number of laser pulses (100). Laser irradiation was performed at fluences ranging from 0.38 Jcm^{-2} to 4.37 Jcm^{-2} (available range). The surface morphology of irradiated targets was analyzed by Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM). However, Energy Dispersive X-ray Spectroscopy (EDS) and X-ray Diffraction (XRD) techniques were employed to study the variation in the chemical composition and crystallinity, respectively. In case of nanosecond laser irradiation, SEM analysis of metallic targets reveal the formation of micro scale structures (Laser Induced Periodic Surface Structures (LIPSS), cavities, cones and grains) for different ambient environments (vacuum, Ar & O_2). In case of femtosecond laser ablation of S.S, Ti and Al formation of nano scale-LIPSS, nano-protrusions and nano-cavities for low fluence regime is revealed. Formation of micro/nano scale-LIPSS, conical microstructures and microcavities is observed for higher fluence regime for different ambient environments of vacuum and O_2. The EDS analysis of all metals shows the variation of chemical composition in all ambient environments, for both nanosecond and femtosecond laser ablation. XRD analysis of unirradiated and laser irradiated metallic targets exhibits that no new phases are formed in nonreactive environment for both nanosecond and femtosecond laser ablation. Whereas, in case of reactive O_2 environment new phases in the form of oxides are formed on the irradiated targets. For various laser fluences the variation in the peak intensity, crystallinity, d-spacing, crystallite size, dislocation density and residual strains for all materials is revealed for all ambient environments, for various laser fluences.