Abstract

The aim of the present work is to explore the suitable combination of laser irradiance, angles of the ion collector, with respect to target surface, biasing voltages as well as different distances of collector from target to make laser induced Mg plasma more beneficial as an ion source as well for laser assisted ablation and deposition. For this purpose Nd: YAG laser (532 nm, 6 ns) was employed as an irradiation source. Faraday cup was used as diagnostic tool to probe ion energy and flux by using Time of Flight (TOF) measurements. The energy and flux measurements on various laser irradiances ranging from 4.5 GW/cm^2 to 6.9 GW/cm^2, at various angles of ion collector with respect to target surface normal varying from 0^0, 15^0, 30^0, 45^0, 60^0 at different biasing voltages from 10 V to 70 V and at various distances of collector to target i.e. (4 cm, 6 cm, 8 cm and 10 cm) was performed. The TOF measurements reveal two different peaks. The first peak is sharp and corresponds to fast processes of photoionization therefore it has time delay in nanoseconds (ns) with respect to laser signal whereas, the second peak has longer delay in microseconds (μs) and represents the ion emission by thermal processes. It is revealed that energy and flux of Mg plasma ions increases with increasing laser irradiance. The energy of slow ions increases from 328 eV to 637 eV and the energy of fast ions vary from 20 keV to 31 keV with increasing irradiance from 4.5 GW/cm^2 to 6.9 GW/cm^2 when Faraday cup was placed at a distance of 8 cm from target. The flux of slow ions increases from 4.1 x 10^{19} cm^{-3} to 11 x 10^{19} cm^{-3} and the flux of fast ions increases from 0.9 x 10^{19} cm^{-3} to 1.1 x 10^{19} cm^{-3}. Similarly, with increasing angles of collector with respect to target surface from 0^0 to 60^0 a decreasing trend in both energy and flux is obtained. This is attributed to anisotropic behavior and forward peaking of plasma. When the biasing voltages applied to the collector are increased from 10 V to 70 V, both energy and flux of ions are increased. When collector distance increases from 4 cm to 10 cm, it is revealed that flux of Mg decreases significantly due to loss of energy. The flux decreases from 14 x 10^{19} cm^{-3} to 2.7 x 10^{19} cm^{-3} when the distance is increased from 4 cm to 10 cm for slow ions and from 0.6 x 10^{19} cm^{-3} to x 0.93 10^{19} cm^{-3} for fast ions when distance of collector increases from 6 cm to 10 cm respectively at a biasing voltage of 10 V. Scanning Electron Microscope Analysis was performed to explore the surface morphology of laser ablated Mg at various irradiances. It reveals the formations of cavities, cones, channels and spikes.

Higher irradiances range from 6.9 GW/cm^2 to 8.1 GW/cm^2 with higher values of energies and flux are responsible for the appearance of suppressed cones and blunt spikes.