Abstract

Nd:YAG (532 nm, 6 ns) laser ablation of Al under ultra-high vacuum condition at various irradiances ranging from 5.2 to 9.4 $GWcm^{-2}$ has been performed to generate plasma. Langmuir probe is employed as a diagnostic technique to evaluate two plasma parameters i.e electron temperature and electron number density of Al plasma at various laser irradiances and at the fixed probe to target distance of 10 mm. Both electron temperature (T_e) and electron density (n_e) of Al plasma show an increasing trend with the increase of laser irradiance and vary from 42 to 91 eV and $1.62x10^{14}$ to $2.43x10^{14}$ cm^{-3} for the laser irradiance ranging from 5.2 to 9.4 $GWcm^{-2}$, respectively. The Al plasma with known parameters is then explored for the measurement of Self-Generated Electric and Magnetic Fields (SGEMFs) by employing electric and magnetic probes with probe to target distance of 10 mm. SGEMFs are measured for different laser irradiances and plume-probe distances. SGEF shows an overall increasing trend followed by an almost saturation with the increase of laser irradiance. The evaluated values vary from a minimum of 50 V/m to a maximum of 380 V/m by varying the laser irradiance from 5.2 to 9.4 $GWcm^{-2}$ for different plume-probe distances of 5, 7.5, 10, 12.5 and 15 mm. Similarly SGMF also exhibits an increasing trend followed by a saturation with the increase of laser irradiance. The evaluated values of SGMF vary from a minimum of 89 G to a maximum of 165 G for the laser irradiance ranging from 5.2 to 9.4 $GWcm^{-2}$ at different plume-probe distances of 5mm and 10 mm. The growth of SGEMFs and polarity have been explained on the basis of quadrupole distribution of charges at leading and trailing fronts of expanding plasma. Scanning Electron Microscope (SEM) analysis is performed to correlate the surface morphologies of laser ablated Al with plasma parameters. SEM micrographs illustrate the formation of Whirlpool type structures, multiple ablative layers at peripheries along with craters and droplets at central area. Conical structures are grown at the inner boundaries of laser ablated regions of the target material. At the outer boundaries, laser irradiated Al surfaces are mainly characterized by the formation of clustered protruding globular structures with few conical appearances and droplets.