Abstract

Laser-ablated Magnesium (Mg) plasma was generated by employing Nd-YAG laser (532 nm, 10 ns). Faraday cups (as TOF technique) along with Electric and Magnetic probes have been employed to evaluate axial and radial plasma parameters and Self-Generated Electric and Magnetic Fields (SGEMFs) of Mg plasma. The number densities, kinetic energy and temperature of charge particles along with SGEMFs of Mg plasma have been measured at various axial (1 cm- 4 cm) and for a corresponding fixed radial distance of 2 cm at various irradiances ranging from 1.8 GW/cm_2 to 4.5 GW/cm_2. The dissertation addresses 2-D mapping of Mg plasma. Therefore, it consists of two parts. Part-1 deals with only axially resolved measurements. Whereas, part-2 deals with comparison of axially and radially resolved plasma parameters along with SGEMFs. For the used laser irradiance and axial distance range, the evaluated axial number densities of ions vary from 1.4 x 10_{13} cm_{-3} to 6.91 x 10_{13} cm_{-3} whereas, the corresponding radial number densities vary from 0.5 x 10_{13} cm_{-3} to 0.9 x 10_{13} cm_{-3}. The axial electron number densities variation is from 2.38 x 10_{13} cm_{-3} to 5.15 x 10_{13} cm_{-3} whereas, the corresponding radial densities vary from 3.06 x 10_{13} cm_{-3} to 7.85 x 10_{13} cm_{-3}. Ion kinetic energies vary from 0.1 keV to 0.4 keV axially and 0.5 keV to 13 keV for the corresponding radial distances. From lower to moderate irradiances, the axial and radial electron temperature (T_e) shows a significant difference, and their variation exhibits TET (Two-Electron Temperature) distribution. However, for higher irradiances, the axial and radial T_e overlap with the persistence of TET distribution. T_e varies from 1.3 eV to 125 eV axially and from 1.8 eV to 222 eV for the corresponding radial distances. Moreover, higher values of radial T_e and ion K.E for the corresponding axial ones are observed. The axial variation in SGEF ranges from 0.3 V/cm to 20 V/cm and 0.3 V/cm to 2.4 V/cm for the corresponding radial positions. Whereas, SGMF ranges from 978 Gauss to 2628 Gauss axially and 1038 Gauss to 3300 Gauss radially. It is observed that amplitude of SGEF is more peaked at target normal and decreases radially whereas, SGMF depicts the opposite variation. The shape of SGEMF signals also transforms from unipolar to bipolar with increasing laser irradiances. The 2-Dimentional measurements of SGEMFs of laser-induced Mg plasma were taken to correlate them with the spatially resolved charged particle dynamics. The charge separation of plasma species, TET distribution and bi-polar signals of SGEMFs confirm the quadrupolar distribution of charges. This is further supported by the direct relation of variation of electron density gradients with the axial and radial SGEMFs uncovering the importance of ion and electron number density gradients in plasma dynamics. The comprehensive investigations of laser-induced Mg plasma make it an efficient source of high energy ions, electrons and SGEMFs.