

Abstract

The effect of spatial confinement on laser generated metallic plasmas (Bi & Ti) has investigated by placing metallic blocker at different distances. In order to confirm the validity of spatial confinement the plasma has been diagnosed by two different characterization techniques i.e. Langmuir probe and Optical Emission Spectroscopy. For this purpose the dissertation is divided into three independent parts. Parts A & B deal with Langmuir probe characterization of spatially confined laser generated Bi & Ti plasmas respectively. For this purpose Nd:YAG laser ($\lambda=532$ nm, 6 nm) at different irradiances ranging from 2.9 GWcm⁻² to 6.2 GWcm⁻² was employed as irradiation source under vacuum condition. The spatial confinement is introduced with the help a blocker placed at different distances of 5 mm, 10 mm and 15 mm from the target. The biasing voltage applied to Langmuir probe is varied from +5V to +90V, whereas, recorded signals are shown only for +30V, +45V and +60V. It is clearly seen from all the results that introduction of blocker is responsible for significant enhancement of electronic signal amplitude, emission intensity, electron temperature (T_e), electron density (n_e), electron thermal velocity ($v_{th,e}$) and Debye length (λ_D) which is attributed to enhance collisional frequency due to plasma compression and confinement after employment of restriction on free expansion. In part A results related to Bi plasma are presented. It is observed that with increasing laser irradiance from 2.9 GWcm⁻² to 6.2 GWcm⁻² the evaluated values of T_e , n_e and $v_{th,e}$ vary from 4.5 eV to 13 eV, 1.3×10^{17} cm⁻³ to 1.7×10^{17} cm⁻³ and 1.4×10^8 cms⁻¹ to 2.4×10^8 cms⁻¹ respectively without blocker. Whereas, these values are significantly enhanced in case of blocker and vary from 9 eV to 31.6 eV, 1.9×10^{17} cm⁻³ to 2.9×10^{17} cm⁻³ and 2×10^8 cms⁻¹ to 3.8×10^8 cms⁻¹ at minimum blocker distance of 5 mm. Similarly, in part B with increasing laser irradiance from 2.9 GWcm⁻² to 6.2 GWcm⁻² the evaluated values of T_e , n_e and $v_{th,e}$ of Ti plasma vary from 3.2 eV to 10.9 eV, 1×10^{17} cm⁻³ to 1.3×10^{17} cm⁻³ and 1.2×10^8 cms⁻¹ to 2.2×10^8 cms⁻¹ respectively without blocker. Whereas, these values are significantly enhanced in case of blocker and vary from 7.2 eV to 26.3 eV, 1.2×10^{17} cm⁻³ to 2.4×10^{17} cm⁻³ and 1.8×10^8 cms⁻¹ to 3.4×10^8 cms⁻¹ at minimum blocker distance of 5 mm. The analytical values of work done to compress the plume are also evaluated. In a completely independent part C Optical Emission Spectroscopy (OES) of Ti plasma is performed by using Nd:YAG (1064 nm, 10 ns) laser at different irradiances ranging from 0.8 GWcm⁻² to 1.4 GWcm⁻². The spatial confinement is introduced with the help of metallic blocker placing at different distances of 4 mm, 6 mm and 8 mm from the target. All the 18 measurements are performed under the Ar environment at different pressures of 10 Torr, 20 Torr, 50 Torr and 100 Torr. Without blocker, the maximum value of T_e and n_e are about 7000 K and 1.4×10^{18} cm⁻³ respectively under Ar pressure of 50 Torr and laser irradiance of 1.4 GWcm⁻². A significant enhancement in emission intensity along with $T_e \approx 9810$ K and $n_e \approx 2.2 \times 10^{18}$ cm⁻³ is achieved in the presence of blocker at the same Ar pressure and laser irradiance.