Abstract

The characterization of laser-induced Iron (Fe) plasma is diagnosed by using two optical techniques i.e Laser Induced Breakdown Spectroscopy (LIBS) and Probe Beam Deflection (PBD) technique at different fluences as well as under different pressures of Ar gas. Nd: YAG laser (1064 nm, 10 ns, 10 Hz) is employed as a source of irradiation for generating Fe plasma. In order to explore the spatial confinement effects on laser-induced Fe plasma, a metallic blocker with pinhole arrangement in the form of Al plate is embedded between the Fe target and laser beam at a distance of 8 mm from the target. In the first part only LIBS analysis of Fe plasma is performed and it deals with the evaluation of electron temperature (T_e) and electron number density (n_e) at different fluences in the presence and absence of blocker. For this purpose the target surfaces are exposed to laser pulses at various fluences ranging from 7.4 Jcm^{-2} to 30 Jcm^{-2} under the ambient environment of argon (Ar) gas at a fixed pressure of 100 Torr. It is observed that both plasma parameters i.e electron temperature (T_e) and electron number density (n_e) increase with increasing laser fluence and achieve their maxima at 11 Jcm^{-2}. This enhancement is attributed to the enhanced energy deposition as well as the excessive ablation. Afterwards, with further increase in laser fluence from 11 Jcm^{-2} to a maximum value of 30 Jcm^{-2}, a slow decrease in plasma parameters is observed which is attributed to the shielding effect. The blocker introduces confinement effects on Fe-plasma due to reflection of shockwaves. In the absence of blocker the values of T_e vary from 4297 K to 4667 K whereas in the presence of blocker the range of T_e enhances from 4380 K to 4840 K. Similarly the values of n_e without blocker vary from 9.5×10^{17} cm^{-3} to 1.3×10^{18} cm^{-3}, whereas, with the blocker, n_e varies from 1×10^{18} cm^{-3} to 1.5×10^{18} cm^{-3}. It is clearly revealed that spatial confinement effect introduced by blocker is responsible for the enhancement of excitation temperature as well as number density. In the second part of dissertation characterizations of Fe plasma are performed by using two techniques i.e Laser induced breakdown spectroscopy and probe beam deflection technique under different pressures of Ar gas ranging from 5 Torr to 760 Torr at a fixed laser fluence of 22 Jcm^{-2}. By employing LIBS, it is observed that both plasma parameters i.e electron temperature (T_e) and electron number density (n_e) increase with increasing Ar pressure and achieve their maxima at 10 Torr and 20 Torr respectively. This enhancement is attributed to the spatial confinement effect offered by Ar gas which restricts the free expansion of Fe plasma. Afterwards a slow decrease in Te is observed up to 760 Torr. Whereas ne drastically decreases with increasing Ar gas pressure from 20 Torr to 50 Torr and then saturates up to 760 Torr. The values of T_e vary from 4260 K to 4620 K, whereas, n_e varies from 1.04×10^{18} cm^{-3} to 1.65×10^{18} cm^{-3} with the variation of Ar pressure from 5 Torr to 760 Torr. The additional confinement effect of blocker is also investigated for all pressures. It is revealed that blocker is responsible for slight enhancement in both plasma parameters ($T_{e,\,max}$ = 4680 K and $n_{e,\,max}$ = 1.72×10^{18} cm^{-3}) which is attributed to the less pronounced confinement effects on Fe plasma in the presence of high pressure of Ar gas. Probe Beam Deflection (PBD) signal of Fe plasma is explored for Ar pressure ranging from 400 Torr to 760 Torr (No probe beam signal is detected below 400 Torr). The increasing trend of amplitude of acoustic signal and decreasing trend for velocities of ablated species (12 ms^{-1} to 5 ms^{-1}) with increasing Ar pressure from 400 Torr to 760 Torr is clearly revealed by PBD technique. The decreasing trend in Te at higher pressures investigated by LIBS technique and decrease in velocities of ablated species of Fe plasma explored by PBD technique are well correlated.