Abstract

The effect of magnetic field on Laser Induced Breakdown Spectroscopy (LIBS) and surface modifications of Germanium has been investigated at various fluences as well as under different pressures of Argon gas. Germanium targets were exposed to Nd: YAG pulses (1064 nm, 1 Hz ,10 ns) at different fluences and under different pressures of Argon gas. The magnetic field of strength 0.45 T perpendicular to the direction of plasma expansion was employed by using two permanent magnets. The emission spectra of laser induced Ge plasma was detected by LIBS-Spectrometer system. Electron temperature (T_e) and number density (n_e) are evaluated by using Boltzmann plot and stark broadening methods respectively. The variations in emission intensity, T_e and n_e of Germanium plasma are explored at various fluences and under different pressures of Ar, with and without employment of magnetic field. It is observed that magnetic field is responsible for significant enhancement of both T_e as well as n_e for all fluences and pressures of Ar gas. This enhancement is attributed to the Joule heating effect and adiabatic compression. The effect of increasing laser fluences on plasma parameters is explored from 3 Jcm^{-2} to 26 Jcm^{-2} at fixed Ar gas pressure of 50 Torr. It is revealed that with increasing fluence both plasma parameters increase and achieve their maxima at a fluence of 12.8 Jcm^{-2} and then decrease with increasing fluence upto a maximum value of 26 Jcm^{-2}. With the variation of fluence, the values of T_e range from 15269 K to 16190 K in the absence of magnetic field whereas this range enhances from 17589 K to 20123 K in the presence of magnetic field. Similarly values of n_e are from 4×10^{17} cm^{-3} to 2×10^{18} cm^{-3} in the absence of magnetic field and are enhanced to range of 1×10^{18} cm^{-3} to 3.6×10^{18} cm^{-3} with magnetic field confinement with variation of fluences. In order to explore the effect of Ar gas pressure, Ge plasma was generated by laser pulses of fluence 12.8 Jcm^{-2} under different pressures of Ar ranging from 5 Torr to 760 Torr. It is revealed that with increasing pressure both plasma parameters increase, achieve their maxima at pressure of 20 Torr and then decrease upto the maximum pressure of 760 Torr. With the variation of pressures the values of T_e range from 15020 K to 18807 K in the absence of magnetic field whereas this range enhances from 17321 K to 33296 K in the presence of magnetic field. Similarly values of n_e are from 3.7×10^{17} cm^{-3} to 2.5×10^{18} cm^{-3} in the absence of magnetic field and are enhanced to range of 1×10^{18} cm^{-3} to 5.7×10^{18} cm^{-3} with magnetic field confinement under different pressures of Ar. In order to correlate the T_e and n_e with surface modification, Scanning Electron Microscope (SEM) analysis of irradiated Ge was performed. Droplets, cones and cracks are formed for both cases. However, the growth of ridges and distinctness of features is more pronounced in case of absence of magnetic field. Whereas surface structures become more diffusive in the presence of magnetic field with the appearance of cavities. Therefore laser fluence, pressure of environmental gas and magnetic field are controlling factors for plasma parameters as well as micro/nanostructuring of material.