

Abstract

Nd: YAG laser (1064 nm, 10 ns) is used as an irradiation source to generate Nickel (Ni) and Stainless Steel (SS304) plasmas at various laser irradiances under argon environment at 50 Torr pressure. The self generated magnetic field was measured with the help of magnetic probe and it varies from 2.4 Tesla to 27 Tesla for Ni plasma and from 9.6 Tesla to 54 Tesla for SS plasma with the variation of laser irradiance ranging from 0.7 to 2 GWcm⁻². The overall trend of self generated magnetic field is found to be increasing with an increase in laser irradiance and is attributed to enhancement in charged particles and electric currents of plasma with more energy deposition. Laser Induced Breakdown Spectroscopy (LIBS) technique is employed to calculate the electron temperature (T_e) and electron number density (n_e) of Ni and SS plasma. T_e varies from 6360 K to 7035 K for Ni and from 6410 K to 8051 K for SS with the variation in laser irradiance from 0.7 to 2 GWcm⁻². Similarly n_e varies from $0.27 \times 10^{18} \text{ cm}^{-3}$ to $1.68 \times 10^{18} \text{ cm}^{-3}$ for Ni and from $3.10 \times 10^{18} \text{ cm}^{-3}$ to $3.67 \times 10^{18} \text{ cm}^{-3}$ for SS. The corresponding electric fields of Ni and SS plasma evaluated by using the values of number densities are from $0.42 \times 10^6 \text{ Vm}^{-1}$ to $1.41 \times 10^6 \text{ Vm}^{-1}$ for Ni plasma and from $2.12 \times 10^6 \text{ Vm}^{-1}$ to $2.37 \times 10^6 \text{ Vm}^{-1}$ for SS plasma. It is observed that with increasing laser irradiances, T_e of Ni and SS plasmas initially exhibits an increasing trend and then decreases at moderate laser irradiances and shows a saturation behavior at higher laser irradiances. A similar behavior is observed for n_e and electric field of SS plasma whereas, for Ni plasma n_e and electric field increase with the enhancement in laser irradiance and saturate with insignificant variations at higher values of laser irradiances. Surface morphologies of laser ablated Ni and SS targets are explored by Scanning Electron Microscopy (SEM) analysis. SEM analysis reveals the growth of different structures like ridges, cones, cavities, pores and unorganized ripples for Ni whereas, polluted ripples with droplets are observed for SS. The growth of these structures is strongly dependent upon laser irradiance which in turn is controlling T_e , n_e , magnetic and electric fields of plasmas.