Abstract

In present study, the modifications in the surface morphology, elemental composition, phase changes and Field Emission (FE) properties of 304 Stainless Steel (SS) after Silicon (Si) ion irradiation has been investigated. These characterization are performed by using Scanning Electron Microscopy (SEM) along with optical microscopy analyses, X-Ray Diffraction (XRD) and Fourier transformation Infrared Spectroscopy (FTIR) and field emission techniques. The dissertation consists of two independent parts. The part A deals with irradiation of SS with high energy of 500keV Si ions generated by Pelletron accelerator at different fluences of 1.1×10^{14}, 2.5×10^{14}, 5.0×10^{14}, 9.1×10^{14} and 12×10^{14} ions/cm^2. The part B of dissertation deals with low energy of 30keV Si ions irradiation on SS. Nd:YAG (532nm, 10ns) laser at irradiance of 15GW/cm^2 was used to generate Si-plasma ions at various fluences ranging from 4.6×10^{14}, 9.1×10^{14}, 13.7×10^{14}, and 18.5×10^{15} ions/cm^2. FESEM analysis reveals that morphological features are grown non uniformly on SS. However, at lower ion fluence, the formation of pits/voids and cavities are observed, whereas, high ion fluences are responsible for the formation of sputtering channels and agglomers. In case of low energy Si ions generated by laser induced Si plasma, SEM analysis reveals the formation of nanoscale surface features including pores, craters, embedded particulates and protruded disk-like structures with multiple ablative layers at the fluence of 4.6×10^{14} to 13.7×10^{14}ions/cm^2. At the highest ion fluence of 18.3×10^{14} ions/cm^2, the flake/flower-like morphology is observed. Optical microscopy analysis shows the formation of pits, voids and tracks. XRD analysis reveals that no new phase is formed after 500 keV ion irradiation. An increase in peak intensity and crystallite size and a decrease in stresses and dislocation density is observed with increasing ion fluence. However, in 30keV Si ion irradiation of SS, the identification of new phase of Si (111) is observed with an anomalous trend in crystallite size, dislocation line density and induced stresses in response to the irradiation with various Si ion fluences. FTIR analysis shows that the stretching band of Si-O-Si is formed in SS material after Si ion irradiation in both cases. FE properties of Si ion treated SS samples are explored by measuring the I-V characteristics of targets under UHV conditions in diode configuration. The Fowler–Nordheim plots are obtained from I-V characteristics to evaluate the turn-on field, field enhancement factor β and a maximum current density. In case of accelerator ion irradiated SS these FE parameters are ranging from 2.5V/μm to 6.5V/μm, 1097-8514 and 42 nA/cm^2 to 681 nA/cm^2 respectively. Whereas, in the case