Abstract

Argon (Ar) thermal plasma irradiation effects on surface morphological, structural and field emission property of Aluminum (Al) have been investigated. For this purpose, Al targets were treated for varying exposure times ranging from 2 minutes to 12 minutes at constant Ar flow rate of 10 L/min using Twin torch configuration of thermal plasma with applied dc voltage of 11KV. Optical and Scanning Electron Microscopy (SEM) analyses were used to explore the surface morphology of plasma treated Al. The growth of a dense morphology comprising of cavities, pores, flakes and wavy thread like structures is revealed and is attributed to thermal plasma irradiation induced sputtering, re-deposition, hydrodynamic instabilities and quenching. Fourier transform infrared (FTIR) analysis shows that there are no compositional changes in Al after Ar plasma treatment. XRD analysis reveals the absence of any new phase. However, variation in peaks intensities and 2 theta positions are observed which are attributed to plasma irradiation induced heating, melting, recrystallization, generation/annihilation of lattice defects and stresses. The field emission characterizations of thermal plasma treated Al targets are performed in a diode configuration under UHV. The current density Vs electric field characteristic curves and Fowler-Nordheim plots are used to estimate the values of the turn-on field (E_o), field enhancement factor (β) and maximum current density (J_{max}) which come out to be in the range of 3 V/µm to 8 V/µm, 1856–3660 and 158-3131 nA/cm^2, respectively. The improved FE parameters exhibit a strong correlation with density and geometrical shapes of surface morphological features. The electrical conductivity measured by four probe method of treated Al samples is significantly smaller as compared to untreated target. However, it initially increases and then decreases slightly with increasing exposure time which is attributed to defect annihilation (annealing) and generation respectively.