Abstract

The present work deals with the thermal plasma induced surface structuring of Cu correlated with field emission properties. For this purpose, polycrystalline Cu targets were treated with Ar thermal plasma under atmospheric pressure at different treatment times ranging from 5 minutes to 30 minutes. XRD patterns revealed the absence of new phase in treated samples. However, significant variation in peak intensities and shifting is observed which is explained on the basis of thermal plasma ions induced defect generation and annihilation processes. The decreasing trend of crystallite size and increasing trend in dislocation line density are observed with increasing treatment times. Four-point probe was used to measure electrical conductivity and it lies in the range of 70 MS/m to 1.9 MS/m. Surface modification induced work function alternations investigated by employing Scanning Kelvin Probe (SKP) technique are in the range of 4.69 eV 4.97 eV. The irradiated morphology explored by optical and scanning electron microscopy analyses revealed the formation of flakes, grains, hillocks, spherical particulates and cracks which are explainable on the basis of Coulomb's explosion, thermal spike model, plasma induced sputtering and re-deposition. Field emission (FE) properties of thermal plasma treated Cu are measured in diode configuration by measuring I-V characteristics of target under ultra-high vacuum condition. The improved FE parameters such as turn-on field (E_o), field enhancement factor (β) and maximum current density (J_{max}) come out to be in the range of 3 – 7.5 V/μm, 1715-3223 and 284 – 872 nA/cm2 respectively. The variation in FE properties is well correlated with plasma induced surface structural, morphological and work function modifications.

Key words Thermal plasma, surface structuring, Work function, field emission, electrical conductivity