Abstract

The influence of argon gas concentration (10 % – 40 %), time durations and gas pressures on the surface properties of molybdenum (Mo) is studied in nitrogen-argon mixture using 100 Hz pulsed dc glow discharge technique. The analysis is carried out by using X-ray diffractometer (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM) and Vickers microhardness tester to investigate surface properties of the nitrided samples. XRD results exhibit the formation of molybdenum nitrides. Phase analysis shows the formation of more molybdenum nitride molecules for all concentrations, longer nitriding durations and fill gas pressures of 2 mbar and 3 mbar (1 bar = 10^5 Pa). The calculated lattice parameters confirm the presence of gamma molybdenum nitrides for relatively longer nitriding durations. Crystallite size analysis and SEM morphology confirm the growth of nanostructured molybdenum nitride layers. The nitridation rate increases with argon gas concentration in the admixture and reaches its maximum value at 30 % argon in argon nitrogen mixed plasma. A considerable increase in surface microhardness (approximately by a factor of 2) is observed for longer duration (10 h), 2-mbar pressure and 30% argon in nitrogen-argon. Longer duration (10 h) and 2-mbar fill gas pressure favors the formation of homogeneous, smooth, hard layers by the incorporation of more nitrogen.

Zirconium nitrides are synthesized utilizing plasma enhanced hot filament nitriding (PEHN) technique and the effects of nonreactive sputter gas (argon) flow rates on the surface properties of zirconium are investigated in argon-nitrogen admixture (60 sccm). The nitrided specimens are analyzed using X-ray diffractometry (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM) and nano hardness tester to study their surface properties. Phase analysis (XRD) confirms the development of o-Zr_3N_4 phase for all exposure conditions. Crystallite size analysis using XRD and AFM morphology confirms the growth of nanostructured zirconium nitride layers. Considerable enhancement in hardness is found when the sample is treated for 40 sccm argon in the admixture Ar : N_2 (60 sccm).

Deposition of niobium nitride thin films on silicon substrate is achieved by using plasma enhanced hot filament deposition (PEHFD) technique for various deposition times. X-ray diffractometry (XRD), Raman spectroscopy, Fourier transformation infrared spectroscopy,

scanning electron microscope (SEM) and atomic force microscope (AFM) are utilized to study the structural, chemical composition and morphological analysis of the deposited films. Four point probe is utilized to investigate electrical resistivity of the deposited films. Film mechanical properties are studied utilizing surface nanohardness analysis. Phase analysis confirms the deposition of niobium nitride thin films on silicon. The increase in average crystallite size, reduction in average dislocation density, microstrains and electrical resistivity (14 $\mu\Omega$ cm) indicates the synthesis of high-quality conductive Nb-N films deposited on Si substrate for 2 hrs treatment time, whereas the better mechanical properties are achieved for higher deposition time (4 hrs).