OR1101

Expanding microwave plasma for thin molybdenum films nitriding: nitrogen diffusion and surface structure investigations.

Isabelle Jauberteau[1], Thérèse Merle-Méjean[1], Saïd Touimi[2], Sylvain Weber[3], Annie Bessaudou[4], Armand Passelergue[4], Jean Louis Jauberteau[1], Jacques Aubreton[1]

[1]UMR6638 CNRS SPCTS, Limoges, France [2]UMR6638 CNRS SPCTS, Limoges, France [3]UMR7556 CNRS LPM, Nancy, France [4]XLIM UMR6172 CNRS, Limoges, France

isabelle.jauberteau@unilim.fr

Transition metal nitrides exhibit very interesting physical and chemical properties such as high hardness, wear resistance, high melting point, good chemical stability, low electrical resistance as well as good catalytic properties.
The catalytic properties of molybdenum nitrides can be compared to those of noble metals for hydroprocessing, hydrogenolysis, hydrogenation and H_2-D_2 exchange reactions.
The nitriding process consists of performing expanding plasma exposures on very thin molybdenum films about 200 nm thick coated on Si (001) substrates and heated at 400°C, only.
The influence of impinging plasma species is investigated both by using various (Ar-N_2 -H_2) gas mixtures and by changing the location of the workpiece surface relatively to the centre of the discharge.
A large transfer of nitrogen into the metal films exposed to ternary (Ar-N_2-H_2) plasma up to the molybdenum-silicon interface is detected by secondary neutral mass spectrometry (SNMS). A simultaneous decrease of remaining oxide amounts is also detected that confirms the role of hydrogen species as reducer agents. The effect of $NH_{x<3}$ simple radicals is also evidenced. On the contrary, pure N_2 gas and (Ar-N_2) gas mixtures exposures lead both to a slight nitrogen transfer, only and a strong oxygen amount in the vicinity of the surface. These results are correlated to analysis of the structure of the surface by Raman spectroscopy. A reduction of MoO_3 into MoO_2 is clearly identified on Raman spectra corresponding to molybdenum films exposed to pure N_2 gas and (Ar-N_2) gas mixtures. Moreover additional Raman features could indicate the formation of non-stoichiometric molybdenum nitride. The whole results are compared to those obtained at higher temperature. Atomic force microscopy (AFM) investigations performed on the nitrided surface shows that it consists of grains of nanometric size.

Keywords
expanding plasma
nitriding process
thin films
nitrogen diffusion

molybdenum nitrides and oxides