PO1014

Reduced atomic shadowing in HiPIMS: role of the thermalized metal ions

João Carlos Oliveira[1], Fábio Ferreira[1], André Anders[2], Albano Cavaleiro[1]

[1]University of Coimbra, Coimbra, Portugal [2]Leibniz Institute of Surface Engineering, Leipzig, Germany

joao.oliveira@dem.uc.pt

Traditionally, the most influential deposition parameters regarding both bombardment and shadowing effect in magnetron sputtering-based deposition processes are the depostion pressure and substrate biasing. Decreasing the process pressure results in an increased discharge voltage and less collisions with gas atoms and molecules and thus it increases the average energy of the sputtered species. On the other hand, the high-angle component of the angular distribution of the impinging species also decreases thus weakening of the shadowing effect. Substrate biasing allows us to bombard the growing film with ions extracted from the plasma with an energy proportional to the applied voltage (and ion charge state). This triggers re-sputtering if a high enough voltage is used. However, the vast majority of the sputtered species in magnetron sputtering are neutrals, not ions, and thus mostly Ar ions are involved in re-sputtering.

Additional control of the bombarding flux can be obtained by ionizing the sputtered flux. In the last decade, High-Power Impulse Magnetron Sputtering (HiPIMS) has been popularized for this purpose. In a previous paper it was shown that Deep Oscillation Magnetron Sputtering (DOMS), a variant of HiPIMS, allowed us to overcome the shadowing effect and, thus, to deposit Cr thin films with much smoother surfaces and densely packet columns even at relatively high pressure. The main objective of the present work is to identify the mechanisms which effectively decreases the shadowing effect in DOMS. For this purpose, the deposition conditions and properties of two Cr films deposited by DOMS at higher pressure and DCMS at lower pressure were studied and compared. In both cases the energy distributions of the energetic particles bombarding the substrate were evaluated by energy-resolved mass analysis and the angular distribution of the Cr species impinging on the substrate was simulated using Monte Carlo-based programs. The microstructure, structure and mechanical properties of the films were characterized by SEM and AFM, XRD and nano-indentation.

Keywords
Shadowing
HiPIMS
DOMS