Atomic shadowing in HiPIMS: role of the ionized species

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In magnetron sputtering-based deposition processes the ability to tailor the properties of a thin film deposited under conditions of low mobility of the ad-atoms depends primary on the effective control of the flux of particles arriving at the growing film surface. Traditionally, in direct d.c. magnetron sputtering (DCMS) the most influent deposition parameters regarding both bombardment and shadowing effect are the deposition pressure and substrate biasing [1]. However, in high power impulse magnetron sputtering (HiPIMS) metallic thin films with smooth surfaces and densely packet columns can be deposited even at relatively high pressure by decreasing the strength of the shadowing effect rather than by decreasing its effectiveness [2], as is usually the case in magnetron sputtering when using high energetic bombardment.

In this work, the relation between ionization of the sputtered species and thin film properties is investigated in order to identify the mechanism which effectively decreases the shadowing effect strength in deep oscillations magnetron sputtering (DOMS), a variant of HiPIMS. Two Cr films, one deposited at high pressure (1.0 Pa) by DOMS and another deposited at low pressure (0.2 Pa) by DCMS were compared. The average energy of the energetic particles bombarding the substrate during film growth was evaluated by energy-resolved mass analysis (ERMS) using an EQP. The angle distribution of the Cr species impinging on the substrate was estimated by simulation of the DCMS deposition process using Monte Carlo-based programs. Finally, the microstructure, structure and mechanical properties of the deposited Cr films were characterized by SEM and AFM, X-Ray diffraction and nano-indentation.

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References

[1] - J.A. Thornton, Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films 4 (1986) 3059.

[2] - F. Ferreira, R. Serra, A. Cavaleiro and J.C. Oliveira, Thin Solid Films 619 (2016) 250.

SHORT BIO

J.C. Oliveira graduated in Physics from the University of Lisbon in 1994 and completed his Master's degree in Surface Science and Engineering in 1997. The researcher then moved to the University of Coimbra received his PhD degree in Mechanical Engineering in 2003. Since then, his research work has been cantered on the development of thin films for mechanical applications by magnetron sputtering. At present J.C. Oliveira is responsible for the developments of thin films by High Impulse Magnetron Sputtering (HiPIMS) at The SEG-CEMMPRE laboratory of the University of Coimbra. His main field of research is the Process-Properties relationship in thin films deposited by Deep Oscillations Magnetron Sputtering, a variant of HiPIMS.