ION FLUX–FILM STRUCTURE RELATIONSHIP DURING REACTIVE MAGNETRON SPUTTERING OF TUNGSTEN.

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In this work, we are aiming at evaluating the influence of the ion bombardment on the crystalline constitution of WO₃ thin films. The intensity of the ion bombardment has been tuned by using an unbalanced (UBM) and a balanced magnetron (BM) and by sputtering the magnetron cathode in different discharge regimes: DC magnetron sputtering (DCMS), pulsed DCMS (pDCMS), High Power Impulse Magnetron Sputtering (HiPIMS), and Modulated Pulse Power sputtering (MPP), with pulse duration ranging from 10-50 µs in HiPIMS to 500-1000 µs in MPP. The average power was kept constant to 400 W whatever the sputtering conditions. The main ion populations (Ar⁺, O⁺, WOₓ⁺) were monitored using an energy-resolved mass spectrometer while the ion current at the substrate was measured by using a Faraday cup. The data show that: (i) according to the discharge regimes, the ionic current increases by a factor of 2 to 5 as the UBM is used; (ii) the ion flux during HiPIMS and MPP discharges is significantly increased (3x) as compared to the DCMS and pDCMS regimes. Moreover, HiPIMS and MPP mass spectra highlight a significant increase in the number of singly and doubly charged W and Ar ions as compared to the DCMS discharge. X-ray diffraction demonstrates that all films crystallize in the monoclinic phase. Nevertheless, the texturation of the films is affected by the sputtering conditions: a (0,0,2) texturation is observed for MPP, DCMS and pDCMS discharges; for the two latter cases, only for BM configuration. If the UBM configuration is used in these cases, a (2,0,0) texturation is observed. Finally, for HiPIMS deposited films, a (-1,1, 2) texturation appears. The comparable texturation between MPP and the low ion flux situation of the DCMS discharge (BM configuration) is explained by the increased deposition rate of the MPP sputtering plasma (~ 4 x DCMS) resulting in a reduced ion-to-neutral ratio as compared to the HiPIMS situation for example.

Keywords
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HiPIMS
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