OR2002

Temporal and spatial distribution of negative ion density in a pulsed DC magnetron

ShaoDong You[1], Robert Dodd[1], James W Bradley[1]

[1]University of Liverpool, Liverpool, United Kingdom

youshaodong@hotmail.com

Reactive magnetron sputtering in argon-oxygen atmospheres is an important industrial technique for depositing engineering-quality dielectric thin films. Despite the success of this technique, there is still a lack of understanding of the role of negative ions in these discharges and their influence on the growth of the deposited oxide films.
Here, we present spatially and temporally-resolved measurements of the negative ion densities in a pulsed-DC magnetron discharge (100 kHz, 50% duty) obtained using an eclipse laser photo-detachment technique combined with a Langmuir probe. The probe was moved along the discharge centre line from 35 mm to 125 mm from the target and time-resolved measurements of electron and negative ion densities were obtained at each position. Around the position of the magnetic null ($B_z = 0$), the electron density reached a maximum (1.9×10^{16} m^{-3} in the on-phase and 2.1×10^{16} m^{-3} in the off-phase); however the negative ion density was not a maximum at this position, still rising as the probe-target distance was increased. It was found that the electron density slightly increased during the on-phase, and then decreased during the off-phase, but the negative ion density showed the opposite trend, reaching a maximum of 9.8×10^{15} m^{-3} at t = 5 ms (end of the on-time). The data suggest that the negative ions seen in the off-time are created in the plasma bulk; while those observed in the on-time come largely from the cathode. The negative ion-to-electron density ratio, α was found to vary with operating conditions, with a maximum value of α ~ 0.7 for 90 % argon and 10 % oxygen gas mixtures and an average power of 400W at 10 mTorr chamber pressure. This occurred just at the begining of the on-time.

Keywords
negative ions diagnostic
pulsed dc magnetron
sputtering
laser photo-detachment