OR2301

Sputtering with and without a magnetic field

Stephen Muhl[1], Luis Sanchez-Balanzar[2], Luis Escobar-Alarcon[3], Enrique Camps[3]

[1]IIM-UNAM, Mexico, Mexico [2]Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, Mexico, Mexico [3]Departamento de Física, Instituto Nacional de Investigaciones Nucleares, Mexico, Mexico

muhl@servidor.unam.mx

The magnetron as a sputtering device was first reported in the 1960s and since then have been continuously developed and are extensively used for thin film deposition. Basically, magnetrons use a magnetic field close to the cathode to trap electrons leading to an increased trajectory and thus an intensification of the gas ionization even at low gas pressure. The optimal magnetic field strength depends on a combination of the sheath width, which depends on the plasma characteristics, and the target voltage. If the resulting electron cyclotron radii are significantly less than, or much larger than, the sheath width then little increase in the ionization is produced. It has been proposed that with RF or high frequency pulsed DC (pDC) excitation the overvoltage associated with restarting the plasma in each cycle plus the varying target voltage means that there is little benefit of using a magnetron, i.e. that the magnetic field is only effective for a small part of each cycle. To study this proposal we have prepared thin films by low pressure argon sputtering (1.3Pa), with and without the magnets, from graphite and titanium targets, using the same experimental conditions, but using DC, RF or 250 kHz pDC. The deposition rates without the magnets were approximately half the value of when they were used, independent of the target or type of high frequency excitation, and the DC deposition rates were 2 to 3 times the high-frequency rates. However, without the magnets the maximum plasma power which could be applied was less than 80 W for the RF and 200 W for the pDC, using the graphite target, and 300 W RF and 200 W pDC using the titanium target. Attempts to apply higher powers resulted in very unstable plasmas and plasma extinction. The thickness uniformity, hardness and adhesion of the films to the substrates were strongly dependent on whether DC, RF or pDC was used.

Keywords
Sputtering
Magnetic field
DC
RF
Pulsed DC