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Thin film deposition using rarefied gas jet DR. SAHADEV PRAD-
HAN, Indian Institute of Science — The rarefied gas jet of aluminium is studied at
Mach number $Ma = (U_j / \sqrt{kb \, T_j / m})$ in the range $.01 < Ma < 2$, and Knud-
sen number $Kn = (1 / (\sqrt{2}\pi \, d^2 \, n_d \, H)$ in the range $.01 < Kn < 15$, using
two-dimensional (2D) direct simulation Monte Carlo (DSMC) simulations, to under-
stand the flow phenomena and deposition mechanisms in a physical vapor deposition
(PVD) process for the development of the highly oriented pure metallic aluminum
thin film with uniform thickness and strong adhesion on the surface of the substrate
in the form of ionic plasma, so that the substrate can be protected from corrosion
and oxidation and thereby enhance the lifetime and safety, and to introduce the
desired surface properties for a given application. Here, H is the characteristic di-
mension, U_j and T_j are the jet velocity and temperature, n_d is the number density
of the jet, m and d are the molecular mass and diameter, and kb is the Boltzmann
constant. An important finding is that the capture width (cross-section of the gas
jet deposited on the substrate) is symmetric around the centerline of the substrate,
and decreases with increased Mach number due to an increase in the momentum of
the gas molecules. DSMC simulation results reveals that at low Knudsen number
$((Kn = 0.01);$shorter mean free paths), the atoms experience more collisions, which
direct them toward the substrate. However, the atoms also move with lower mo-
mentum at low Mach number,which allows scattering collisions to rapidly direct the
atoms to the substrate.

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