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Thin film deposition using rarefied gas jet DR. SAHADEV PRADHAN, Department of Chemical Engineering, Indian Institute of Science, Bangalore-560 012, India — 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 Knudsen 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 understand 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 dimension, 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 momentum at low Mach number,which allows scattering collisions to rapidly direct the atoms to the substrate.

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