

### SLT#3 Physical vapor deposition (PVD)

3.1	Describe briefly the principle of thermal evaporation with Joule heating and e-beam. What materials are typically used, and what materials are difficult or impossible to consider? Draw the setup and explain the purpose of a planetary wafer system in evaporation?
3.2	Use a schematic illustration to describe the principle and system settings of a DC sputter system, including how plasma is generated, how the plasma is used for sputtering, and what materials can be sputtered?
3.3	What are the limitations of DC sputtering? How do RF and magnetron sputtering solve these problems? What are the differences regarding their system design compared to DC sputtering?
3.4	Assume you must deposit a ~30 nm thick layer of Al <sub>2</sub> O <sub>3</sub> on a non-flat substrate with some 3D surface profile [1]. Compare working principles of CVD, ALD, and PVD to derive an ideal deposition method from perspective of deposition principle, temperature, film quality, and step coverage.
3.5	Discuss challenges in PVD related to the thin film growth mechanism, adhesion of PVD films to surfaces, and stress as function of deposition parameters. What are possible post-deposition treatments to resolve those challenges?
3.6	Compare the relevant PVD techniques for evaporation, sputtering, molecular beam epitaxy (MBE), pulsed laser deposition (PLD), and ion (beam) assisted deposition (I(B)AD) in terms of material of choice, working pressure and temperature, and controllability.

[1] Besides SiO<sub>2</sub>, alumina (Al<sub>2</sub>O<sub>3</sub>) is a dielectric and encapsulation material used in transistor fabrication.