Microelectronics processing

1. You are tasked with the problem of growing VO_2 thin film on a platonic substrate by evaporation. This is a challenging material to work with due to the strict requirement for compositional control to obtain desirable functional properties. Derive an expression for optimal oxygen partial pressure for obtaining the exact stoichiometry. State all variables. *Note: first, derive the impingement rate for V atoms. For the final answer, check whether your approach is feasible, by considering the scattering of V atoms during the deposition.*

2. Light interaction with photoresist and modification of the physical properties enables lithography and device fabrication. assume the photoresist is a dilute mixture with the photo active compound along with the rest of the solvent we discussed in class. Light interaction can be considered along two approaches. One, the light propagation through the resist can be described by Beer-Lambert law. Second, the electronic properties of the active medium in the resist result in electron excitation processes from photon absorption. Derive a relationship between the macroscopic absorption co-efficient and the microscopic absorption process. State all variables.

3. If the pumping speed is constant (and known), derive a relation between pumping speed and pump down time in a vacuum system, say from atmospheric pressure to some low value. How is this derivation modified if we want to pump from moderate vacuum to high vacuum?

4. SiGe alloys are widely used in electronics for transistors and opto-electronics. Consider the case of silicon replacing germanium in GeO_2 as an additional mechanism during thermal oxidation of this alloy. This can indeed occur under some conditions since SiO_2 is a rather stable compound. Derive an expression to estimate the oxide growth rate in this scenario. *Note: you may use the Deal-Grove model of pure silicon (dry) oxidation as a starting point.*