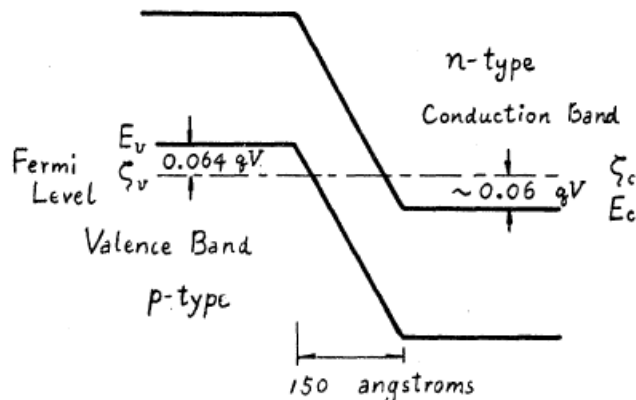


Practice problems, *Microelectronic Processing*

- Lithography resolution is critically dependent on the photoresist as we have discussed in class. Photoresist typically consists of a mixture of three components that absorb light, namely an inhibitor, resin and reaction products. Let us assume that light intensity decays exponentially as it propagates through the resist layer with distinct absorption co-efficient for each of these components. A reasonable assumption to make is that the resin does not change concentration during the exposure period. Write down expression for change in intensity though thickness. Write down an expression for destruction of the inhibitor with exposure time. State all variables.
- Researchers have been continuously improving the Deal-Grove oxidation model ever since its publication to improve the match to experimental data and apply to various other semiconductor systems in a more general setting. In this regard, let us consider one specific scenario. Assume the reaction at the $\text{SiO}_2\text{-Si}$ interface is directly proportional to the oxidant concentration at the interface, with reaction rate co-efficient k . Also, let the oxidation reaction at the silicon interface occur due to the entire incoming flux of oxygen from the previously formed oxide film. Derive an expression for the rate of oxide growth. State all variables.
- A pressurized chamber contains a hole of area A due to a manufacturing defect. Consider the case when the container is used to store a gas species which escapes into a region where its concentration is zero. Derive an expression for the flow rate of the gas through this defect. State all variables.
- Derive an expression for the specific contact resistance of a metal-semiconductor junction for the case when the dominant transport mechanism is emission across the barrier. Explain quantitatively what happens when the semiconductor Fermi level approaches $3kT$ of the band edge.
- Derive a simple expression between time to failure and atomic flux divergence in a metal interconnect wire subject to strong electric field. Assume V_c is the critical mass depletion volume needed for onset of electromigration failure. State all variables.
- Leo Esaki observed in 1958 that the current transport characteristics in heavily doped p-n junctions of crystalline germanium showed negative differential resistance. The band diagram for this junction is shown below, taken from his original paper in Physical Review.



Considering the modular topics covered in our course, create step-by-step diagram showing a process integration scheme to fabricate a complete Esaki device that can be electrically studied. Subsequently, estimate the depletion width for such a prototypical device and compare your answer to Esaki's analysis.