MINOR-1

Elements of Materials Processing (PYL116)

Time: 60 minutes | **02 Feb, 2017 (9:30 AM)** | **Max. Marks: 25**

1. (a) Describe the three basic growth modes for the nucleation of epitaxial thin films on a substrate. Write the value of contact angle θ in each case. (4)

   (b) Draw a sketch (**no explanation**) showing the influence of misfit on the regime of influence for the three thin film growth modes in terms of surface energy ratio $(\gamma_s-\gamma_f)/\gamma_s$. (2)

2. (a) Show graphically the variation of nucleus density with time at different substrate temperatures. (2)

   (b) Comment on the temperature dependence of ΔG^*, the energy barrier for nucleation during heterogeneous nucleation process. (2)

3. What do you understand by the terms grains and grain boundaries in a thin film? How can you find out experimentally about the existence of grains in a thin film? (3)

4. (a) What do you understand by the terms homoepitaxy and heteroepitaxy? Give one example for each case. (3)

   (b) Suppose an ultrathin (say 10 nm) epitaxial layer of $Ge_{0.10}Si_{0.90}$ is grown over crystalline Ge substrate. What kind of stress will exist in this epilayer? Explain. (2)

   (c) If a thick (say 1 micrometer) epilayer of GaN is grown over sapphire, what kind of stress will exist in this layer? Given a_o (sapphire) > a_o (GaN) and α (sapphire) > α (GaN). (2)

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5. If the interfacial energy increases by 10%, the homogeneous nucleation barrier for a spherical particle increases by
   (a) 10% (b) 20% (c) 30% (d) 40%

6. When the contact angle is 60°, the heterogeneous nucleation barrier height expressed as a fraction of the homogeneous barrier height is
   (a) ½ (b) ¼ (c) 1/8 (d) none of these

7. Write the **inequality relationship** among the various surface energies that leads to 2D (or layered) type of film growth on a substrate surface.

8. Chose the **condition(s)** that are favorable for obtaining films with **large grain size**.
   (a) Higher substrate temperature (c) Lower substrate temperature
   (b) High deposition rate (d) Lower deposition rate

9. How does the nucleation barrier height **vary** with substrate temperature?
   (a) Increase (b) Decrease