048

The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Final Examination –2005
ECD 2208 – Electronic Manufacturing Technology **(Closed Book)**

Time: 1330-1630 hrs. Date: 15.03.2006

Answer any five questions.

1. (a) State a relationship to determine the latent heat of evaporation of a metal using its vapor pressure and identify its parameters.
   (b) Calculate the vapor pressure of a metal to have an evaporation rate of 1.2×10^{14} $s^{-1}cm^{-2}$ at 1750 ^0C. State your assumptions if any. Also calculate the growth rate of the film.
   Atomic mass of the metal = 27
   1 torr. = 1.333×10^3 $dyne.cm^{-2}$
   Boltzmann's Constant = 1.38044×10^{-16} $erg.K^{-1}$
   Avogadro's number = 6.023×10^{23}
   Density of the film = 2.0 $g.cm^{-3}$
   (c) Describe briefly the operation of a method suitable for obtaining a film of an alloy by evaporation.

2. (a) Name popular reactions used to obtain silicon atoms for epitaxial growth.
   (b) Write the simplified overall reaction for each case above.
   (c) How does the deposition is avoided on the reactor tube used for epitaxial growth? What is the method used to heat the substrate?
   (d) Name the dopant gases used in epitaxy.
   (e) Explain why sapphire is chosen as an insulating substrate for silicon films.
   (f) What are spinels? Why are they more suitable as substrates?

3. (a) How does the material to be evaporated is removed in sputtering?
   (b) What is 'binding energy'? What is its significance in sputtering?
   (c) Sketch the graph of sputtering yield versus ion energy for a typical bombardment. Explain the curve with respect to its use in sputtering.
   (d) Briefly describe the use of reactive sputtering.
   (e) State the advantages of chemical etching. Name the method and techniques used to overcome these disadvantages.

4. (a) In oxidation of silicon, the two oxidizing species are oxygen and water vapor. Write down the equations of these chemical reactions.
   (b) Explain why the oxide formed is weak and porous when water vapor is used.
   (c) What is the use of chemical nitride films?
   (d) Write the reaction equations for the methods producing silicon nitride.
   (e) What are the two types of photo resists and their major differences?

5. (a) What is ion implantation? State the advantages of it over diffusion.
   (b) Identify the parameters of the following equations.

$$S_n^o = K_1 \frac{Z_1 Z_2}{\sqrt{Z_1^{2/3} + Z_2^{2/3}}} \frac{M_1}{M_1 + M_2}$$

$$S_e(E) = K_2 \sqrt{E}$$

(c) What is 'critical energy' with respect to ion implantation? Obtain an expression for 'critical energy".

(d) Arsenic atoms with 200 KeV energy are implanted in an amorphous silicon target. If $K_1 = 2.5\times10^{-15}$ eVcm^2 and $K_2 = 0.2\times10\text{-}15$ eV$^{1/2}$cm^2, comment on the energy loss mechanism of arsenic atoms giving the reasons.

element	atomic mass	atomic number
arsenic	1.24×10^{-22} g	33
silicon	4.66×10^{-23} g	14

(e) Briefly explain 'channeling'.

6. (a) Draw the cross section of a junction isolated bipolar structure.
(b) Name the method used to reduce the undesirable effects of the basic junction isolated circuit.
(c) Write the advantages of beam-lead sealed junction circuit.
(d) Name the material used to isolate regions when using countersunk oxide isolation method.
(e) Explain the necessity to remove silicon from the inter island channels before oxidation in countersunk oxide isolation method.
(f) Name the methods used to provide isolation in the V-groove isolation method.

7. (a) Explain why a device is sectioned to determine the junction depth.
(b) Explain the reasons for staining.
(c) Draw a schematic diagram showing measurement of junction depth by lapping.
(d) What are the disadvantages of voltage dependent monolithic capacitors?
(e) Draw the cross section of a voltage independent monolithic capacitor.
(f) Explain how a non-polar capacitor is made out of tantalum thin film capacitors. State one disadvantage of this scheme.

8. (a) State one important advantage of thin film resistors over integrated circuit resistors.
(b) A 25 mW integrated meander resistor of 10 KΩ is made by a resistor material of power density 10 Wcm^{-2}. If the resistor is having 8 meanders, estimate the sheet resistance of the material and the minimum track width required. What are the other dimensions of the resistor? You may use the following assuming usual notation.

$$n = \left[\frac{w_p}{w_l} - 2 + \frac{w_s}{w_l} + 2K_1\right]\frac{l_p - w_s}{w_s + w_l} + \frac{w_s}{w_l} + 2K_2 \qquad \text{where,}$$