M.TECH/VLSI/1ST SEM /VLSI 5103/2015

2015

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Microelectronics Technology and IC Fabrication
(VLSI 5103)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following: **10 x 1=10**

(i) The active components in an Integrated Circuit are
(a) resistors (b) capacitors (c) transistors (d) all of the above.

(ii) Electronic grade silicon has a purity level at least of about
(a) 98% (b) 99% (c) 99.9999% (d) 99.9999999%.

(iii) Isotropic etching occurs in
(a) all directions (b) in a particular direction
(c) in two directions (d) none of the above.

(iv) Optical masking is used for
(a) pattern transfer (b) protection
(c) cleaning (d) none of the above.

(v) The liquid source employed for basic diffusion of Phosphorous in Silicon is
(a) P_2O_5 (b) PH_3
(c) $POCl_3$ (d) PH_4.

(vi) For deposition of SiO_2 over polysilicon or in order to obtain excellent SiO_2 film uniformity which of the of the following chemical reactions are normally employed ?
(a) Oxygen reduction of SiH_4 at 450°C
(b) Oxygen reduction of PH_3 at 450°C
(c) Decomposition of $Si(OC_2H_5)_4$ Tetraethylorthosilicate at 700°C
(d) Reacting dichlorosilane, $SiCl_2H_2$ with nitrous oxide at 900°C.

(vii) VPE stands for
(a) vapour phase epitaxy (b) vacuum phase epitaxy
(c) vapour phase etching (d) none of the above.

(viii) Photoresist is a __________ compound
(a) radiation-sensitive
(b) radiation-insensitive
(c) radiative
(d) non-radiative .

(ix) Sputtering is a __________ process
(a) physical (b) chemical (c) mechanical (d) none of the above.

(x) Metallization is used for
(a) interconnection
(b) packaging
(c) protection
(d) all of the above.

Group – B

2.(a) Mention the uses of SiO_2 in the IC fabrication industry.

(b) Differentiate between dry and wet oxidation. Write down the corresponding chemical equations. Explain with a suitable schematic diagram a typical horizontal tube oxidation furnace set-up.

4 + (1+2+5) = 12

3.(a) Describe with suitable schematic diagram, the processes carried out for growth of silicon in silicon float zone technique.

(b) Describe the relative importance of Silicon Float zone technique & Czochralski method in production of very pure single crystal silicon. Discuss the neutron irradiation technique for fractional transmutation of silicon into phosphorous.

6+6=12

Group – C

4.(a) What is wet chemical etching? What are the characteristics of an ideal etchant used for wet chemical etching?

(b) Discuss Buffered Oxide Etching, its advantages and limitations.

(1+5)+6=12

5.(a) Discuss the basic diffusion process in silicon (with suitable schematic diagram of an open tube diffusion system. Distinguish between vacancy diffusion and interstitial diffusion.

(b) What is Fick's diffusion equation? Find the solution to the Fick's diffusion equation for constant total dopant diffusion.

6+6=12

Group – D

6.(a) State the advantages and disadvantages of ion-implantation.

(b) Use the LSS theory to calculate the implant dose required to give a peak dopant concentration of $5x10^{18}$ boron atoms cm^{-3} in an n-type Si, doped with 10^{15} phosphorous atoms $cm^{-3}$when boron is implanted at 200 keV into Si. Given the lateral straggle for boron ions at 200 keV is 0.086 micron.

7+5=12

7.(a) Write down the chemical equations governing the deposition of SiO_2 and Si_3N_4 from (i) silane (ii) dichlorosilane

(b) What is sputtering? How is it advantageous as compared to the different evaporation techniques used in film depositions?

8+4=12

Group – E

8.(a) List the properties that a material must have to be useful as an interconnect.

(b) What do you mean by aluminium junction spiking? Discuss how it can be overcome.

4+(5+3)=12

9.(a) Distinguish between CMOS & BiCMOS technologies. Draw the cross sectional structure of a CMOS inverter.

(b) Discuss the fabrication sequences of Ga As MESFET. Mention some important features of Ga As MESFET.

8+4=12