

**M.TECH/AEIE/2ND SEM/AEIE 5202/2015
2015**

**Micro Sensor Science and Technology
(AEIE 5202)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

***Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one 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 alternative for the following:

10 x 1=10

(i) The toughest plane for processing in a single silicon crystal is:

- | | |
|---------------------|----------------------|
| (a) The (100) plane | (b) the (110) plane |
| (c) The (111) plane | (d) the (101) plane. |

(ii) Photolithography is used in microfabrication

- (a) to take photograph of micro-device
- (b) to create patterns in micro-scale on substrate
- (c) to develop pictures on micro scale
- (d) to create pictures on micro-device.

(iii) Any material that develops a change in electrical properties after being exposed to certain gases, can be used as a

- | | |
|---------------------|---------------------|
| (a) chemical sensor | (b) bio-sensor |
| (c) thermal sensor | (d) optical sensor. |

(iv) The deflection of the thin diaphragm in micro-pressure sensors is measured by

- | | |
|----------------------|---------------------|
| (a) mechanical means | (b) optical means |
| (c) electrical means | (d) chemical means. |

(v) The most popular structural material in surface micromachining is:

- | | |
|---------------------|-----------------|
| (a) Silicon | (b) Polysilicon |
| (c) Silicon dioxide | (d) PSG. |

(vi) One of the principal advantages of LIGA process is its ability to produce:

- | | |
|--|-----------------------------------|
| (a) microstructures with high aspect ratio | (b) microstructures with low cost |
| (c) microstructures with precise dimension | (d) none of the above. |

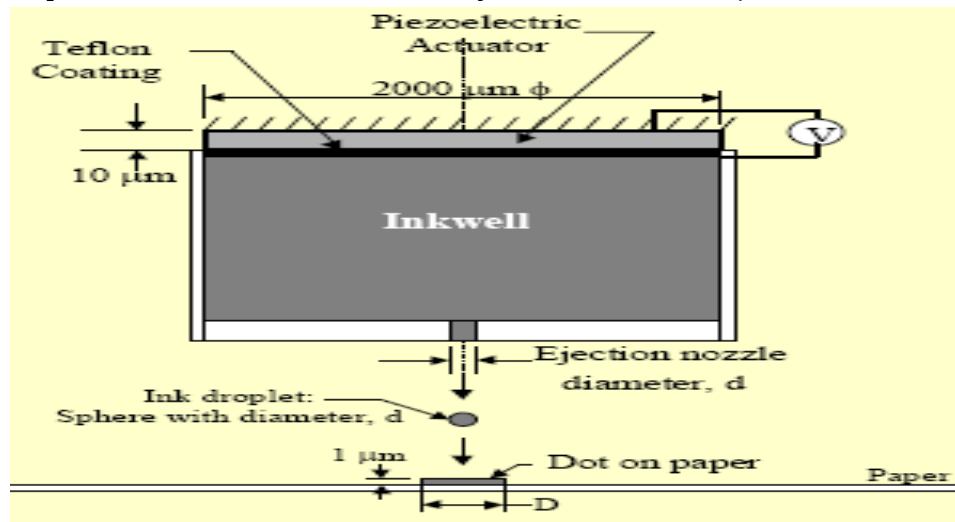
(vii) Diffusion analysis is based on

- | | |
|-------------------|--------------------|
| (a) Fourier's Law | (b) Fick's law |
| (c) Hooke's Law | (d) Coulomb's Law. |

- (viii) For sustaining of plasma, one needs to keep supplying
 (a) high temperature (b) high pressure
 (c) high electric field (d) all of the above.
- (ix) Stiction in finished micro-structures is made by
 (a) bulk micromachining (b) surface micromachining
 (c) LIGA (d) LASER microfabrication.
- (x) DRIE stands for
 (a) dry etching (b) dry reactive ion etching
 (c) deep reactive ion etching (d) direct reactive ion etching.

Group - B

- 2.(a) "Silicon- an ideal substrate material for micro-sensor fabrication" – why? Why are Polymers preferred as industrial material?
- (b) Determine the required electric voltage for ejecting a droplet of ink from an inkjet printer head using PZT piezoelectric crystal as a pumping mechanism. The ejected ink will have a resolution of 300 dpi (dots per inch). The ink droplet is assumed to produce a dot with a film thickness of 1 μm on the paper. The geometry and dimension of the printer head is shown below. Assume that the ink droplet takes a shape of a sphere and the inkwell is always re-filled after ejection.



(4+3)+5=12

- 3.(a) Explain the difference between physical vapour deposition and chemical vapour deposition techniques. How does metal vapour form in sputtering? What is used as carrier gas in sputtering?
- (b) What is the mechanism of DRIE? State the difference between dry and wet etching.
 (3+2+2)+(2+3)=12

Group - C

- 4.(a) State the different types of Chemical vapour deposition techniques in micro-fabrication process.
- (b) What are the advantages of positive photo resist over negative photo resist in photolithography? Which type of light source is used in photolithography? What is PLASMA and how do you produce it?

(5)+(2+1+4)=12

- 5.(a) What are the applications of micro-grippers? Explain the mechanical problem associated with surface micromachining.
- (b) Write short notes on any two:
(i) Piezoelectric crystals
(ii) Sputtering
(iii) Doping mechanism in semiconductor.

(3+3)+(3+3)=12

Group - D

- 6.(a) Why are electrostatic forces used to run micromotors rather than conventional electromagnetic forces? Explain why this actuation technique is not used in macrodevices and machines.
- (b) When will you prefer LIGA process? Define its advantages over the conventional micro machining technologies.

(4+3)+(2+3)=12

- 7.(a) What are the mechanical aspects one should consider for designing a diaphragm based micro-pressure sensor? Specify the reasons of selecting LB films as good conducting material.
- (b) Why is GaAs treated as excellent material for photoelectronic applications? What do you mean by SU-8 photoresistive material?

(2+4)+(3+3)=12

Group - E

8. Write short notes on the followings:
i) Pattern generation and transfer using masking
ii) Bio-sensor
iii) Scaling in miniaturization.
iv) Sensor networking

(3+3+3+3)=12

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- 9.(a) Define “Smart Sensor” in electronic measurement system. How does micro electronics differ from micro-system?
- (b) Write short note on any one of the followings: -
- i) Ion implantation vs. diffusion
 - ii) Low pressure chemical vapor deposition vs. Oxidation
 - iii) Optical sensor vs. Thermal sensor.

(3+6)+3=12