SOFT METHODS IN MICROSTRUCTURE FABRICATION (CHEN 4127)

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)

Choose the correct alternative for the following: $10 \times 1 = 10$ 1. (i) The first commercial example of a microfluidic device (a) Lab on chip device (b) inkjet printer (c) injection syringe (d) none of above (ii) One component of a microfluidic device is (a) syringe pump (b) droplet (c) fluidic interconnect (d) microreservoir The material most commonly used for soft lithogprahy can be classified as (iii) (a) a thermoplast (b) an elastomer (d) a metal (c) a photopolymer (iv)Which of the following statement is true _____ (b) PDMS is a thermoplast (a) SU8 is an elastomer (c) SU8 is light sensitive (d) PDMS is light sensitive (v) paper microfluidic The technique most commonly used device in (a) patterning to create water resistant channels (b) creating 3d channels for fluidic interconnects (c) building 2d structures with paper as substrate (d) using it as an absorber to store fluids (vi) CMC value decrease with during polypropylene oxidepolyethylene oxide block polymerization. (a) an increase in the polyethylene oxide chain length (b) a decrease in the polyethylene oxide chain length (c) an increase in the polypropylene oxide chain length (d) a decrease in the polypropylene oxide chain length

(vii)	0	for calcium algina 54 nm UV at 50°C (b) 3 hours		U C	gel is generally (d) 5 hours	a	ıt
(viii)	(a) superlattices	anostructures are comprised of Iperlattices norphous material		f (b) planar networks (d) none of above			
(ix)	Langmuir Blodget process is used to (a) deposit a solid monolayer on the substrate (b) deposit a liquid film monolayer on the substrate (c) deposit resist material on substrate (d) deposit a thin polymer layer on substrate						
(x)	Self assemnbly o (a) van der waal (c) both (a) and ('s forces		(b) hydrog (d) none of	en bonding Fabove.		

Group-B

- 2. (a) How would you mathematically express the force needed to separate two interfaces that are joined together by Van der Waal's force? Explain all terms in expression. [(CO1) (Remember/LOCQ)]
 - (b) A liquid bubble is formed on a solid-air interface. What factors govern the spread of the droplet on the solid surface? [(CO1) (Understand/LOCQ)]
 - (c) How would oil spread on a solid surface? Explain in terms of spreading coefficient and surface tension. [(CO1)(Analyze/IOCQ)]

5 + 5 + 2 = 12

- 3. (a) When two polar molecules are introduced in aqueous phase, what interaction starts to happen? [(CO2) (Remember/LOCQ)]
 - (b) When two planes ae bound by adhesion, explain mathematically the expression for the force needed to separate them. [(CO2)(Apply/IOCQ)]
 - (c) For gases, what is the fundamental scale used. State mathematically.

[(CO4)(Analyse/IOCQ)] 4 + 5 + 3 = 12

Group - C

- 4. (a) Explain the chemistry by which cross-linking takes place in PDMS. [(CO2) (Remember/LOCQ)]
 - (b) Explain with step-wise sketch how a mu-pad device is created.

[(CO2) (Understand/LOCQ)]

(c) What properties of PDMS make it the preferred polymer in soft lithography?

[(CO2)(Remember/LOCQ)]

3 + 6 + 3 = 12

- 5. (a) What is dry etching? Draw a schematic of the equipment explaining the process by which dry etching is performed. [(CO2) (Understand/LOCQ)]
 - (b) With relevant diagrams, explain the difference between positive and negative tone photoresist. Give examples of each. [(CO2) (Apply/LOCQ)]

6 + 6 = 12

Group - D

- 6. (a) In a core-shell hydrogel preparation what is the purpose of entrapping "bait" within the core of the hydrogel? If a small protein (pI=6) needs to be concentrated from a solution with pH=4 using core-shell hydrogel, what will be the nature of the "bait" one must consider? For the same protein if the recovery will be made from a solution with pH=9, what will be nature of the "bait"? [(CO3) (Understanding/LOCQ)]
 - (b) Drug for cancer treatment is entrapped within a hydrogel made up of 'A' (pKa~6) as one of the hydrogel components. *In-vitro* study shows that drug is more prone to be released at pH=2 compared to pH=9. What can we conclude about the surface charge of the hydrogel? If the intracellar matrix shows alkaline nature, what do you feel about the efficacy of the drug on tumor cell? Provide proper justification on your conclusion. [(CO3) (Evaluate/HOCQ)]
 - (c) Develop a surfactant system (HLB 10) after combining two surfactants A (HLB 17) and B (HLB 3) to use it for the hydrogel preparation using emulsion polymerization. [(CO3)(Analyze/IOCQ)]

(2+2+2) + (2+2) + 2 = 12

7. (a) During hydrogel preparation using block copolymerization unimers A_n and B_m are there in the system at a constant mass ratio 2:1, when n=50 and m=100. The aggregation or CMC value is 1 mM. What happens to the CMC (more or less than 1 mM), when n=100 and m=50? Justify your answer with appropriate reasoning. Given: Mass ratio=2:1, A_n is hydrophilic and B_m is hydrophobic.

[(CO3) (Analyze/IOCQ)]

(b) During the preparation of hydrogel using 0.17g of alginate and 2 g of PAAM, it was seen that the final percentage of alginate is 6.5% (w/w) based on the total amount of alginate, PAMM, Potassium persulfate and bisacrylamide in the product sample. Two types of samples were prepared, where sample A was prepared in 0.2 ml of water and sample B was prepared in 7 ml of water. Which of the sample will appear as hydrogel and elaborate the reason for your decision? Density of water = 1 g/ml. [(CO3) (Evaluate/HOCQ)]

(c) "Precipitation polymerization process for hydrogel preparation increases the purity of the hydrogel compared to emulsion polymerization" – Justify the appropriateness of the statement. [(CO3) (Analyze/IOCQ)]

(2+4) + (3+1) + 2 = 12

Group - E

- 8. (a) Describe the process of gelation with a sketch. [(CO4) (Remember/LOCQ)]
 - (b) What are the types of bonds present in a gel matrix? What types of structures that have been developed with a gel matrix? [(CO4) (Understand/LOCQ)]

6 + 6 = 12

- 9. (a) Explain the fundamental principle of LbL assemblies. [(CO4)(Remember/LOCQ)]
 - (b) How is LbL aseemblies different from films draw with LB process?

[(CO4) (Understand/LOCQ)] 6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	70.84%	20.83%	8.33%

Course Outcome (CO):

After the completion of the course students will be able to:

- 1. Demonstrate the concept of microscopic system.
- 2. Identify various applications and fabrication methods of microfluidics.
- 3. Illustrate the basics of hydrogels and its fabrication technologies.
- 4. Summarise the concept of organometallic structure and compare various methods of self-assembly of organic molecules in nanostructures.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
BT	https://classroom.google.com/c/NDA1MzEwNzgxNjU4/a/NDU00TIzMTk3MzM2/details