CH62052: Instability Class Test: Spring 2023-2024

Total Marks 20

Please choose the correct Answer and write in the designated box on the first page.

There is only one correct answer and no negative marking.

You have to return the entire booklet. Please do not detach any pages.

SERIES E

Name: **Roll No.**

Answers: (Maximum one striking off is allowed)

Question No	Answer	Question No.	Answer
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

Questions:

1) Identify the correct statement:

a) The assumption that two objects while in contact has a minimum separation distance d_0 is attributed to Born Repulsion
b) Induced dipole – induced dipole type van der waal's interaction is a consequence of Hard sphere approximation.
c) There can be polar interaction between molecules that does not have permanent dipole.
d) The internal potential energy of ideal gas molecules is much higher than internal Kinetic Energy of these gas molecules.

2) For a film to become unstable:

a) Disjoining pressure must be positive and its strength higher than that of Laplace pressure
b) Disjoining pressure must be positive and its strength lower than that of Laplace pressure
c) Disjoining pressure must be negative and its strength higher than that of Laplace pressure
d) Disjoining pressure must be negative and its strength lower than that of Laplace pressure

3) Identify the odd entry.

a) Conjoining pressure
b) Young's Equation
c) Marangoni Flow
d) Hole formation

4) Laplace pressure in a thin film:

a) Stabilizes the film once holes form.
b) Destabilizes the film and aids hole growth.
c) Opposes destabilization till the film ruptures.
d) Responsible for hole growth.

5) Pick up the correct statement

a) The necessary condition for a thin film to become unstable is $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h}$ is positive. Also $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h} = \frac{A_E}{6\pi h^2}$ and therefore A_E is positive for an unstable film.

b) The necessary condition for a thin film to become unstable is $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h}$ is positive. Also $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h} = -\frac{A_E}{6\pi h^2}$ and therefore A_E is positive for an unstable film.

c) The necessary condition for a thin film to become unstable is $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h}$ is negative. Also $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h} = \frac{A_E}{6\pi h^2}$ and therefore A_E is negative for an unstable film.

d) The necessary condition for a thin film to become unstable is $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h}$ is negative. Also $\frac{\partial(\Delta G_{Ex}^{lw})}{\partial h} = -\frac{A_E}{6\pi h^2}$ and therefore A_E is positive for an unstable film.

6) Soft baking in photolithography is required for

a) Creation of a replica
b) Removal of the photoresist
c) Removal of the remnant solvent from the Photo Resist Layer
d) Crosslinking of the photoresist.

7) The effect of Entanglement will be maximum in a:

a) Linear Polymer with short chain length
b) Linear Polymer with long chain length
c) Branched Polymer with long chain length
d) Branched Polymer with short chain length.

8) Identify the correct sequence of events:

a) Barrier Layer formation – Spin coating– soft baking – exposure – post baking.
b) Barrier Layer formation – Spin coating – hard baking – etching – post baking.
c) Barrier Layer formation – Spin coating – soft baking – etching – post baking.
d) Barrier Layer formation – Spin coating– soft baking – exposure – hard baking.

9) The expression for the van der Waals component excess free energy between two thick blocks of thickness d_1 and d_2 separated by a distance d

a) $$\Delta G^{LW} = -\frac{A_{12}}{12\pi}\left(\frac{1}{d^2} - \frac{1}{d^2 + d_1^2 + d_2^2}\right)$$

b) $$\Delta G^{LW} = \frac{A_{12}}{12\pi}\left(\frac{1}{d^2}\right)$$

c) $$\Delta G^{LW} = -\frac{A_{12}}{12\pi}\left(\frac{1}{d^2} - \frac{1}{d_2^2} - \frac{1}{d_1^2}\right)$$

d) $$\Delta G^{LW} = -\frac{A_{12}}{12\pi}\left(\frac{1}{d^2} + \frac{1}{d_2^2} + \frac{1}{d_1^2}\right)$$

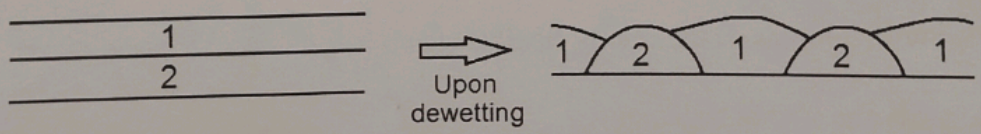
10) What is the profile of the polymer meniscus at the intermediate stage of patterning by Nano Imprint Lithography?

a) Flat Surface
b) Convex downwards
c) Convex upwards
d) undulating meniscus

11) Which statement is correct about MIMIC (Micro Moulding in Capillaries)?

a) There is no pattern height reduction in MIMIC
b) MIMIC results in patterns with residual polymer layers
c) A non-wettable stamp is required for MIMIC
d) MIMIC cannot be used for making isolated structures

12) In a polymer bilayer comprising of polymer 1 and polymer 2, the following final morphology is observed upon dewetting.



Which rupture sequence is true?

a) Bottom layer ruptures first below an intact top layer followed by dewetting of top layer over the dewetted bottom layer droplets.
b) Bottom layer ruptures first below an intact top layer followed by dewetting of top layer at locations where the top layer is in contact with the substrate
c) Simultaneous rupture of top and bottom layer.
d) Top layer ruptures first followed by bottom layer

13) Hard baking is performed after:

a) Coating Photo Resist Layer
b) After Development
c) After etching and subsequent removal of strengthened Photo Resist patterns.
d) After etching before subsequent removal of strengthened Photo Resist patterns.

14) For a colloid to be stable (identify up the correct statement):

a) The strength of the polar interaction between the colloids and the liquid must be higher than the strength of the van der Waal's interaction between them.
b) The strength of the polar adhesive interaction between the colloids and the liquid must be higher than the strength of the van der Waal's interaction between them.
c) The strength of the polar cohesive interaction between the colloids and the liquid must be higher than the combined strength of the polar adhesive interaction and the van der Waal's interaction between them.
d) The strength of the polar adhesive interaction between the colloids and the liquid must be higher than the combined strength of the polar cohesive interaction and the van der Waal's interaction between them.

15) In Nano Imprint Lithography, pattern replication takes place due to:

a) Visco Elastic Deformation of a Soft Solid Polymer Layer
b) Visco Plastic Deformation of a liquefied high viscosity Polymer Layer
c) Due to cross linking of a thermos curable polymer
d) Rise of capillary meniscus along the contours of the stamp.

16) In Nano Imprint Lithography, the extent of accumulated residual stress will

a) Increase with the molecular weight of the polymer to be patterned.
b) Decrease with the molecular weight of the polymer to be patterned.
c) Is independent of the molecular weight of the polymer to be patterned.
d) Depend on the Temperature at which patterning is performed.

17) Capillary force Lithography (CFL) is best performed:

a) With a low surface energy rigid stamp
b) With a high surface energy rigid stamp
c) With a low surface energy flexible stamp
d) With a high surface energy flexible stamp

18) Identify the wrong statement

a) Nano Imprint Lithography always requires a rigid stamp.
b) Micro transfer Molding always requires a rigid stamp.
c) Micro Molding in capillaries always requires a flexible stamp.
d) Micro Contact Printing always requires a flexible stamp.

19) A 400 nm thick Polystyrene ($\gamma_{PS} \approx 40$ mJ/m^2) film on a surface coated with Teflon

a) Is thermodynamically stable and will remain intact with time.
b) Is thermodynamically stable but will rupture with time.
c) Is thermodynamically unstable but will remain intact with time.
d) Is thermodynamically unstable and will rupture with time.

20) In micro contact printing, the type of surface-active molecules that are used are:

a) Thiols, and the end group that attaches to a surface is S.
b) Silane, and the end group that attaches to a surface is S.
c) Thiols, and the end group that attaches to a surface is Si.
d) Silane, and the end group that attaches to a surface is Si.