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NPTEL

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Courses » Heat Treatment and Surface Hardening-I

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## Unit 7 - Week-6

### Course outline

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- Maximum nucleation rate for homogeneous nucleation
- Maximum nucleation rate for heterogeneous nucleation
- Nucleation kinetics in solid state
- Interface controlled growth
- Diffusion controlled growth
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### Assignment 6

The due date for submitting this assignment has passed. **Due on 2018-03-21, 23:59 IST**  
As per our records you have not submitted this assignment.

1) Which of the following statement is correct?

1 point

- Below the critical nucleation rate, rapid nucleation takes place.
- Nucleation rate always increases with increase in undercooling.
- Barrier to nucleation increases with increase in undercooling.
- Undercooling required for homogeneous nucleation is larger than that for heterogeneous nucleation under the similar condition.

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*Undercooling required for homogeneous nucleation is larger than that for heterogeneous nucleation under the similar condition.*

2) During a phase transformation, nucleation rate of  $10^9 \text{ m}^{-3}\text{s}^{-1}$  occurs at 250 K when the critical nucleation energy is  $3 \times 10^{-19} \text{ J}$ . If the nucleation energy for critical sized nucleus is decreased by 10 %, the nucleation rate ( $\text{m}^{-3}\text{s}^{-1}$ ) will be

1 point

- $6 \times 10^{12}$
- $4 \times 10^{11}$
- $3 \times 10^{14}$
- $2 \times 10^{13}$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*$6 \times 10^{12}$*

3) The homogeneous nucleation rate of  $10^7 \text{ m}^{-3}\text{s}^{-1}$  occurs at 300 K during a liquid to solid phase transformation when the nucleation energy for critical sized nucleus is  $1 \times 10^{-19} \text{ J}$ . The interfacial energy between the liquid-solid interface is  $0.09 \text{ J m}^{-2}$ . If the interfacial energy is increased by 10%, the nucleation rate ( $\text{m}^{-3}\text{s}^{-1}$ ) will be

1 point

- 2267
- 1238
- 3458
- 4623

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:***3458*

4) The critical homogeneous nucleation rate is  $10^6 \text{ m}^{-3}\text{s}^{-1}$  at 400 K. If it is desired to achieve a nucleation rate of  $10^9 \text{ m}^{-3}\text{s}^{-1}$ , the nucleation energy for critical sized nucleus ( $\Delta G^*$ ) should be decreased by [Assume  $I_0 = 10^{42} \text{ m}^{-3}\text{s}^{-1}$  and  $DG_D$  is significantly smaller than  $DG^*$ ] **1 point**

- 5.5 %
- 6.5 %
- 3.2 %
- 8.3 %

**No, the answer is incorrect.****Score: 0****Accepted Answers:***8.3 %*

5) During homogeneous nucleation, the radius of critical nucleus is 0.6 nm. The radius of critical nucleus (in the shape of spherical cap) during heterogeneous nucleation with a contact angle of  $75^\circ$  will be **1 point**

- 0.4 nm
- 0.5 nm
- 0.6 nm
- 0.7 nm

**No, the answer is incorrect.****Score: 0****Accepted Answers:***0.6 nm*

6) In heterogeneous nucleation, if the contact angle is  $0^\circ$ , then the barrier to nucleation will be **1 point**

- zero
- 1
- Infinity
- can not be calculated

**No, the answer is incorrect.****Score: 0****Accepted Answers:***zero*

7) During a heterogeneous nucleation (in the shape of a spherical cap), if the energies associated with various interfaces are  $\gamma_{SL} = 0.7 \text{ J m}^{-2}$ ,  $\gamma_{SM} = 0.02 \text{ J m}^{-2}$  and  $\gamma_{LM} = 0.5 \text{ J m}^{-2}$ , then the ratio of  $(\Delta G^*)_{\text{hetero}}$  to  $(\Delta G^*)_{\text{homo}}$  is **1 point**

- 0.017
- 0.124
- 0.068
- 0.094

**No, the answer is incorrect.****Score: 0****Accepted Answers:***0.068*

8) Two specimens A and B of the same material have the average grain sizes  $1\ \mu\text{m}$  and  $30\ \mu\text{m}$ , respectively. During the solid state phase transformation, the nucleation rate (assuming that the nucleation occurs heterogeneously on grain boundaries) will follow which of the following trend under the identical conditions. **1 point**

- Higher in specimen A
- Higher in specimen B
- Same in both the specimen
- Data in sufficient

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*Higher in specimen A*

9) During an interface controlled growth of copper, the activation barrier for an atomic jump is  $5 \times 10^{-20}\ \text{J}$ . If the jump distance is  $0.1\ \text{nm}$ , the growth rate at  $1300\ \text{K}$  (assuming a large undercooling) will be **1 point**

[Assume lattice vibration frequency =  $10^{13}\ \text{s}^{-1}$ ]

- 11.5 m/s
- 28.5 m/s
- 61.6 m/s
- 94.7 m/s

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*61.6 m/s*

10) Which of the following is incorrect for diffusion controlled growth? **1 point**

- Parabolic growth
- Growth is proportional to supersaturation
- Velocity is inversely proportional to time
- Growth rate is constant for a given undercooling

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*Growth rate is constant for a given undercooling*

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