

## Atomic bonding

Ionic: Anions gain electrons, cations lose electrons

Covalent: electrons shared between two atoms

Metallic: electrons shared between many atoms

Van der Waals: temporary or permanent dipole

Interacts with other objects

## Crystal structures

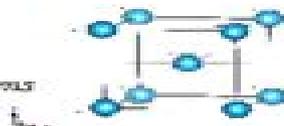
### BODY CENTERED CUBIC

$$4R = \sqrt{a^2 + a^2 + a^2}$$

$$4R = a\sqrt{3}$$

1 center atom, 8 corner atoms

2 atoms per unit cell



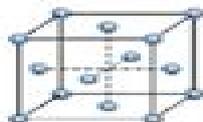
### FACE CENTERED CUBIC

$$4R = \sqrt{a^2 + a^2}$$

$$4R = a\sqrt{2}$$

6 face atoms, 8 corner atoms

4 atoms per unit cell



Volume of a cubic =  $a^3$

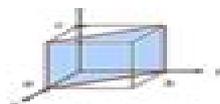
$$A = 10^{-10} \text{ m}$$

$$\text{Avogadro No} = 6.022 \times 10^{23} \left( \frac{\text{atoms}}{\text{mol}} \right)$$

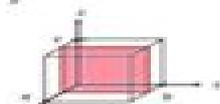
$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{\# \text{ of atoms} \times \text{atomic mass}}{\text{volume of unit cell} \times \text{Avogadro}}$$

## Miller Indices

crystal	h	k	l
1. Intercepts	1	1	1
2. Reciprocals	1/1	1/1	1/1
3. Reduction	1	1	1
4. Miller indices	(111)		



crystal	h	k	l
1. Intercepts	1/2	1	1
2. Reciprocals	2/1/2	1/1	1/1
3. Reduction	2	1	2
4. Miller indices	(212)		



$$\text{Planar Density} = \frac{\text{atoms per face}}{\text{area of face}}$$

$$\text{Packing Factor} = \frac{\text{volume of atom} \times \text{number of atoms}}{\text{volume of the unit cell}}$$

## Point Defects

$$n_v = n \cdot e^{-\frac{Q_v}{RT}}$$

$$n_v = \# \frac{\text{vacancies}}{\text{cm}^3}, n = \# \frac{\text{atoms}}{\text{cm}^3}$$

$Q_v$  = energy for 1 mol of vacancies,  $T$  = Temp

$$R = \text{Gas constant} = 1.987 \frac{\text{cal}}{\text{mol} \cdot K} = 8.314 \frac{\text{joules}}{\text{mol} \cdot K}$$

## Diffusion

$$D = D_0 \cdot e^{-\frac{Q}{RT}}$$

$D_0$  = constant based on material

$Q_v$  = energy for 1 mol of vacancies,  $T$  = Temp

$$R = \text{Gas constant} = 1.987 \frac{\text{cal}}{\text{mol} \cdot K} = 8.314 \frac{\text{joules}}{\text{mol} \cdot K}$$

$$J = -D \cdot \frac{dc}{dx}, x = \text{thickness}, J = \text{Flux} \text{ - Fick's 1st law}$$

$c$  = Compositions in atomic percent

## Mechanical Properties

$$\text{Engineering stress } (S) = \frac{F}{A_0}$$

$$\text{Engineering Strain } (e) = \frac{\Delta l}{l}$$

$$\text{Young Modulus } (E) = \frac{S}{e}$$

$F$  = Force,  $A_0$  = Area

$\Delta l$  = Change in length,  $l$  = Original length

$$K_f \text{ or } K_{fc} = f \sqrt{\pi a}$$

$\sigma$  = Exposed stress,  $a$  = flaw size

$f$  = geometry factor for the specimen and flaw

$K_{fc}$  = fracture toughness

$K_{Ic}$  = plain strain fracture toughness

$$\pm \sigma = 5.09 \cdot \frac{FL}{d^3}$$

$F$  = Applied Load,  $L$  = Length of shaft

$d$  = diameter of shaft

$$1 - K(V) = \exp \left[ - \left( \frac{\sigma}{\sigma_0} \right)^m \right]$$

$m$  = Weibull Modulus,  $\sigma_0$  = Flexural Strength

$F$  = Failure,  $\sigma_0$  = Initial Flexural Strength

$$\text{Poissons Ratio } (\nu) = \frac{-\epsilon_{lateral}}{\epsilon_{longitudinal}}$$

$$\text{Modulus of resilience } (E_r) = \frac{1}{2} (\text{yield strength}) (\text{strain@yielding})$$

$$\text{Ductility \%Elongation} = \frac{l_f - l_0}{l_0} \cdot 100\%$$

$$\text{Ductility \%Reduction in area} = \frac{A_0 - A_f}{A_0} \cdot 100\%$$

$$\text{True Stress} = \frac{F}{A_f}$$

$$\text{True Strain} = \ln \left( \frac{l}{l_0} \right)$$

$$\sigma_t = K \epsilon_t^n$$

$n$  = strain coefficient,  $K$  = Constant

$\epsilon_t$  = True strain,  $\sigma_t$  = True Stress

$$\sigma_m = 2\sigma_0 \left( \frac{a}{r_0} \right)^{\frac{1}{2}}$$

$\sigma_m$  = Stress @ Crack tip,  $\sigma_0$  = Applied stress

$a$  = Crack Length,  $r_0$  = radius of curvature

$$\sigma_c = \left( \frac{2E\gamma_s}{\alpha\pi} \right)^{\frac{1}{2}}$$

$\sigma_c$  = Critical Stress,  $E$  = elastic modulus

$\gamma_s$  = specific surface energy

$\alpha$  = one half length of internal crack

## Solidification and Nucleation

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**Padhraic Smyth**



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28 full papers and 17 short papers included in this book were carefully reviewed and selected from 109 submissions They were organized in topical sections as follows Full Conference Papers Work in Progress Interactive Entertainment Showcase and Student Competition

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to June 1915), with answers by tutors of University correspondence college London univ, exam. papers,1894      **National Educators' Workshop: Update 2002 - Standard Experiments in Engineering, Materials Science, and Technology** Edwin J. Prior,2003      **Mechanical Discipline-specific Review for the FE/EIT Exam** Michel A. Saad,1997 The FE exam the first in the two part engineering licensing process is taken typically by upper level students or recent graduates in April or October This eight hour exam is closed book except for a handout provided in the examination room The exam is divided into morning and afternoon sessions The morning exam with 120 multiple choice problems is the same for everyone In the afternoon examinees must choose to take a discipline specific DS or a general exam each with 60 multiple choice problems The Discipline Specific Reviews are used to study for the afternoon DS exams      Electrical Discipline-specific Review for the FE/EIT Exam Robert Brownell Angus,John E. Hajjar,Abdulrahman Yassine,1997 The FE exam the first in the two part engineering licensing process is taken typically by upper level students or recent graduates in April or October This eight hour exam is closed book except for a handout provided in the examination room The exam is divided into morning and afternoon sessions The morning exam with 120 multiple choice problems is the same for everyone In the afternoon examinees must choose to take a discipline specific DS or a general exam each with 60 multiple choice problems The Discipline Specific Reviews are used to study for the afternoon DS exams      Chemical Discipline-specific Review for the FE/EIT Exam Stephanie T. Lopina,1997 The best preparation for discipline specific FE exams 60 practice problems with full solutions Two complete simulated 4 hour discipline specific exam Covers all the topics for that particular discipline Provides the in depth review you need Topics covered Chemical Reaction Engineering Chemical Thermodynamics Computers Numerical Methods Heat Transfer Mass Transfer Material Energy Balances Pollution Prevention Process Control Process Design Economics Evaluation Process Equipment Design Process Safety Transport Phenomena      *El-Hi Textbooks in Print* ,1982      *Science model answers. Being the papers set at the intermediate and preliminary scientific examinations, July 1889, followed by full answers, by S. Rideal [and others].* London univ, exam. papers,1889      *Florida School Bulletin* ,1961  
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