Ch3:- Atomic and Ionic Arrangements.

- 3.1. Short-Range order versus long-Range order
- 3.2. Amorphous Materials: Principles and Technological Applications.
- 3.3. lattice, Unit cells, Basis, and Crystal structures.
- 3.4 Allotropic or Polymorphic Transformations
- 3.5. Points, Directions, and Planes in the unit cell.
- 3.6 Interstitial sites.
- 3.7. Crystal structures of Ionic Materials
- 3.8. Covalent structures.

3.1 Short-Range order versus long-Range order.

* short-Range order :- the regular and predictable arrangement of the atoms a short distance - usually one or two atoms spacings.

* long-Range order :- A reguler repetitive arrengement of atoms in a solid which extends over a very large distance

* Bose-Einstein Condensate (BEC): A newly experimentally verified state of a matter in which a group of atoms occupy the same quantum ground state

* classification of material based on the type of atomic order
  - Monoatomic Gases
  - Amorphes Material
  - liquid Crystal
  - crystallin Materials
    - single
    - polycrystalline

3.2. Amorphous Materials: Principles and Technological Applications.

* Amorphous material: Material, including glasses, that have no long-range order, or crystal structure.

* Glasses solid: non-crystalline materials (typically derived from the molten state) that have only short-Range atomic order.

* Glasses Ceramics: A family of materials (tipically derival from inorganic glasses and processed into crystalline materials whith very fine grain size and improved mechanical properties

3.3. Lattice, Unit cells, Basis and Crystal structures.

* lattice:- a collection of points that divide space into smaller equally sized segments.

* Basis:- A group of atoms associated with a lattice point.

* Unit cell:- A subdivision of the lattice that still retains the overall characterstics of the entire lattice.

* Atomic radius:- The apparent radius of an atom, typically calculated from the dimensions of the unit cell, using close-packed direction (depends upon coordination number)

* packing factor:- The fraction of space in a unit cell occupied by atoms.

note that :-

$$P.F = \frac{(\# \text{ of atoms})(\frac{4}{3}\pi r^3)}{a_0^3}$$

\# of atoms: = 1 SC, = 2 BCC, = 4 FCC

a_0:
- → $2r$ SC
- → $\frac{4r}{\sqrt{3}}$ BCC
- → $\frac{4r}{\sqrt{2}}$ FCC
- → $2r$ Hexagonal closed HC

$$\rho = \frac{(\# \text{ of atoms})(\text{atomic mass})}{(\text{volum of unit cell})(\text{Avogadro's})}$$

\# of atoms:
= 1 SC
= 2 BCC
= 4 FCC

Avogadro's → 6.023×10^{23}

volum of unit cell → Depend on structure

* cubic → a^3
* Tetragonal ⇒ a^2c
* Hexagonal ⇒ $0.866\, a^2 c$
* orthorhombic ⇒ abc
* Monoclinic ⇒ $abc \sin\beta$

HCP ⇒ $V = a_0^2 c_0 \cos\beta$

note that : # of atoms ≡ # of lattice Point

Change in volume %

$$= \frac{\text{final volum} - \text{initial volum}}{\text{final volum}} \times 100\%$$

3.4. Allotropic or Polymorphic Transformations

* Allotropy : the charactrestic of an element being able to exist in more than one crystal structure, depending on tempreture and Pressure

* polymorphsim :- compounds Appear more than one type of crystal structure.

3.5.

① Planer Density $= \dfrac{\text{atom per face}}{\text{area per face}}$ ⇒ a_0^2 ≡ lattice Parameter

② Packing fraction $= \dfrac{\text{area of atoms per face}}{\text{area of face}} = \dfrac{(\text{\# of atoms})\pi r^2}{a_0^2}$

area of face → a_0^2

3.5. Points, Directions, and Planes in the Unit cell.

* Miller indices :- A shorthand notation to describe certain crystallographic directions and planes in a material. Denote By [ ] brackets, A negative number is represented by a bar over the number.

* Directions of a form :- Crystallographic directions that all have the same characteristic, although their "sense" is defferent. Denote by ⟨ ⟩ brackets.

* Repeat distance :- The distance from one lattice point to the adjacent lattice point along a direction

* linear density :- The number of lattice points per unit length along a direction

* Packing factor :- the fraction of a direction (linear Packing fraction) or a plane (planer packing factor) that is actually covered by atoms or ions.

3.6. Interstitial site.

* interstitial site :- locations between the "normal" atoms or ions in a crystal into which another - usually different interstitial location is smaller than the atom or ion that is to be introduced

* cubic site :- An interstitial position that has a coordination number of eight. An atom or ion in the cubic site toches eight other atoms or ions.

* Octahedral :- An interstitial position that has a coordination numbal of six. An atom or ion in the octahedral toches six other atoms or ions.

* Tetrahedral :- An interstitial position that has a coordination number f four. An Atom or ion in the tetrahedral toches four other atoms or ions.

3.7. Crystal structures of Ionic Materials

⇒ factors need to be considered in order to understand crystal structures of ionically bonded solids :-

① Ionic Radii.
② Electrical Neutrality
③ Connection between Anion Polyhedra
④ Visualization of crystal structures using computers.

3.8. Covalent structures.

* Covalently bounded :- materials frequently have complex structures in order to satisfy the directional restraints imposed by the bonding.

* Diamond Cubic (DC) :- A special type of face-centered cubic crystal structure found in carbon, sillicon, and other covalently bounded materials.

→ $a_0 = \frac{8r}{\sqrt{3}}$, # of atoms = 8 ≡ # of littice point

3.9. Diffraction Techniques for Crystal structure Analysis.

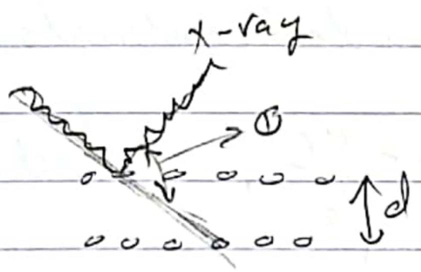
* Diffraction: the constructive interference, or reinforcement, of a beam of x-rays or electrons interacting with a material. The diffracted beam provides useful information concerning the structure of the material.

* Bragg's law:- The relationship describing the angle @ which a beam of x-rays of a particular wavelength diffracts from crystallographic planes of a given interplaner spacing.

* In a diffractometer:- a moving x-ray detector records the 2θ angles @ which the beam is diffracted, giving a characteristic diffraction pattern.

$$\sin\theta = \frac{\lambda}{2d} \Rightarrow d = \frac{\lambda}{2\sin\theta}$$

$$a_0 = d\sqrt{h^2+k^2+l^2}$$



* # of vecanses nv

$$nv = n \exp\left(\frac{-Q}{RT}\right)$$

Q → cal/g

T → Temp in K

R → 1.987 (gas const)

n ↓

$$\# \text{ of atoms} = \frac{\# \text{ of lattic point}}{a_0^3}$$

* # of vecancy per unit cell = lattic point − atoms/cell

$$\# \text{ of vecancy per } cm^3 = \frac{\text{per unit cell}}{\text{volum}}$$

Chapter 4 :- Imperfections in the Atomic and Ionic Arrangements.

* 4.1 Point Defects
* 4.2 Other Point Defects
* 4.3 Dislocations
* 4.4 Observing Dislocations
* 4.5 Significance of Dislocations
* 4.6 Schmid's law
* 4.7 Influence of Crystal Structure
* 4.8 Surface Defects
* 4.9 Importance of Defects

Definitions :-

4.1 Point Defects

* Point defects :- Imperfections, such as vacancies, that are located typically

* Extended defects :- Defects that involve several atoms/ions and thus occur over a finite volume of the crystalline material (e.g, dislocations, stacking faults,)

* Vecancy :- An atom or an ion missing from it's regular crystallographic site.

* Interstitial defect :- A point defect produced when an atom is placed into the crystal at a site that is normally not a lattice point.

* Substitutional defect :- A point defect produced when an atom is removed from a regular lattice point and replaced with a different atom, usually of a different size

4.2. Other Point Defects

* Interstitialcy :- A point defect caused when a "normal" atom occupies an interstitial site in the crystal.

* Frenkel defect :- A pair of point defects produced when an ion moves to create an interstitial site, leaving behind a vacancy.

* Schottky deffect :- A point defect in ionically bonded material. In order to maintain a neutral charge, a stoichiometric number of cation and anion vacancies must form.

* Kroger-Vink notation :- A system used to indicate point defects in materials. The main body of the notation indicates the type of defect or the element involved.

4.3. Dislocations.

* Dislocations:- A line imperfection in a crystalline material.

* Screw dislocation:- A dislocation produced by skewing a crystal so that one atomic plane produces a spiral ramp about the dislocation.

* Edge dislocation:- A dislocation introduced into the crystal by adding an "extra half plane" of atoms.

* Mixed dislocation:- A dislocation that contains partly edge components and partly screw components.

* Slip:- Deformation of a metallic material by the movement of dislocations through the crystal

4.4 observing Dislocations

* Etch pits:- Tiny holes created at areas where dislocations meet the surface. These are used to examine the presence and number density of dislocations.

* Slip lines:- A visible line produced at the surface of a metallic material by the presence of several thousand dislocations.

* slip band:- Collection of many slip lines, often easily visible.

4.5. Significance of Dislocations

* Plastic deformation:- refers to irreversible deformation or change in shap that occurs when the force or stress that caused it is removed.

* Elastic deformation:- Deformation that is fully recovered when the stress causing it is removed.

* Dislocation density:- The total length of dislocation line per cubic centimeter in a material.

4.6 Schmid's law

* schmid's law:- The relationship between shear stress, the applied stress, and the orientation of the slip system - that is

$\Rightarrow \tau = \sigma \cos \lambda \cos \phi$ // σ: axial stress

* critical resolved shear stress:- the shear stress required to cause a dislocation to move and cause slip. (τ_r)

4.7 Influence of Crystal structure.

* Critical Resolved shear stress
* Number of slip system
→ * Cross-slip :- A change in the slip system of dislocation.

4.8 surface Defects

* surface defects :- Imperfections, such as grain boundaries, that form a two-dimensional plane within the crystal.

* Hall-petch equation:- The relationship between yield strength and grain size in a metallic material - that is, ⇒

$$\sigma_y = \sigma_0 + K d^{-1/2}$$

* ASTM grain size number (n) :- A measure of the size of the grains in a crystalline material obtained by counting the number of grains per square inch a magnification x 100.

* small angle grain boundary:- An array dislocations causing a small misorientation of the crystal across the surface of the imperfection.

* Burgers vectors :- is a unit vector of the lattice if the dislocation is a unit dislocation, and a shorter stable translation vector of the lattice if the dislocation is portial dislocation.

Types of imperfections :-

Imperfections

- point defects
  - Extendal defects
  - interstitial defects
  - substitutional defects
  - Frenkel defect
  - schattky defect
- Dislocation
  - screw dislocation
  - Edge dislocation
  - Mixed dislocation
- surface defects.

⇒ Importance of Defects :-

1- effect on mechanical properties via control of the slip process.
2- Strain Hardening
3- solid - Solution strengthening
4- Grain size strengthening
5- Effects on electrical, optical, and Magnetic Propeties.

Ch4 :-

$\tau = \sigma \cos\lambda \cos\phi$

- * axial stress ≡ $\sigma = f/A_0$
- * resolved shear stress = τ
- * critical resolved shear stress ≡ $\tau_r = \frac{F_r}{A} = \frac{f\cos\lambda}{A}$
- * deform in slip ⇒ λ = angle

Ch6:-

* 6.1 :- Technological significance
* 6.2 :- Terminology for Mechanical Properties
* 6.3 :- The Tensile Test :- Use of the stress - Strain Digram
* 6.4 :- Properties obtained from the Tensile Test
* 6.5 :- True stress and True strain
* 6.6 :- The Bend test for Brittle Materials
* 6.7 :- Hardness of Materials
* 6.8 :- Strain Rate Effects and Impact Behavior
* 6.9 :- Properties obtained from the Impact test
* 6.10 :- Fracture Mechanics
* 6.11 :- The importance of fracture Mechanics.
* 6.12
* 6.13
* 6.14
* 6.15
* 6.16
* 6.17
* 6.18
* 6.19
* 6.20
* 6.21

Definitions :-

6.2. Terminology for Mechanical Properties

* stress :- force or load per unit area of cross-section over which the force or load is acting

* strain :- Elongation change in dimension per unit length.

* Young's modulus :- The slope of the linear part of the stress-strain curve in the elastic region, same as modulus of elasticity.

* Shear modulus (G) :- The slope of the linear part of the shear stress - shear strain curve

* Viscosity (η) :- Measure of resistance to flow, defined as the ratio of shear stress to shear strain rate (units Poise or Pa-s)

* Thixotropic behavior :- Materials that show shear thinning and also an apparent viscosity that at a constant rate of shear decreases with time.

6.3. The Tensile Test :- Use of the Stress-strain Diagram.

* load :- The force applied to a material during testing

* Strain gage or Extensometer :- A device used for measuring change in Length and hence strain.

* Glass temperature (Tg) :- A temperture below which an otherwise ductile material behaves as if it is brittle.

* Engineering stress :- The applied load, or force, divided by the original cross-sectional area of the material.

* Engineering strain :- The amount that a material deforms per unit length in tensile test.

6.5 . True Stress and True strain.

* True stress :- the load divided by the actal cross-sectional area of the specimen at that load.

* True strain :- the strain calculated using actual and not original dimensions, given by $\left(\varepsilon_t \ln \frac{L}{L_0}\right)$

6.6 The Bend Test for Brittle Materials.

* Bend test :- Application of a force to the center of a bar that is supported on each end to determine the resistance of the material to a static or slowly applied load

* Flexural strength or modulus of rupture :- the stress required to fracture a specimen in a bend test.

* Flexural modulus :- The modulus of elasticity calculated from the results of a bend test, giving the slope of the stress-deflection curve.

6.7. Hardness of Materials.

* Hardness test:- Measures the resistance of a material to Penetration by a sharp object

* Macrohardness:- overall bulk hardness of materials measured using loads > 2N

* Microhardness :- Hardness of materials typically measured using load less than 2N using test as Knoop (HK).

* Nano-hardness :- Hardness of materials measured @ 1-10 nm length scale using extremely small (~ 100 μN) forces

6.8. Strain Rate Effects and Impact Behavior

* Impact test :- Measure the ability of material to absorb the sudden application of a load without breaking.

* Impact Energy :- The energy required to fracture a standard specimen when the load is applied suddenly.

* Impact toughness :- Energy absorbed by a material, usually notched, during fracture, under the conditions of impact test.

* Fracture toughness :- The resistance of material to failure in the presence of a flaw.

6.9. Properties obtained from the Impact test

* Ductile to brittle transition temperature (DBTT) :- temperature below which a material behaves in a brittle manner in an impact test.

* Notch sensitivity :- Measure the effect of a notch, scratch, or other imperfection on a material's properties such as toughness or fatigue life.

6.10 Fracture Mechanics

* Fracture mechanics:- The study of a material's ability to withstand stress in the presence of a flaw.

* Fracture toughness:- The resistance of a material to failure in the presence of a flaw.

6.11 The Importance of Fracture Mechanics

* Selection of a Material
* Design of a Component.
* Design of a Manufacturing or Testing Method

* Griffith law:- A crack or flaw in a material that concentrates and magnifies the applied stress.

* Delamination :- The Process by which differal layers in a composite will begin to debond.

6.14 Weibull statistics for failure strength Analysis

* Weibull distribution:- A mathematical distribution showing the probability of failure or several of a material as a function of the stress.

6.15. Fatigue.

* Fatigue : is the lowering of strength or failure of a material due to repetitive stress which may be above or below the yield strength.

* Creep:- A time dependent, permanent deformation @ high temperatures, occurring @ constant load or constant stress.

* Beach or clamshell marks:- Patterns often seen on a component subjected to fatigue.

* Rotating cantilever beam test:- an older test for fatigue testing.

* S-N curve (also known as the Wohler curve):- A graph showing stress as a function of number of cycles in fatigue.

6.16. Results of the Fatigue Test

* Endurance limit :- An older concept that defined a stress below which a material will not fail in a fatigue test.

* Fatigue life :- the number of cycles permitted @ a particular stress before a material fails by fatigue.

* Fatigue strength :- the stress required to cause failure by fatigue in a given number of cycles, such as 500 million cycles.

* Notch sensitivity :- Measures the effect of a notch, scratch, or other imperfection on a material's properties, such as toughness or fatigue life.

* Shot peening :- A process in which metal spheres are shot @ a component

مستر مطلوب

6.18. Creep, Stress Rupture, and Stress Corrosion

* stress-rupture curve:- A method of reporting the results of a series of creep tests by Plotting the applied stress versus the rupture time.

* stress-Corrosion:- A phenomenon in which materials react with corrosive chemicals in the environment leading to the formation of craks and lowering of strength.

6.20. Use of creep Data.

* stress-rupture curve:-

* Larson-Miller parameter:- A parameter used to relate the stress, temperature, and rupture time in creep.

6.21. Superplasticity.

* Superplasticity:- large deformation in materials, resulting from high temperatures and low strain rates.

Ch 6.

Properties obtaine from tensile
- → Elastic limit
- → Tensile strength
- → Tensile toughness
- → Hok's law
- → Poisson's Ratio
- → modulus of resilience
- → Ductility

$\sigma = \frac{F}{A}$, $\varepsilon = \frac{\Delta l}{l}$

Engineering stress ⇒ $\sigma = \frac{F}{A_0}$ → A_0 original cross.

Engineering strain ⇒ $\varepsilon = \frac{\Delta l}{l_0}$ → l_0 original length.

* Modulus of elasticity $= E = \frac{\sigma}{\varepsilon}$

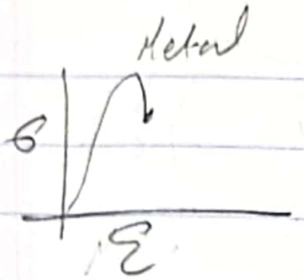
* Hooke's Law ⇒ $\varepsilon = \frac{\sigma}{E}$

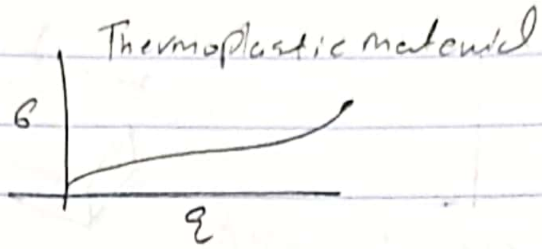
* % Elongation $= \frac{L_f - L_0}{L_0} * 100\%$

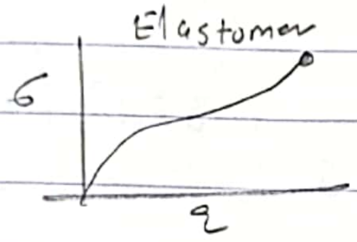
* % Reduction in Area $= \frac{A_0 - A_f}{A_0} * 100\%$

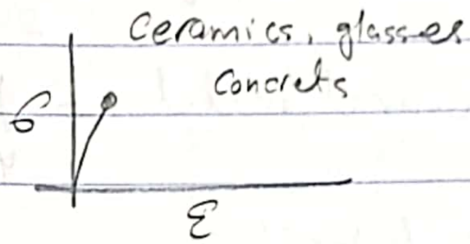
true stress ⇒ $\sigma = \frac{F}{A}$ → A Actual

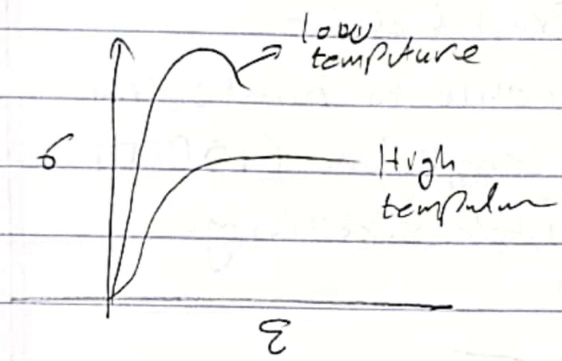
trues strain ⇒ $\varepsilon = \ln \frac{l_0}{l} = \ln \frac{A_0}{A}$

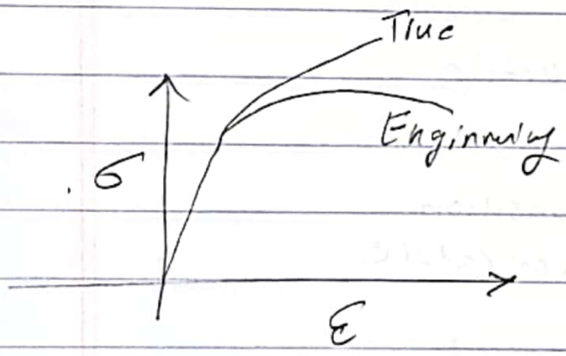

Metal
σ
ε

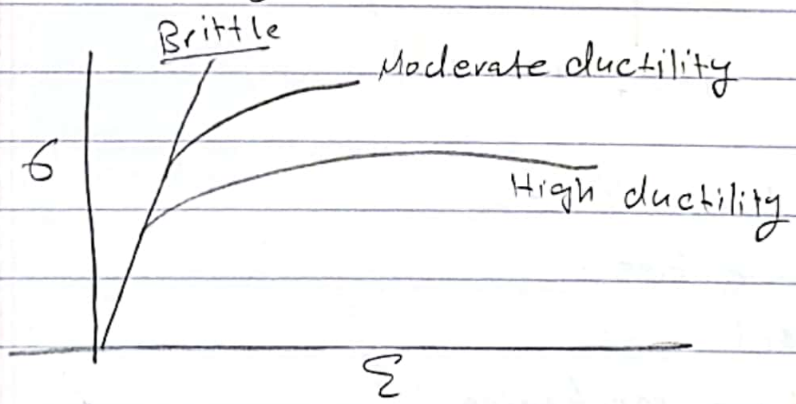

Thermoplastic material
σ
ε


Elastomer
σ
ε

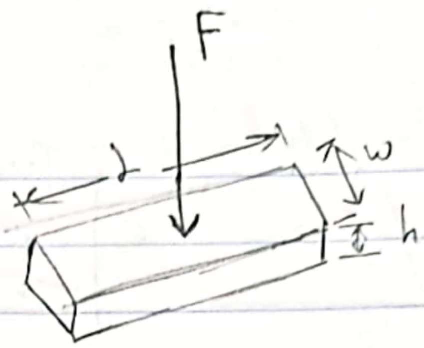

Ceramics, glasses
Concrets
σ
ε


low
tempreture
High
tempreture
σ
ε


True
Engineerin
σ
ε


Brittle
Moderate ductility
High ductility
σ
ε

Bend test



* flexural strength = $\frac{3FL}{2wh^2}$

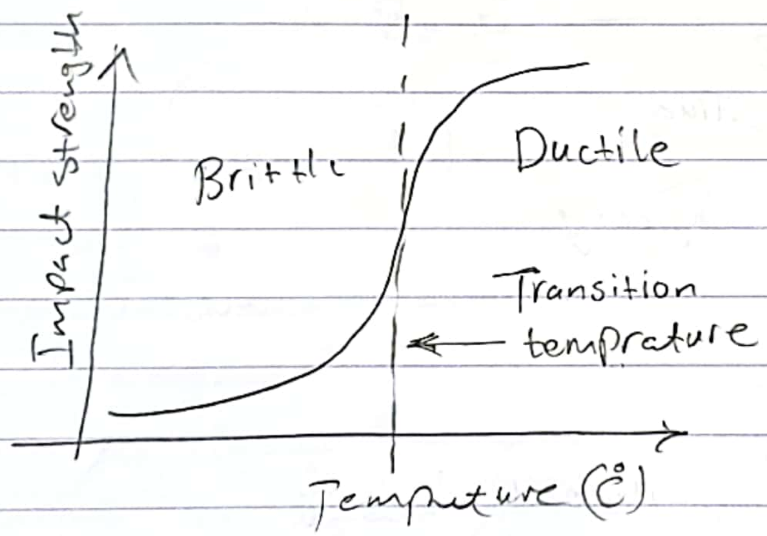
* Flexural modulus = $\frac{L^3 F}{4wh^3 \delta}$, δ : Deflection

Impact test

Properties :-

① Ductile to brittle transition temperature (DBTT)

② Notch sensitivity



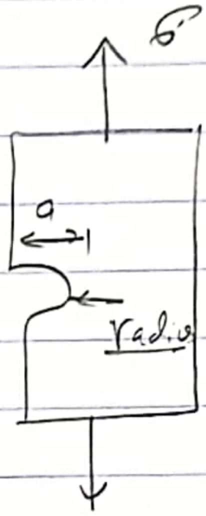
The importance of :-

* Tensile test
* Impact test
* Fracture mechanics.

⊟ Fracture Mechanics.

Fracture toughness :- K_{Ic}

$$K_{Ic} = f \sigma \sqrt{a\pi}$$



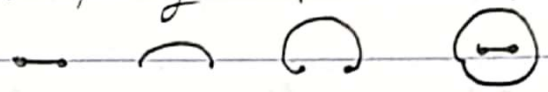
tensile strength :

$$\sigma_{actual} = 2\sigma \sqrt{\frac{a}{r}}$$

Ch 7:- Strain Hardening and Annealing.

7.2 Strain-Hardening Mechanisms.

* Frank-Read source:- A pinned dislocation that, under an applied stress, produces additional dislocations, This mechanism is at least partly responsible for strain hardening.



* Thermoplastics:- A class of polymers that consist of large, long spaghetti-like molecules that are interwined. as Polyethylene

7.6 The three Stages of Annealing.

* Recovery :- A low-temperature annealing heat treatment designed to eliminate residual stresses introduced during deformation without reducing the strength of the cold-worked material

* Recrystallization :- A medium-temperature annealling heat tratment designed to eliminate all of the effects of the strain hardenning produced during cold working.

* Grain growth :- Movement of grain boundaries by diffusion in order to reduce the amount of grain boundary area.

Stages of Annealing →
- → Recovery
- → Recrystallization
- → Grain growth

7.8. Annealing and Materials Processing

* Heat-affected Zone (HAZ):- The volume of material close to a weld that is heated during the welding process above some critical temperature at wich a change in the structure, such as grain growth or recrystallization, occurs

!!! 7.10. superplastic forming (SPF)

* Superplasticity:- The ability of a metallic or ceramic material to deform uniformly by an exceptionally large amount.

* Strain rate:- The rate at which a material is Deformed.

* التركيز على القرينات:-

* Example 7.3 slide 24 ⟸ Design سؤال
[* Example 7.4 slide 27

Ch9:- Solid solutions and Phase Equilibrium.

- 9.1. Phases and the Phase Diagram.
- 9.2. Solubility and solid Solutions
- 9.3. Conditions for Unlimited Solid Solubility.
- 9.4. Solid - Solution Strengthening
- 9.5. Isomorphous Phase Diagrams.
- 9.6. Relationship Between Properties and the phase Digram
- 9.7. Solidification of a Solid-Solution Alloy.
- ~~9.8~~. Nonequilibrium solidification and segregation.

9.1 Phases and the Phase Digram.

* phase :- Any portion including the whole of a system which is physically homogeneous within it and bounded by a surface so that it is mechanically separable from any other Portions

* Gibbs phase rule :- Describes the number of degrees of freedom, or the number of variable must be fixed to specify the temprature and Composition of a phase ($2+C=P+T$), where Pressure and temprature can change ($1+C=P+T$) where Pressure or temprature is constant.

* P-T diagram :- A diagram describing thermodynamic stability of phases under different temprature and pressure conditions.

9.2. Solubility and solid solutions.

* Solubility :- The amount of one material that will completely dissolve in a second material without creating a second phase

* unlimited solubility :- when the amount of one material that will dissolve in a second material without creating a second phse is unlimited

* limited solubility :- when only a maximum amount of a solute material can be dissolved in a solvent material.

* Copolymer :- a polymer that is formed by combining two or more different types of monomers usually with the idea of blending the properties affiliated with individual Polymers, example Dylark a copolymor of maleic anhydride and stryene

9.3. Conditions for Unlimited solid Solubility.

* Hume-Rothery rules :- The conditions that an alloy or ceramic system must meet if the system is to display unlimited solid solubility

Hume-Rothery rules :-

1. size factor
2. crystal structure
3. valence
4. Electronegativity.

9.4. Solid-solution strengthening.

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* solid-solution strengthening :- Increasing the strength of a metallic material via the formation of a solid solution

* Dispersion strengthening :- strengthening, typically used dispersions of a second phse.

9.5. Isomorphous phase Diagrams.

* Binary phse digram :- a phase diagram for a system with two components.

* Ternary phase digram :- A phase diagram for a a system with three components.

* Isomorphous phase dragram :- A phase digram in which components display unlimited solid solubility

* liquidus temperature :- the temperature @ which the first solid begins to form during solidification.

* solidus temperature :- the temperature below which all liquid has completly solidified.

9.7. solidification of a Solid-solution Alloy

* segregation :- The presence of composition differences in a material, often caused by insufficient time for diffusion during solidification.

Ch10:- Dispersion strengthening and Eutectic Phase Digram.

تشتت

10.1 Principles and Examples of Dispersion Strengthening.

* Dispersion strengthening:- Increasing the strength of a material by forming more than one phase.
تشكيل ←

* matrix:- The continuous solid phase in a complex microstructure

ترسب
* precipitate:- A solid phase that forms from the original matrix phase when the solubility limit is exceeded. ⇒ تجاوزت

* Eutectic:- A three-phase invariant reaction in which one liquid phase solidifies to produce two solid phases.

$$L = Solid_1 + Solid_2.$$

10.2. Intermetallic Compounds

* Intermetallic compounds :- A compound formed of two or more metals that has it's own unifue composition structure, and properties.

متكافئ

* Stoichiometric intermetallic compound :- A phase formed by the combination (دمج) of two components تتحد into a compound having a structure and properties different from either component.

* Nonstoichiometric intermetallic compound :- A phase formed by the Combination of two components into a compound having a structure and properties different from either component.

* Ordered crystal structure :- solid solutions in which the different atoms occupy specific, rather than random, sites in the crystal structure.

10.3. Phase Diagrams Containing Three-Phase Reactions

* Peritectic :- A three phase reaction in which a solid and a liquid combine to produce a second solid on cooling.

* Monotectic :- A three phase reaction in which one liquid transforms to a solid and a second liquid on cooling.

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* Miscibility gap :- A region in a phase diagram in which two phases, with essentially the same structure, do not mix, or have no solubility in one another.

* Metastable Miscibility gap :- A miscibility gap that extends below the liquidus or exists completely below the liquidus.

10.4. The Eutectic Phase Digram.

* solvus :- A solubility curve that separates a single-solid phase region from a two-solid phase region in the phase diagram.

* Isopleth :- A line on a phase diagram that shows constant chemical composition

* Hypoeutectic alloy :- An alloy composition between the left hand-side end of the tie line defining the eutectic reaction and the eutectic composition.

* Hypereutectic alloy :- An alloy composition between the Right-hand-side end of the tie line defining the eutectic reaction and the eutectic composition

D.O.F :-

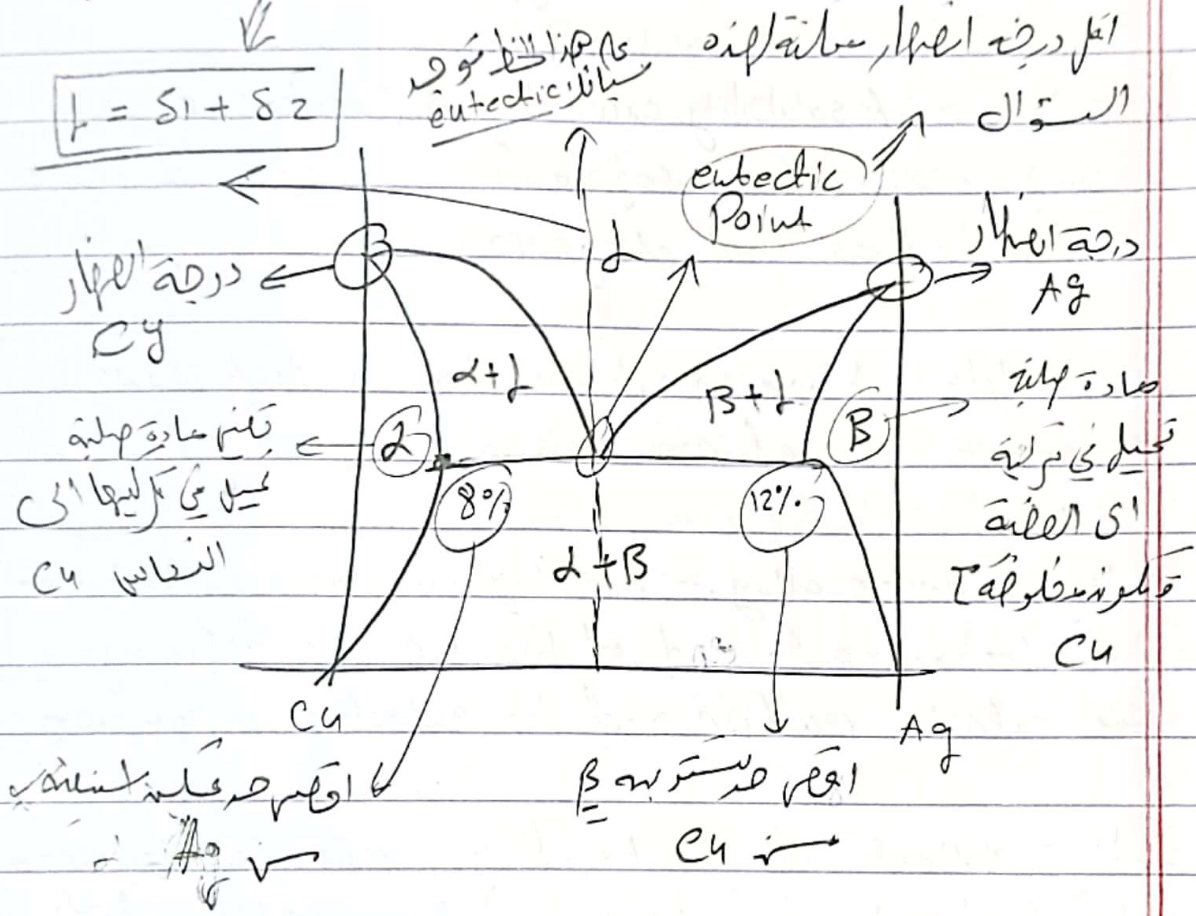
$P + F = C + N$

C → # of compount (A, B, ..)

P ↳ phase → solid, liquid, ...

N ↳ the variable in the system like tempert.

⇒ The eutectic reaction :-



$L = S_1 + S_2$ ⇐ تحول السائل الى مادتين صلبتين.

10.5. strength of Eutectic Alloys.

* Eutectic colony size.
* Interlamellar spacing.
* Amount of Eutectic
* Microstructure of the Eutectic.

10.8. Ternary Phase Diagrams.

* Ternary alloy :- An alloy formed by combining three element or components.

* Ternary Phase Diagram :- A phase digram between three components showing the phases present and their Compositions at various temperaturs. This Diagram requires a three-dimensional plot or is presented as two dimensional isothermal sections of a three-dimensional diagram.