24/9/2017

NO. Chapter #1

1 → Candedits → elémenation → optimum material.

✓ → 1. crystalline structer on ← expansion — atomic structure التفسير بناءً على

2. morfous structure

✓ → bronze → reactivity of copper is less (alloy with copper).

Then free > ممكن يكون

تفكيك [illegible]

Al age (by electrical hydrolesis) ⇒ Plastic Age (Polymer) and selicon.

iron → active but not highly. من وقت القدم لانه نشاطيته أكبر

Ages because of their reactivity (moving to more reactive)

✓ * leader of polymer دول النفط لانها تحتوي

على C و H عالي .

Polymer* resim عشان تشكيل البلاستيك .

✓ Plastic → أقل التكلفة easy forming.

Plastic → Thermoplastic : can be melted and recycled many times.

rubber → Thermosets ✗ recycled — irreversable rxn (never get back to its origin)

لأن السلسلة تتقطع بسبب التعرض لحرارة عالية جدا .

✓ • ↑ melting of recycling → ↓ quallity (الجودة و الروابط). تتغير الخصائص , M.W

+ degredatio تشوه

• Poly mer — molecular weight for them not the same

متعدد بنية

(3500, 4950, 3501) بسبب اختلاف طول السلسلة .

• الخواص في العمود الدوري اذا اختلف العدد الذري تختلف لكن ليس

في البلمرات . 〃

• recycle for 20%. 25% because there is direct contact.

الا اذا الاحتياج 100%

✓ → rubber → crushing after cooling (to change from ductile to bottlel

+ glass transition Temp. of Polymer ← أعلى → brittle مثل الزجاج
أقل → ductile

4

التصنيع

✓ comtability, fabrication, cost

28/9/2017

NO. Chapter #1

7 • القاسية تبع الهرم بتعتمد على structure

• Firstly performence → properties → processing All through characterization.

• ↑ driving force   ↑ fast cooling   ↑ فوضى (miss structure)
↑ cooling rate   ↑ hardness no.   more hardness forming

بيقصفوا الطرق بدخلوا مادة خضرية (طرية مثلاً مشان التشكيل وبس
نخلص التشكيل منرفع درجة الحرارة بيعمل عاكي للسطح "recrystallining"
مشان يكون السطح قاسي وما يعني ~~[illegible]~~ من الداخل.

8 (brittle ← تقل التغيير oriented   الي بجد الروابط ductile •
not oriented ← بنزيد

metals have cloud of electrons.

الروابط المعدنية < الروابط التشاركية   الروابط الايونية < المعدنية
< التشاركية] "غالباً"
نحتاج الحرارة أعلى لصهرها.

لأنه يوجد diamond اقوى من steel الاقوى أيضاً Tungoston carbide.

it will not break because it is ductile (if the same direction of orientation)   يعني السيكون باتجاهين.

• في الكيس البلاستيك رصعوا الـ chains الها عموري مشان تعطي
قوي الشد والوزن (لو افقي بنمزع) بسبب orientation

• احياناً بيشدوا بالطول والعرض (axial orient) بنسميها بالطول والعرض
المعادن ٣×٤ اضعاف الكثافة تبع البوليمر (البلاستيك)

• Polymers with no colours.

. Nacl brittle more than glass.

9 internal structure gives us the property
You make maintanence after cadidates.

10 ↓ rom Temp.   ↓ resistivity
Ni & copper → You must see structure and affect of
Ni on copper, have factors of both (size, electronegativity, valency), & structure of atom.
بتعلم

بنبحث الخصائص المختلفة بنقوم.

• To be comptable you must put the same structure of the atoms

11

13 crystalline → not transparent. (adding impurities).

↑crystal ↑hard to مرور الضوء

when colouring we change the internal structure

14 For marine.

اي annealing يرفع درجة حرارتها بخليها تستوي بعدين بنزل درجة

الحرارة (يوجد طرق أيضاً) ازالة residual structure و

تبطئ السرعة للتهور

ch

chapter # 2

عندما تزداد الحرارة تزداد المسافة بين الذرات فتنفك الروابط (هناك قوى

تجاذب وتنافر بين الذرات in equilibrium) بيطل في building unit

1/10/2017

NO. Chapter 2

2 الروابط ممكن تكون ضعيفة و وسط و قوية

1 exist → there is 2 but we neglect it (vice versa)

3 subshells هي المدارات التي تسبح فيها الالكترونات.

when $P \neq n$ → نظائر isotope مواد أنويتها غير مستقرة.

تحاول أن تصل الى الاستقرار (مواد مشعة)

عن طريق فقدان الطاقة (فترة طويلة).

5 Atomic weight / 2 = proton or nuetron.

هناك حالات استثنائية للقوانين مثل الهيدروجين (فقط الهيدروجين) ~~وهو مستقر~~ وهو مستقر

6 Proton = nuetron > electron

They neglect the weight of e^-

e^- smaller of the ration $\approx 10^{-11}$

7 H do just covalent bond. it's not stable ion عندما يتأين مرة يكون -1

و مرة يكون مستقر.

we can extract e^- from the atom more easier than P & n

لانها ابعد عن النواة و خفيفة

لكن لا نستطيع نزع P / n من النواة.

9 ~~8~~ quarks في وضع مستقر

موجودة في البروتونات.

10 الالكترونات تسبح في الجو و لكن لا يسبح في مدار ثابت بل على الـ shell .

. distance from center of the atom is fixed. (بين e^- و النواة)

من اجل اكتشاف الذرة.

لكن المدار غير ثابت: يوجد استخدامات عديدة للـ e (تلفزيون, طبية, مصانع)

11 (α, β particles and γ gama waves) نوع الاشعاعات للنظائر

نستطيع ايقافها لانها لها وزن. قدرة عالية على الاختراق لوزنها

$\alpha < \beta < \gamma$ و سريعة (اسرع من الجزيئات/ مهمل)

لا نستطيع تكوين الشعاع من مادة مستقرة لكن نستطيع التحكم بالالكترونات

(x ray والاجهزة الطبية عبارة عن e) و الليزر كلها اشعاعات مصنعة

(الليزر) ~~اشعاعات~~ ← 10^6 نسبة

1/100 ش

- huge no. will occupy this volume.
- spheres the atoms → no 100% efficiency of packing.
  in metals max 73% 25% empty

**الضغط compact للذرات هو الذي يؤثر على الكثافة.

12. • ↑ shells ↑ no. sub shells ↓ energy to take e^-

13.

valence e^- = ~~obtit no.~~ actit no.

- المعادن في نفس العمود لأنه كلها الها نفس الالكترونات في المدار الأخير وهذا الالكترون هو الذي يحدد الخصائص المختلفة :
- العناصر الخاملة لا يوجد أي الكترون حر مداراتهم مكتملة .
- كل العناصر الي على شمال عمود العناصر الخاملة لها different reactivity تكون على شكل مركبات .

14. • كل sub shell لها capacity محددة

2 = S
6 = P
d = 10
F = 14

- كل D , ... عندها energy محددة .

15. فمش لازم يكون في طاقة في الالكترون عشان يدخل الـ sub shell محددة .

- كلما ذهب ابعد حسب الشكل يحتاجوا الالكترونات طاقة أعلى و نحتاج طاقة أقل لكسر الرابطة (نزع الالكترون من الذرة).

16. Helium zero reactivity.

3/10/2015

NO. Chapter #2

17 العناصر الخاملة octic no.=0

look to total no. of shell not of subshells.

max. octic no. = 7

18 H is not a metal; to be stable H must take on e^-

A latest shell is the purpose of making bonds.

Iron is not completed shell it needs 6e^-.

20 في الفحوصات المخبرية للتبريد نضع عناصر خاملة مشان ما تتفاعل (eg Ar)

Alkaline معادن و أشباه معادن

أشباه المعادن less reactive than metals

على يمين الجدول الدوري معظمهم غازات الا اذا كان هناك روابط أيونية مع المعادن .

روابط ضعيفة لانها تشاركية

التي على يسار الجدول روابط قوية لانها روابط معدنية أو أيونية).

يمين مع يسار ← روابط أيونية، أملاح.

21 - electropositivity: willing to donate e^-.
- 2 atoms with approximately electro +ve or −ve ⟹ no bonding between these 2 atoms.

23 at the top of periodic table → highly electronegativity.

. These no. of electronegativity is rounded to one figure.

24 electronegativity بالمقارنة مع غيرها

" it's a relative value

$X_A - X_B$ to know if there is bonding.

if two same elements Ed(AB) بروح و بنعوض الجمع و كمان ضرب

25 ↑ difference of electronegativity ↑ probability to make bonds

e.g. NaCl big difference مشان هيك مرتفعة كتير

$\sqrt{\text{electron volt}}$ to take dimensionless no.

شحنة e^- 1.602×10^{-19}

$\sqrt{eV} \times \frac{1}{\sqrt{eV}}$

بعد 0.4 وارد انه يصير ترابط

 $r_1 + r_2$

Distance between center to center at least must be summation of it's radius.

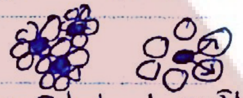
NO.

26 secondary strength < 1° neglect if there is 1°
↓
exist in all bonding.

27

metallic > ionic > covalent
ملح ماء

. الروابط الايونية روابط غير موجهة
Joined network / Wad structure



كل مرة يعمل رابطة مع ذرة
ليست موجهة لانه ذرة Na
حولها بجرمن Cl كل مرة
يعطي وحدة وكذلك Cl

between metals & halogens because of valence e^-.

e.g
||
Na 2,8,$\boxed{1}$ shell #3
↳ take, empty shell, we don't need it

2. because of different charges.

equilibrium of two forces in bonding : attraction & repulsion.

distance is of minimum energy.

non directional → مو شرط تقتل الرابطة مستقلة

28 bonding (taking / accepting e^- permanently)

5/10/2017

NO. Chapter # 2

30 it is a stable network.

3&2 • repulsion from nucleus (as a result from protons)

• attractive & repulsion → function of radius → as a center to center not the radius of atom.

• attraction → ↓ distance → negatively.

ما بوصل min.energy لانه المسافة = صفر يعني المركز للنواتين نفسها فوق بعض

$r_1 + r_2 = \underline{min}$ بس مستحيل ملوصين الا ما يكونوا مبعدين عن بعض بسبب التنافر

L > D of one atom   دليل انه في قوى تنافر

الي حسناها قبل

$\frac{dE_N}{dr} = 0$ You can have r equilibrium

عوض في Net E بتحصل على

34 ionic band → solid state   مشان وجودها في state المذكور بحال الروابط قوية او ضعيفة.

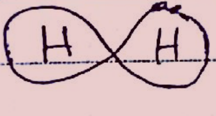
covalent → gases
  ↳ liquid

inert gases (no covalent bond)

instantaneusly taking and donating.

covalent غير موجود   اذا فكوا عن بعض بتخرب الذرة.

→ Non polar → between the same atoms e.g H_2, ...

35 

movement of two e-

Temprorary stability.

38 CO monocarbon monoxide

39 liquids of covalent band لها قابلية للاشتعال more than gases

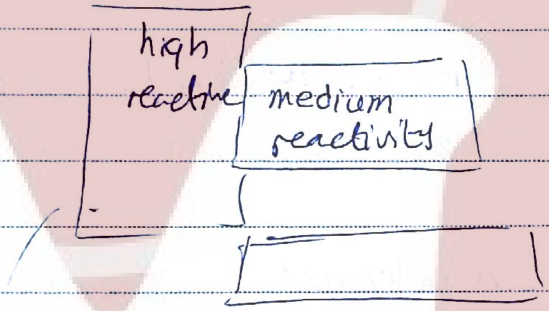
ionic band احتمال قليل للاشتعال

FIVE APPLE

NO.

- الايونية توصل التيار لانها عندما تتفكك تتحول الى أيونات موجبة وسالبة . 40
- أما التشاركية لا يتحول اذا انا وضعتها like dissolves like ,8
تنفك الروابط بل يخفف فقط . (التفكيك ، hydrolysis بنفكوا الى عناصر
بطّل مركب ، NaCl
بحر او برد
بيرجع كل واحد .

40



- Na بنحط في كاز ، تونيخ .
- Al highly reactive with atmosphere
بتشكل طبقة تحمي من التفاعل .
- بعد العنصر الاول يحتاج الذرة الى ٨ الكترونات مشان يصبح مستقل .
You must fill s & p sub sh

Na needs 7 electrons
2,8,1

41 الالكترونات بيسبحوا ← بحر من الالكترونات ← في كل لحظة يوجد ذرة حولها ٨ e^-
مشان هيك highly conductive

at ~~sto~~ instant there is stable atom.

- في الايونية يجب وجود رابطة أما في المعدنية لا يجب رابطة فقط الكترونات حرة سابحة .
It is net stablity, no one stable at any moment.

الروابط الثانوية اضعف من الاساسية .

8/10/2017

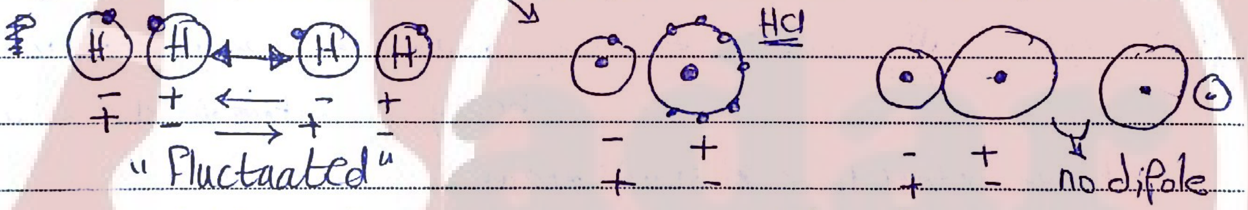
NO. Chapter # 2

40 الوابطة المعدنية رابطة تشاركية غير موجهة أما التشاركية موجهة ،

42 • exept Hg because it is liquid.
- Al the layer is not corrosion, Fe corrosion the will be rust عبارة عن صدأ والنحاس أيضاً.
- ionic & meattallic ⇒ solide: state the difference is the sliding of crystalline structure.
  metals : hammer → sliding. ionic : brittle bond.

تسخين درجة الحرارة ثم طرق ولا يتكسر

43 • Inert gases → 2° bonds
- between atoms or usually between molecules
- liquid or molten state of ionic bonds → 2° bonds.
- Fluctuated : similar atoms of molecules.
  Permanent : different atoms in molecule



will not differ if we flip the molecule → here it will differ if we switch no bond between 2H atoms.

H_2O ⇒ hydrogen bonding (same as permanent induced dipole)

45 dissimilar of covalent → polar.

47 considered from 2° bonds (2° week because between molecules)
water similar to permenant induced dipole.

48 covalent H_2O, ... small energy. روابط غير موجهة تعالية
ضعيفة ما عدا: لنقل التيار والحرارة بسبب e^-

meltalic قوية ما عدا

49. melting → تكسير الروابط الموجودة → migrates because of vibration & friction
↑ Temp. ↑ migration ↑ #bonds
يصل لمرحلة الروابط المتبقية غير قادرة على حمل structure
melting because of migrates of atoms from the structure.
- gas → weakest bond. (so there will be distribution).
it is gas because of low boiling point < room temp.
. لهيك كل المواد الصلبة تتحول الى غاز.

50. deepest min. energe → strongest bonding (↓ peak → weaker bonds).
. min. energy مؤشر عن قوة الرابطة
أقرب الى x-axis.
أبعد عن y-axis
[↑ width ↓ bonds]

narrow & deep → strong bonds and vice versa

52. ↓ min. energy → more expansion (contraction) why ??
expansion → ↑ distance between atoms →
→ ↓ α (deep of min energy & narrow).
المادة مارح تشتغل

Bring the sheet from elearning.

NO. chapter #3

1 molecule — building block

البنية التركيبية ↓ — ↓ البنية الاساسية لتركيب المواد.

ionic → crystalline structure   lamina → chanes ↷ buildinblock ↷ molec. atoms ↲

→ semicrystalline " ~

crystallline x ammorphous

↓ melting Temp. — ↓ no melting temp. if you ↑ Temp. there will be degredation ↲

molten state — no liquid state — impossible to build a structure again.

10/10/2017

2 crystalline → 100% (with no space of amorphous) which it not possible   semicrystalline معظم المواد "Polycrystalline". متعدد البلورات

3 . single crystal → one nuclii e.g.: diamond. (rare case)

- amorphous → very small crystal size. we can't consider it as a crystal.
- Bulk density (volumetric density) حجم ← أكثر واحد مشهور

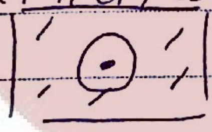
linear density طول

planar density مساحة

4 . You can't make amorphous → crystalline

لا تستطيع تغير عشوائي كريستال،

↑ # competetors ↓ size of crystals.
(↑ # crystals).



limit no. of chains.

↘ Big size

↘ small size

nuleating agent to be the center of crystals → ↓ time
long time to become crystals without agent.

~~Inuclea~~

crystalli.

1. nuleation 2. growth   ↑ nucleation ↑ growth ↓ size of crystals (vice versa).

من هنا بطلت أنقل

NO.

- sharp cooling → no enough time to make crystals → small crystals size
- not necessarry that crystal is better than amorphous.
  ↑size ↑ tensile properties (↓ area of surface) حسب انا شو اللي
  crystals → does not عبور الضوء (optical properties) بدي اياها -

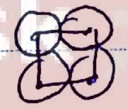
✓ • no way to make amorphous → crystalline
nuecleation agent بنرجع العكس بإضافة

الشكل b ←

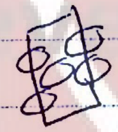
amorphous → mèsregularity in general
لكن هنا لا يعني انه لا يوجد تنظيم بالمرة

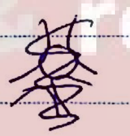
5 length of molecule differs
البوليمرات تتشكل من mol. أو chains

- maybe the building block have 1 sphere, but there is no building block with 1 sphere اجزاء مجمعة مع بعض
  the portion of sphere at the edge = $\frac{1}{8}$ (3 cuts كل كرة نصف المنتصف)
  Body → full atom → 100% portion
  Face → $\frac{1}{2}$ portion
  simple → $\frac{1}{8}$ portion



Simple cube structure





Just ↑

The closest distance = D of atoms.

6 unit cell → Building block
مكعب يحتوي على ذرات على الزوايا وفي منتصف السطوح
4 mainly structures of building Blocks

7 ✓ another materials, may contain all these shapes.
metals.

8 ✓Lattice → 1 layer
bonds between all things.
lamina → chains (bonds between chains).
repitition/building. ← شو الي بترتب ✓
pattern lamina ← كيف بترتب ✓
✓symmetry when putting lines there is mirror image.

NO. Solving sheet #1 (from problems of the book)

11/10/2017

1 ⑪

a. d shell uncompleted → Transition metal.

b. inert gas

c. halogen

d. alkaline earth metal

e. transition metal.

f. alkali metal.

2 ⑬

$$A_F = \frac{1}{4\pi \times 8.85\times10^{-12}} \times \frac{(1.6\times10^{-19})^2 \times 2\times1}{(1.6\times10^{-9})^2} = \boxed{1.8\times10^{-10} N}$$

covalent shared = 8 − valence
الكترونات
المدار الأخير

3 ㉑

- $_{32}Ge$ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^2$ $8-N' = 8-4 = 4$
- $_{15}P$ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ $8-3=5$
- $_{34}Se$ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^4$ $8-6=2$
- $_{17}Cl$ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ $8-7=1$ covalent bond / atom

4 ⑲

- TiO_2 $\%IC = (1-e^{(-0.25[3.5-1.5]^2)})\times100\% = 63.2\%$
- $ZnTe$ $\%IC = (1-e^{(-0.25[2.1-1.6]^2)})\times100\% = 6.05\%$
- $CsCl$ $\%IC = (1-e^{(-0.25[3-0.7]^2)})\times100\% = 73.4\%$
- $InSb$ $\%IC = (1-e^{(-0.25[1.9-1.2]^2)})\times100\% = 1.0\%$
- $MgCl_2$ $\%IC = (1-e^{(-0.25[3.0-1.2]^2)})\times100\% = 55.5\%$

5 ㉒

1. metallic 2. covalent (C & H) with some Van der Waals 3. ionic ~~with some covalent~~

4. xenon → inert gas ⇒ $\overset{\text{secondary bond}}{\cancel{\text{Van der waals}}}$ 5. (copper & tin) → metallic covalent

6. covalent (perhaps some Van der waals) 7. covalent ~~with some ionic~~.

6 ⑭

$$E_N = E_A + E_R = \frac{-A}{r} + \frac{B}{r^n} = -Ar^{-1} + Br^{-n}$$

$$1.\ \frac{dE_N}{dr} = Ar^{-2} + -nBr^{-n-1} = \frac{A}{r^2} + \frac{-nB}{r^{n+1}} = 0$$

$$2.\ \frac{A}{r_0^2} = \frac{nB}{r_0^{n+1}} \qquad A r_0^{n+1} = nB r_0^2 \div r_0^2 A \qquad \left(r_0^{n-1} = \frac{nB}{A}\right)^{\frac{1}{n-1}} \qquad r_0 = \left(\frac{nB}{A}\right)^{\frac{1}{n-1}} = \left(\frac{A}{nB}\right)^{\frac{1}{1-n}}$$

3. $E_0 = \frac{-A}{r_0} + \frac{B}{r_0^n} = \frac{-A}{\left(\frac{A}{nB}\right)^{\frac{1}{1-n}}} + \frac{B}{\left(\left(\frac{A}{nB}\right)^{\frac{1}{1-n}}\right)^n} = \frac{-A}{\left(\frac{A}{nB}\right)^{\frac{1}{1-n}}} + \frac{B}{\left(\frac{A}{nB}\right)^{\frac{n}{1-n}}}$

$\frac{7}{⑮}$

$E_N = E_A + E_R = \frac{-1.436}{r} + \frac{5.8 \times 10^{-6}}{r^9}$

$\frac{dE_N}{dr} = \frac{1.436}{r_0^2} + \frac{-52.2 \times 10^{-6}}{r_0^{10}} = 0 = 1.436 r_0^{-2} + -52.2 \times 10^{-6} r_0^{-10}$

$(1.436 r_0^{-2} = 52.2 \times 10^{-6} r_0^{-10}) \div 1.436 r_0^{-2}$

$1 = 36.35 \times 10^{-6} r_0^{-8}$ $\qquad r_0^8 = 36.35 \times 10^{-6}$ $\qquad \boxed{r_0 = 0.279\,nm}$

$\rightarrow E_0 = -5.147 + 0.566 = \boxed{-4.58\,eV}$

15/10/2017

NO. Chapter #3

9 ✓ *lattice: ✓ ترتيب building block في , ~~latt~~ واحد بطريقة منتظمة.
level معين داخل البلورة.

10 ✓ *paked ← كثافة عالية بسبب ✓ اسهل أنواع الأشكال
✓ • metals → same radii of atoms → more packed

11 ✓ grain boundary, impurities → make polycrystalline
✓ similar amorphous not completely amorphous (grains).

• لا نستطيع منع نمو البلورات لكن نستطيع التحكم بحجم البلورات على اساس انه يشبه amorphaus

- in alloy of metals the radii are compatable (no big difference in rad the atom) but in ionic there is big radii.
- when there is difference in foregin atom it will make $\underbrace{>15\% \; <15}_{\text{difference}}$ not compatable

12 ① simple cube → digonal is not ملامسين # in touch

identical spaces
not in toch → D of atoms.

8 atoms in edges. ∴ every atoms 3 times of cutting. تصنّف المتبقي
every atoms participate in $\frac{1}{8}$ portion.

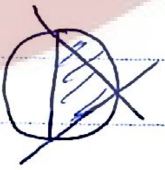
② still vacent in centers.
corners → 3 times cut   Face → Just 1 time cut.
14 atome participating 4 atoms only.

③ insertion of complete atom at the centers
9 ∴ 5 atoms participating 2 atoms only.

④ 3 atoms support
7+7+3 atoms

$\frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$

particpating ↘
$\left(\frac{1}{6} \times 6 + \frac{1}{2} \times 1\right)2 + 3 = 6$ atoms



13 ✓ 83 element one Just have simple cube structure (1 Just "Po")

✓ Packing. E : actual no. of atom exist in certain volume

✓ Low density

17 ✓ coordination number :-

✓ largest no. of atoms that touches a single atom, Direct touch.

✓ → Total no. of equivalent atoms = 1

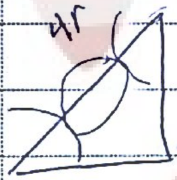
✓ volume of the atoms $= \frac{4}{3}\pi r^3$

✓ volume of the cube $= a^3 = (2r)^3 = 8r^3$

✓ $P.e = \frac{\text{exist volume of atoms}}{\text{volume of cube}}$

17/10/2017

18 ✓



$16r^2 = a^2 + a^2$

$2a^2 = 16r^2$

$a^2 = 8r^2$

$a = \sqrt{8}r$

$\boxed{a = 2\sqrt{2}r}$

20 ✓ العناصر الموجودة اسفل الجدول الدوري ما عدا Al

low density ✓ having less reactivity.

✓ coordination 4×3 = 12 (huge)

✓ Faced bigger 25% from simple

23 ✓ هو شكل الحديد BCC يتغير ترتيب الذرات ؟

BCC عند رفع درجة الحرارة يصير FCC اذا اكثر يرجع

>1200

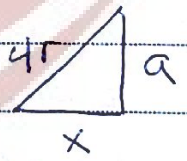
27 ✓ مرتين فيثاغورس ← internal

1 قطر القاعدة

① main internal diagonal

$x^2 + a^2 = 16r^2$

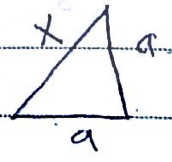
$x^2 = 16r^2 - a^2$



② $x^2 = a^2 + a^2$

$16r^2 - a^2 = 2a^2$

$3a^2 = 16r^2$



$a = \sqrt{\frac{16}{3}}\,r = \frac{4}{\sqrt{3}}r$

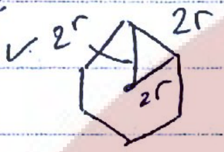
All the Page is Done

NO.

*✓ There is a relation between packing efficiency & coordination no.

↑coordination no. ↑P.E

29



~~the~~

← مثلث متساوي الاضلاع [H-W]

height = edge × Ⓐ coefficient

تأكد 1.63

✓ لا يوجد معدن في الحياة P.E > 74.05%, كل المواد فيها voids (فراغ) غير مستفاد منه ✓

coordination $\underbrace{3+6+3}_{\text{as support}} = 12$

✓ B.C.C = hexagonal in coordination & P.E

33 ✓ You must know what is the building block unit.

24/10/2017

35 ✓ because of the packing & of crystalline structure (distance between atoms).

✓ & composites according to the adding materials.

✓ • معادن & أشباه معادن (بلاط, ...)

36

✓ • الاسمنت، الاملاح ← You can have large single crystal

✓ • بعض المواد حتى لو عينوا الظروف ما بقدر، فعليا crystal تكون Polycrystals

✓ • single crystal → The most strong.

✓ • الصفائح في lamina قوية تختلف عن grain boundary ممكن يكون هناك misregularity impurities stress concentration areas → The ~~f~~ reason of failure.

37 ✓ • metals no single crystalline structure

✓ • isotropic → homogeneous Properties. (properties متساوية في أي اتجاه في المادة).

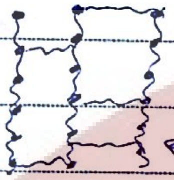
✓ anysotropic → opposite.

FIVE APPLE

building block unit → anisotropic

NO.

✓ e.g shopping bags are anisotropic



no of bonds horizontally < vertically

different properties.

← single orientation منتظم   ممكن نستفيد من هذه الخصائص

✓ long tudenal & traverse

✓ • isotropic → like mesh.

✓ anisotropic → unidirectional orientation

38 nuclii →   → driving force → molecules move → growth in 3D →

study → initially it is a sphere but crystals does imbenjments so it will growth on the other directions

✓ • straight line if the growth are equals, if not it will be ellips and other shapes.

small size & large no.

✓ • ↑grain boundaries ↑ defect ↓ sharp cooling → grains (smechtic)

✓ • grain boundaries are misregularity, whereas in crystal just 1 will resist tensile force.

• يوجد روابط بين الكريستال و داخلها ايضاً (..... Poly)

• في نفس البلورة الخصائص مختلفة عن bulk

we are interested in bulk

✓ الروابط داخل lamila اقوى من بين laminas (روابط أكثر عددا).

39 ✓ may there will be impurities. voldage on grain boundaries.

مناطق ضعيفة.

✓ on the crystals it self : isotropic اذا كان في اتجاه lamila

✓ To all image → anisotropic

40 ✓ high resistanse in diagonal (internal) direction, it will differs than edges.   because of con.

✓ it is anisotropic

FIVE APPLE

chain → lamina → crystalline

26/10/2017

✓ • building block → aniso   distance between atoms are different

46 ✓ • polymorphism   more than one crystalline structure in materials.

✓ •   e.g   C diamond, bucky bold, graphite, [illegible], [illegible] (carbon nanotabe).

✓ • graphite : soft (no bonds between the two layers)

⊙ e.g of metals   Fe, 1. ferrite, 2. Perlite, 3. semintite, 4. anaustrolyte

there is a~~f~~ change BCC → ~~apt~~ often at room temp. or combination of them

>900 FCC

>1400 BCC

↑ ferrite → ductile iron

↓ ferrite ↑ semintyte → brittle

49 ✓ • a sort of aragment but there is dismatch (it has certain properties)

ليس شيء معين حسب الاستخدامات التي تريدها.

⊙ Polyethelene for shopping bag → linear low density → crystalline

→ high   "   "

→ low   "   "

cross lengthed → not crystalline   احسن للأكياس, الانابيب

50 ✓ • imp. for analysis of material (unknown material to know what it is)

لكن لا يستطيعوا معرفة التركيب building unit

⊙ (elemental analysis) في المختبرات تعرض لاشعة / e تعرف كمية العناصر الموجودة)

✓ • direction from certain point (reference change → length of direction will be different)   الطول

(origin) reference point   ـ اذا بدي direction لازم نعطيه شو هي

51 ✓ symmetry will help us in the ~~other~~ shapes.

✓ "The idea is the mirror image"

52 ✓ building block units are the same of the material.

✓ we measure according to the building block   ما الك علاقة بالاطوال مش من شي

(unit cell $\overset{a}{\underset{c}{\angle}}{}_b$)   طول ال unit

✓ no exact measurements.

✓ using right hand rule, ابهام → z in positive.

x → الاصابع   y لوين رايحين الاصابع

53 ✓ point satom in structure

✓ You have to define the centroid.

54 ✓ Point 3number only بدون أقواس direction ـــ / نستخدم اقواس ✓

ولا شي . بيفهم مباشرة فقط

[$\bar{1}$ $\bar{1}$ 0] → line $\bar{1}$ $\bar{1}$ 0 → Point

no -1 → we ~~…~~ write it $\bar{1}$ (الاتجاه العكسي)

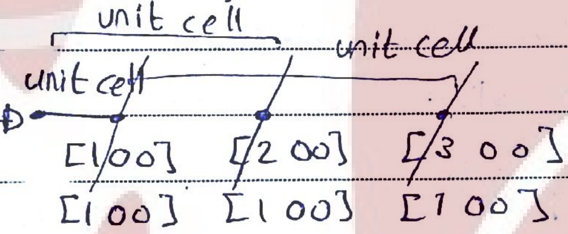
(- bar بس ما يعني -ve في الامتحان ممكن نحط)

✓ You are free to use the origin.

✓ You care about the fraction. (✓ ✓ ✗ على الترتيب x y z) ✗

→ Point nothing direction [ ] family directions < >

القيس بين



→ families of direction <100>
same direction (on same axis)

can be described with the same direction.

29/10/2017

55 الذي يعين Point direction

✓ we need reference point ✓ وسموه من النقطة المرجعية إلى النقطة

58 ✓ Family directions.

✓ can by the same by rotation axis.

✓ e.g 111 : another family ممكن يكون

✓ on 8 building blocks

60 no Fractions ← نقاط التقاطع على المحاور كمقدار لل plane ثم نقلبهم ✓ •

smallest integer no. → ( )

✓ • parallel planes → family of planes.

✓ • in planes You are not free to choose reference Point

* ممنوع يمر أي امتداد للسطح من أي محور من نقطة المرجع

لأنه عندها بصير التقاطع بنقطة المرجع ← O

عندما نقلب بصير $\frac{1}{0}$ يعني ∞ وما بنزبط هيك .

✓ • plane parallel to line → intersect point = ∞ ⇒ $\frac{1}{\infty} = 0$

✓ • avoid to choose reference point make you to expand the plane

✓ • each figure have one easy ~~sa~~ reference point.

على القاعدة احسن . ✓

✓ • Parallel → ∞

62 ✓ Family of planes → مثل صفحات الكتاب

31 / 10/201

64 • ✓ a_1, a_3, a_2 تعمل تماثل
كل محور نص

✓ • اختار ~~[illegible]~~ الذي يسهل calculation
center point.

✓ • ممكن تختار السطح تبع القاعدة او فوق .

✓ • at least I want 3 points. ✓ • Fraction on point عادي / on direction لا

• Take a_1 / a_2 / height a_3 from calculation

✓ $\dot{w}$ → height

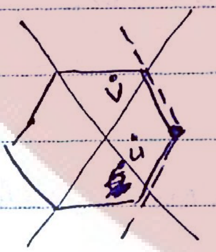
$\dot{u}$ نبعد Projected point على a_1

$\dot{v}$ نبعد Projected point على a_2 ✓

✓ • اذا النقطة ماطلعت على المحاور
اعمل Projection ~~موازية للمحاور~~

Parallel lines
- Parallel a_1 / Pass point
- Parallel a_2 / " "

65



$w = \dot{w} = 0$ go to the equation on slide ~~#~~ 65

$\dot{v} = 1$

$\dot{u} = 1$

$u = \frac{1}{3}$ $v = \frac{1}{3}$ $t = \frac{\bar{2}}{3} \left(\cancel{\quad} - \left(\frac{1}{3} + \frac{1}{3} \right) \right)$

if point ✓

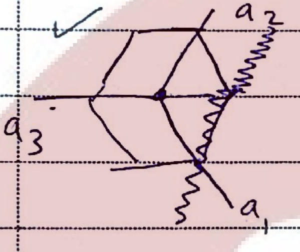
$\left[\frac{1}{3}\ \frac{1}{3}\ \frac{\bar{2}}{3}\ 0 \right] \Rightarrow \left[1\ 1\ \bar{2}\ 0 \right]$

direction

in previous you need 3 points (in point & directions)

67 You need the four point $\underbrace{a_1 \; a_2 \; a_3}_{\text{من القاعدة .}} \; \underbrace{\omega \, (c)}_{\text{اسهل صحه height .}}$

ازا plane للآخر محاذاة $c=\frac{1}{2}$ ازا لصقت الصيغة = $\frac{1}{4}$



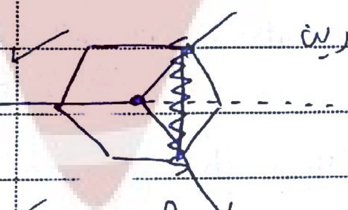
$a_1 = 1$ 1 $(1 0 \bar{1} 1)$

$a_2 = \infty$ 0

$a_3 = \bar{1}$ $\bar{1}$

$c - 1$ 1

ممكن plane يقطع ال٣محاور ازا كان موجود عال محورين

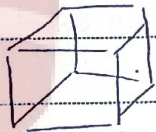


68 no. of atoms center → # diameters in the direction (# atoms)

1st You must know the building block unit.

2nd radius or diameter of the atom.

3rd



69 no 100% plannar density.

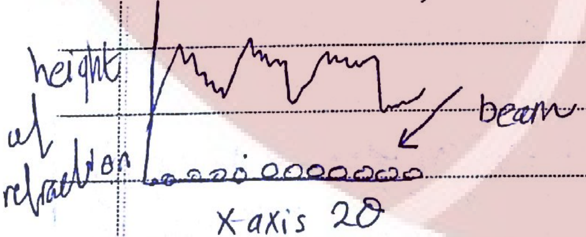
المساحة السطحية للذرات (كعدد الذرات)

المساحة تبع السطح

2/11/2016

71 refraction of x ray by different angles → elemental analysis

The sample may be powder, هرج نقية



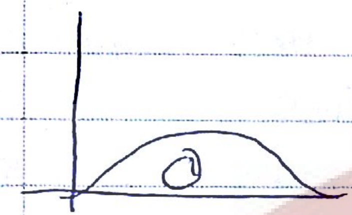
peak الموجودي ل معروف X ray ← element.
صحيه).

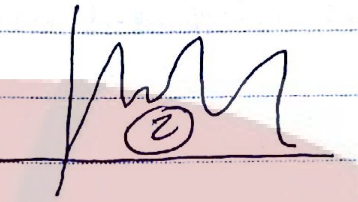
high width of peak related to size of crystals and crystallinity

↑hight ↑high crystallinity

↑hight ⇟→ narrow
(أكثر).

NO.





%percentage of crystallinity : Area① - Area②

You can know the types of crystals from reflection of beam

* All comes from building block units → different refractions.
(X-ray - spectrometer) . . .

✓ reflection اعاقة beam للمرور من خلالها

* mechanical properties because of the internal structure.

- very brittle, ductile, very ductile
صليد مطفة
- mechanical properties is interpretation of internal structure _ reflection

✓ failure because of creep need ~~a~~ time.

✓ • ↑ الاستطالة . ↓ قوة المادة ↓ resisting area.

$$\text{Ultimate stress} = \frac{\text{Force}}{\text{Area of resistance}}$$

يجب ان لا نصل اليها.

Yeild stress اقرب ال elastic

designed by dividing by safety factor

مشان نتجنب الفشل في العمليات . . .

72 • crystalline, amorphous, ... even though mettalic bonds
شكل المادة يحقق ذلك.

✓ conductivity in amorphous (semicrystalline) is more than crystalline
(transfer of electrone) الحركة على grain boundary

graphite > mass

no material ~~is~~ 100% pure

ideal structure كلما زاد العكس قل
في الطبيعي لا يوجد ذلك منشان هيك ما في crystalline

End of chapter

NO. Chapter #4

5/11/2017

1 . in all materials there is misregularity & impurities

naturally "طبيعي"

- what do impurities do, where they will be, why there is no another building block of materials? crystalline struc. مشاكلنا نخرب ال

impurities → solute (minor) with low quantity / solven (major materials)

- impurity = foreign material different than the other material (original)
- Limitation of amount of impurities (for solubility)

اذا كان solid solution

اذا تجاوزنا هذه القيمة بصير في agglomeration في نفس البيئة التركيبية لوحدهم

أما اذا ضمن هذه النسبة تتوزع impurities

- Adding foreign material, 3 posibilities:
  - → foreign atom in the building block
  - or → in space in building block غير محجوزة لذرة → stress concentration area, there will be distortion
  - or → agglomeration
- There is 4 factors for comptability
- Ni on Ag → isomerphous material

They بيتوزعوا because they are comptabale

~~Solut~~ حتى لدرجة انه بيدلو بين solven & solute

iso morphous

second phase

solidification

- 1. nuecleize because of driving force ~~&~~ freezing

2. growth (استقطاب السلاسل الموجودة الى الأنوية)

∴ ↑ # nuclei ↑ rate of growth ∴ ↑↓ small sizes (competition)

Total # chains constant (it is limited)

when there is imbengment (تصادم) → growth will stop.

By the end of the day there will not be sphere shapes.

but there will be growth on the other directions.

- Defects — Point (1 atom) : vacency (شاغر) (ذرة غير موجودة)
  - line defect
  - plane defect (area defect)
  - volume defect (It is the voidage) of impurities.

e.g air bubbles / agglomeration of impurities / space solidification → تثبيت chain   ↑ Temp. → migration of chains → molten structure

NO.

✓. ↑ Temp. ↑ vacency (migration of atom) * melting Temp. → failure of crystalline structure Temp.

~~bot~~ ال chains لا تتفكك لكن اصبحت حرة

for amorphous structure there is no melting Temp. but there is (solid → liquid) Temp. for ~~crystalline and~~ amorphous (softening Temp.)

amorphous material there is softening not melting

السلاسل كانت ثابتة بطريقة غير منظمة اصبحت تتحرك

amorphous → no melting / crystalling

crystalline $\xrightarrow{no}$ glass transition ~~no~~ .

7/11/2017

3 ✓ nucleating agent to have crystall. about it   & nucleation تسريع ✓

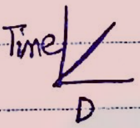
تختصر الوقت ✓

✓ • ↓ Temp. (crystalline) ↑ driving force ↑ rate of nucleation ↑ # nucleas

• ↑ growth ↑ not isothermal crystallization

✓ • if isothermal constant growth rate

if not no straight line



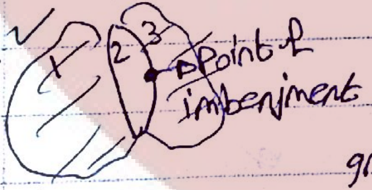
straight line
slope → growth rate

✓ • ↑ # grain boundaries ⇆ ↑ nucleation

fine crystals → high length of grain boundaries

5 ✓ . growth rate of nucleas the same → straight line boundaries (They all where born on the same time).

6 ✓



✓ . different growth rate because of different borns

growth rate of 3 & 2 > 1

7 ✓ same time born but different ~~time~~ growth rate because they are different crystals.

8 ✓ at the center there are not actual spherical because of defects (~~defects~~ of impurities) → They are impurities & alter chains rejection

اللي ما عم يدخلوا داخل الكريستال

✓ They are weak area (stress concentration area).
(impurities & grain boundary)

less no. of bonds

9 ✓ • The defects all mechanical properties depends on it.

10 ✓ No 100% structure there will be defects (except single crystalls)

• Properties will respect to another

• samples must be the in the same conditions

11 carbon on Fe (perlite, ----)

يجب معرفة طبيعة phase diagram

Detection of microscope structure by phase diagram.

To know توزيع الذرات atomic force microscope ----

12 1. point → one single atom in the building block.

3. Area → Top view & in 3D → void فجوة → volume defects

13 ✓ tension or compression in vacancy } ① vacancy

✓ it become stress conc. area.

or self substitution → x ذرة بين] ② self interstitial

حالة ذرة في مكان غير مخصص لوجود ذرة.

فشق

17 ✓ any atom = foreign added → impurity

✓ size of impurity comparable ±15% of original atom substitution "substitutional impurity" حلت الذرة في مكان مخصص لذرة

"interstitial impurity" foreign impurity too small < 15%.

e.g C & Fe

too small

≪ 15%

✓ They all make disturbance becase the atoms were in min. energy and distance → "stress conc. area"

18 ✓ high energy to exist

✓• substitutional impurity ± 15%

✓• ↑ Temp. ↑ vibration (↑ energy) ↑ vacancy because of breakage of bond.

• melting temp. physically increasing no. of vacancy → failure of structure most of there atoms not on their locations. قدرة الذرات على تحمل التركيبة غير كافية .

14 • possible no. of atoms to be in vacancy : Ns ?

✓• You have to convert temp. to <u>kelvin</u>.

✓• ↑ Temp ↑ exp Ns is constant ⇒ ↑ Temp ↑ Nv

15 ✓ Qv every atom needs 0.9 ev to introduce to the structure

✓ vacancy ⋙ self interstetial

above certain Temp. there is not enough no. of atoms to hold the structure

∝↓ if the ratio of ~~$\frac{Ns}{Nv}$~~ $\frac{Nv}{Ns} = 1$ that means that we are at molten state

<u>How</u> increase the Temp. calculate the vacancy and the ratio. then find melting point and compare it with these two points

بنوقف عند درجة الانصهار قريبة vacancy و قريبة النسبة .

melting is before 1

19 ✓ Solute → Impurities

✓ solvent → host / major / solvent

• completely free of any impurities. 100% cost كثير بياخذ impurities انا بدنا نتخلص من

✓ unintentionally غصب عنك intentional أنا بدي

• maybe when you change one property the other properties will be ~~deformed~~ deteriorated, with limit (... "مثلا ما بتقدر الغي كل الخصائص قد ما بدي)

• You have to do experiments of alloy.

• Alloy : any thing more than 1 component.

• impure → alloy

• another element with the metal → alloy

✓ the different is fraction of composition.

NO.

- Any steel 5-6 metals • many alloys of steel they differ in
- stainless steel is one composition and different properties
- of the steel the additives نسبة الكربون و

ولجيا ال additives اللي عليها بتحليه يعني.

- silver is the most ductile element

19 → You can make from it سلك كثير طويل ارفع من الشعرة مع المحافظة على ترابطه

20 ✓ solid solution high comptability of solute & solvent
✓ no limitation قد ما بتضيف ذائب بضل يذوب حتى ينقلب حالي.
✓ second phase there will be agglomeration if you add
- رح يخرب ال structure high amount of solute
- ✓ there is limitation of solubility

solubility تحدد amount of solute

اذا ضفنا كثير مذاب ← يترسب ← heterogeneous.

- solubility exist in tables. علم هندسة المواد متجه لتحقيق المتطلبات

✓ substitutional impurities → homogeneous → maintain crystal structure
✓ interstitial impurities → heterogeneous.

↓ if comptability in size

solid solution ← ↑ solubility ← substitut. ← 1 → 0.98 ✓✓

2nd phase ← ↓ solubility ← ↓ distortion ← limited ← interstitial ← 1 → 1.12 ✓

~~Solid~~

- solid solution solute & solvent ممكن يتبدلوا

12/11/2017

21 ✓ • ↑ Temp ↑ solubility ⊙ We are talking about molten phase
there is no solubility in solid phase.

22 ~~comptable~~ ~~compatable~~ ✓ compatable impurities (with the limit ± 15%)
✓ اذا كانوا متشابهة. ~~vegeo~~ substitution impurtres not interstitial

اذا زدنا ال Cu كثير بصير ال Cu major وال Ni minor

almost the 4 factors are compatable

FIVE APPLE

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23 complet solubility ← • مو شرط يتحققوا كلهم بس اذا تحققوا

✓ • اذا تحققوا ال ٣ الأخرين والاول 8 ما بزبط

✓ We don't expect 100% solubilities.

✓ if there is high electronegativity there will be an ionic bond. قوية ما بذوب

Valancy high Just for the Solute. (valancy solute > solvent).

24 Ag & Al

✓ 1 1. both comparable ±15 ✓ 2. same structure 3. Al : ✓ less, Ag : higher 4. Al : ✓ high, Ag : lower

Both partial solubility $\boxed{\text{Al}}$ answer.

✓ 2 1. Zn-Cu / Cu Zn : 4.225 ✓ Al : 11.972 α 2. α ✓ 3. 1.6 ✓ 1.5 α -4. 2 ~~5~~ α 3 ~~5~~ ✓

$\boxed{\text{Al}}$ answer.

because there is limitation in the location.

✓ • interstitial impurities does not exeed 10% percent.

25 interstitial impurity

no. vacancy is huge There is a large substitution distortion.

26 ✓ • nature of the structure of solvent (dependence) : e.g : on BCC is easier than FCC.

✓ HCP of faces > BCC > FCC

✓ >10% is not preferable → ↑stress → ↑ probability of failure

28 ✓ most of alloys more than 2 elements

in order to know the weight of each element ✓ IMP. mass ↔ mole fraction

weight is more used → أسهل العملي industrially but science mole fraction

never ever write mole fraction for flow sheet.

30 edge defect → linear defect ✓ تك dislocation إزاحة ✓

screw defect shifting of layers ✓.

linear & screw mixture of dislocation ما منقدر نميز بينهم بالنظر ✓

31 ✓ • volume, mass are constant $\xrightarrow{\text{applied force}}$ D of length changes

✓ • not necessary length are exposed to same magnitude of force

✓ • the weaker ~~deformation~~ layer has deformation.

✓ • sliding of layers because of extension of bonds between layers.

elastic behavior → - اذا ازلنا القوة هل تعود الى شكلها ؟ حسب القوة

Then → plastic deformation

→ elastic : it return to its original shape., fully recoverable deformation (elasticity differs between materials).

e.g rubber (high elasticity).

→ plastic : permanent deformation جزء رجع و جزء ما رجع

unrecoverable The net ← recoverable جزء recoverable ، جزء غير

Permanent elongation $\left(\frac{\Delta L}{L}\right)$ or by reduction of cross section area

strain ←

↑ permanent strain ↑ deformation

• Force — longitudinal // axes
  - shearing ⊥ on axes

it is creep as a layer

line / edge / screw — as structure.

✓ - actual image combination between edge & screw 14 / 11/2017

✓ - deformation : permanent ~~dt~~ dislocation ~~(plastic region)~~ (change in struc.)

- 2 stresses — ultimate
  - yield stress (less than ultimate)

* stress : force / cross sectional area resisting the force

32 ✓ difference between edge & screw :

اذا موجود لا يوجد b

✓ Burger's vector (You must know the dislocation line)

قياس مقدار الازاحة

deformation
ازاحة الذرات عن
line

كل ما اقتربنا إلى المنطقة التي تحتوي الازاحة يزيد ميلان الذرات عن مكانها ✓

* region near line of dislocation have the largest displacement

- line of dislocation: مجموعة الذرات الموجودة في منطقة deformation ✓

36 ✓ b has magnitude → There is dislocation

كم هو مقدار المسافة بين الذرة التي وصلت لها والذرة التي بدأت بها.

40 ✓ screw : hellical , look at the top view

بعض الذرات يحصل لها ازاحة وبعضها لا ✓

✓ - according to the applied shear there is min. max. dislocation (there is graduating in displacement) -

- mixture of edge & screw

من كل side view يبين الdislocation of the metals.

44 - You can see it by microscope by microtoming (taking layers of the material to see the internal view). Then you do imagination for 3D structure

16/11/2017

✓ - it not only screw neither edge.

- But you have ductile material you freeze it in order not to scratch it when taking layers. e.g CO_2, N_2 it will be converted to brittle. sometime you adjust the surface by chemical materials.

46 ✓ - impurities & chains غير المرغوبة / grain boundaries ~~stress conc. area~~

Area of defects. it is not line but surface

thickness is negligible 3D → 2D

✓ - if there is a large defect it may be volume defects not surface.

✓ - ↓ size of crystals ↑ grain boundaries ↑ area defect.

✓ but not stress conc. area because the تركيز is homogeneous

لا يوجد منطقة مرتفعة ومنخفضة

المنطقة وحدها ← stress conc. area

③ Slow cooling / isothermal

↑ size ↓ defect but hetrogeneous → stress conc. area

~~in~~ in industry is not for short time

- You must make isothermal at high Temp. to have large size → long time طول وقت ٨ة الماية في تبريد ٧ هنا
- in industry → ~~small~~ grains not crystals (no growth occur)

✓ → "smichtec str." : very high cooling rate طولها تقوى سلك

47 ① because the change of orientations of laminas

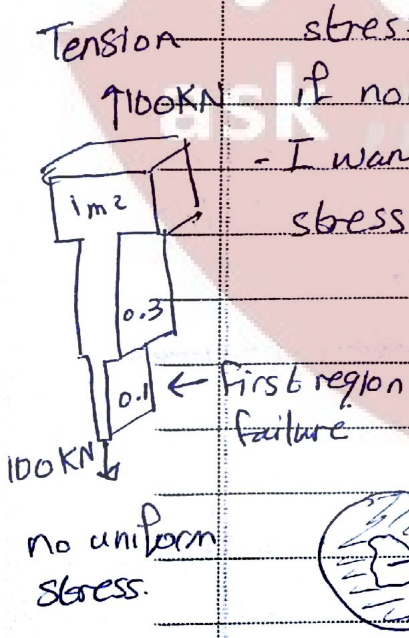
② quick cooling → no. of crystals → few chains → high competition.

✓ - You maybe see less no. of bonds between crystals
vacancy,
agglomeration.

✓ - grain boundaries less strength of bonds but there is bonds.
(few no. of di-bonds).

49 - ~~No~~ voidage as an air bubble in glass

- 3 dimensions can be noticable (thickness is considerable)
- if uniform body → same cross sectional area → 1 magnitude of stress



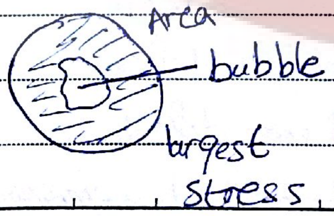
if not uniform → stress conc. area ↑A ↓stress

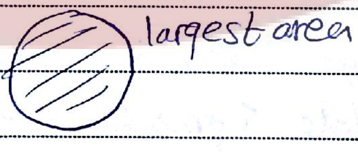
- I want as large as possible area. ليش

$$stress = \frac{applied\ force}{resistance\ area} \rightarrow \text{The smallest area}$$

$$e.g = \frac{100KN}{0.1m^2}$$

the voidage make stress conc. area





NO.

volume defect

(-) maybe as a result of manufacturing, water vapor, agglomeration of impurities, or impurities not on the structure of the solvent

↑ solute ⟵ agglomeration
2nd phase

segregation ضد

✓- conductivity لها علاقة بانسيابية الالكترونات if you have voidage or other structure will ~~s~~ make discontinuity of electrons. اعاقة حركة الالكترونات
e.g: graphite in Fe

50

✓- Atoms at any Temp. have vibration (except at very low Temp.)

(-) ↑ Temp. ↑ vibration (because of vacancy) & ↑ migration of atoms.

سخن برد ↑ Tensio on the bond (there will be ↑ fatigue)

✓- (Tension & compressio) بيصير التسخين والتبريد بسبب bonds لا relaxation & الشد ↙ frequency

80% failure ~~there is~~ because of fatigue.

e.g on curcuit board (the wire inside)

Thermal stress ⟵ التسخين
↓
like Applied force (Tension, compression)

End of Chapter #4

NO. Chapter #5 → imp. for characterization

"Mechanical Properties"

✓- it is by experiments, this experiments is standard (standard procedure) يلخّص شكل العينة قبل الفحص و طريقة الـ Fabrication
Also, Procedure of the test.

- The result must be "متشابهة تقريبا" with a certain tolerance.
- You must know ~~hot t~~ how to ~~interpolate~~ interpletate the curve.

2 - Testing for standards for dimensions & procedure. 19/11/2017

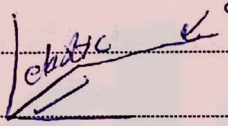
✓- some materials have elastic region only.

3 ?- seilling opposite to external force

- strain: الاستطالة

✓- what ever the force applied there will be strain but not permanent deformation.

- stress → extension → Failure ← strong bonds & brittle.
- linear relation, constant slope.
- ~~if there is elastic + plastic~~
  For rubber



✓ elastic & reversable process.

4 ✓- Force is increased → more seferation between layers (to make elongation) → thinner cross section
$L_f - L_i \rightarrow$ ~~extent~~ extension ΔL

✓ mass is constant

✓ permenant deformation because of sliding (there is sliding and extension), the matter reorganize itself.
can return

✓* elastic is reversible & plastic remains.

✓- modulus of elasticity can't be used just in elastic region. ("hook's law")
linear relation between stress & strain

+ve ↑ -ve ↑ NO.

✓ Tensile x compression → same definition the different is the sign

✓ * plastic : no way to recover the deformation -

5 ✓ * Tensile force : Applied force ⊥ resisting A cross

✓ Tensile stress ← رد فعل العينة على applied force هو في الاتجاه المعاكس

↳ longetudenal force -

✓ - ~~ste~~ or You can put the name instead of sign

~~St~~ ΔL tensile +ve ↓ Diameter / compression vice versa -

✓ → applied force 90° with surface → no shear stress

✓ - shear → applied force not ⊥ on surface → vertically → com. or tensile

↳ horizontally → shear

✓ - Tangentional force → shear stress.

✓ - tensile & shear → same definition.

7 • any force on any surface نقطة

✓ max. stress on min. cross sectional area

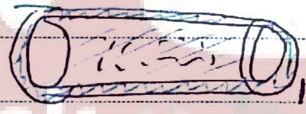
8 liquid propane gas + gas ← تحتوي اسطوانة الغاز

الغاز بيضغط في كل الاتجاهات

↓ liquid → other volume filled with gas.

* how many stresses do we have in pressurized vessel ?

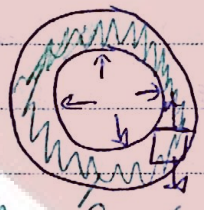
Area for σ_H



• gas on wall : compression every where -

1. gas on the ~~st~~ ends : tension σ_L (longetudenal stress)

cross sectional area



2. σ_h (hoop stress)

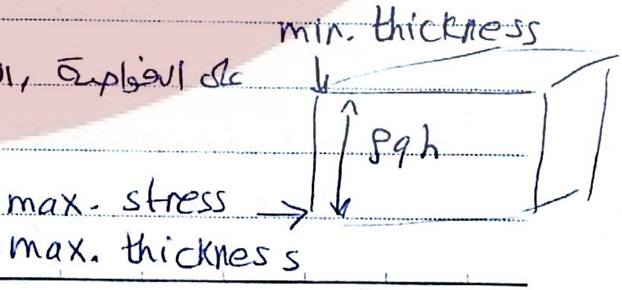
$\sigma_L \perp \sigma_h$

3. compressive stress on the wall

Area for σ_L

* hydrostatic pressure --- على الحيطة، الحواجز

design for colums or سدود



9 ✓ - We measure ~~the~~ deformation by starain.

- $\Delta L / L_0$ مقدار التغير في الأبعاد بالنسبة لبعد معيّن
- $\Delta D / D_0$ variation of diameter
- تعويض الطول على حساب التغير A cross sec.
- no elongation and inflation at the same time

↑ longetudenal stress ↓ compression (Shrinkage)

- elongation with lateral

✓ $\frac{\text{lateral strain}}{\text{longetudenal strain}} = \overset{\nu}{\boxed{0.3}}$ for metals   ν : Possion Factor

$\sigma_{long.} > \sigma_{lateral}$

For metals $0.1 \le \nu \le 0.3$

- shear : deformation of angle "shear strain angle θ"

θ almost small they take tan

10 - lower, upper yield point / toughness / modules of elastricity ---- all from tensile or stress strain test.   21/11/2017

نفس الشيء.

✓ - the two ends hexagonal ~~to~~ / أحياناً بلفوها ب / أحياناً بزيدوا الخشونة

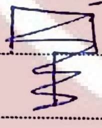
بسهل كمشها وما بتسحل / sandpaper / مشان تسهيل عملية المسك

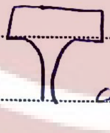
✓ - gauge length must be of uniform cross sectional area and it is the min. cross sectional area.

✓ - At the ends ther angle is curved (ellipse) not 90°

مشان نضمن انو ما يكون عند Test

no graduation





~~the~~ gradually ~~the~~ decreasing

max & min area. مشان تجنب مناطق stress conc. بين

كلما زاد التقوّس (fellet) كان أفضل.

- Zero displacement at the initial points to calculate ΔL ~~the~~ or instant ~~shell~~ $\Delta L / L$ strain

مقابل كل force

- Force is hydraulic pump
- reading for force (by load cell) and ΔL (by extensometer)

✓ not all the materials make failure.

11 -

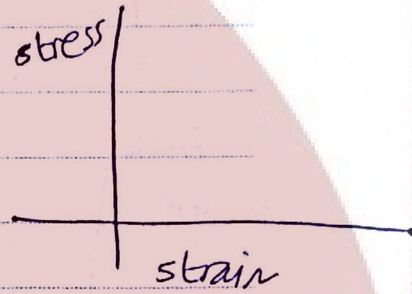
كيف تتم ترجمة القراءات

L_o, A_o is known

[KN] F	ΔL [m]	$F/A_o = 6L$	strain ($\Delta L/L_o$) unitless

data collected stress = F_{ins} / A_{inst}

curves



why A_o?

✓ engineering stress strain curve F/A_o (Just one transducer).

True stress strain curve (F/A) instant

I want two transduces (For diameter & variation of length)

صعب لأنه ما منعرف وين نحطه لأنه ما منعرف وين بدو يصير ال reduct. of area

- stress & strain ratio is constant → You can determine Area of elastic range → they are proportional

✓ magnitued of E is high because ε is low (low variation of ΔL) compared with σ. طبقات ما زالت متماسكة

(high force against small area)

E in gega paskal (110×10^9) in table 110 Just and above 10^9

✓ - reduction is normal to applied force (extension (ΔL) & reduction of width & thickness) حسب شكل العينة

✓ - مع اتجاه الشد (القوة) → normal ~~stress~~ strain - longetudenal

عكسه → lateral strain.

12 ✓ Just in elastic region

reduction = $\frac{1}{3}$ extension

All things we are talcing about in elastic region.

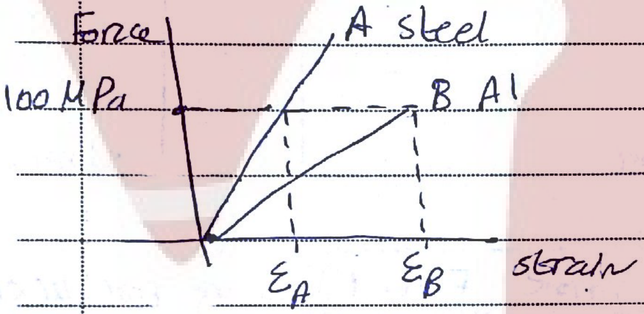
NO.

expansion ε_L -ve ε +ve ν +ve
compression ε_L +ve ε -ve ν +ve

في المعادن بصير failure قبل ما تغير شكل

✓ ν is unitless

13 ✓↑ brittle, more resistance, ~~ston~~ stronger bonds
✓↑ resistance to force
✓↑ strain ↓ strongness of bonds

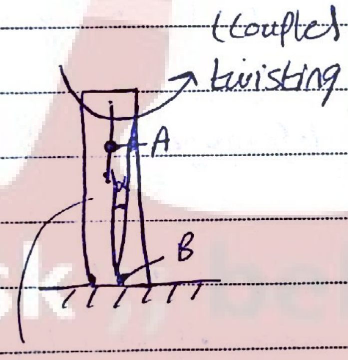


$E = \frac{100\ \text{MPa}}{\varepsilon}$ $\varepsilon_A < \varepsilon_B$

$E_A > E_B$

- ↑ response of ↓ E
✓ line of linear of proportionalty near y axis ↑E ↑ strong bonds

14



Point B is fixed in the same position
Point A change its position
اذا رجعت A لمحلها ← elastic
Deformation — recovered — elastic range
unrecovered (permanent) — plastic

deformation by α angle = shear strain τ shear stress
✓ what is the area, solid or hollow?
✓ regidity: بعد elasticity أكثر شي مستخدم

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23/11/2017

15 - metals → strong bonds → high hardness

✓- Penetration → سحق السطح

✓- When you want to test a material you must use a harder material other wise the thing will be opposite.

16 ① stress = $\frac{\text{Force}}{\text{Area}}$ ② strain = $\frac{\Delta L}{L_0}$ ③ Poisson < 1 = − $\frac{\text{lalent}}{\text{normal}}$
σ ε δ ν

④ hokk's law Just in elastic region $E = \frac{\sigma}{\varepsilon}$

- Derivation of $\delta = \frac{F L_0}{E A_0}$ $\Rightarrow \delta = \frac{\sigma}{E} = \frac{F/A_0}{E} = \frac{\Delta L}{L_0}$ $\Delta L = \frac{F L_0}{A_0 E}$ #

$\sigma = \frac{F}{A_0}$ $\varepsilon = \frac{\Delta L}{L_0}$ $E = \frac{\sigma}{\varepsilon}$ } $E = \frac{F/A_0}{\Delta L/L_0}$

$\nu = \frac{-\varepsilon_L}{\varepsilon} \rightarrow \Delta D/D_0$

✓- Torsion : by فتل غورس ما بيفرق اذا كان solid or hollow

✓ G : modulus of regidity , you can calalate it from another modulus.

17 - unrecovarable extension.

✓- end linear proportionallity

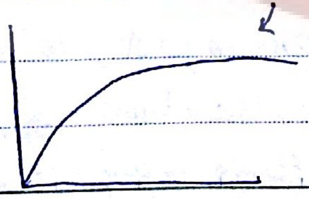
✓- Permanent deformation substract from it the elastic deformation to get the value.

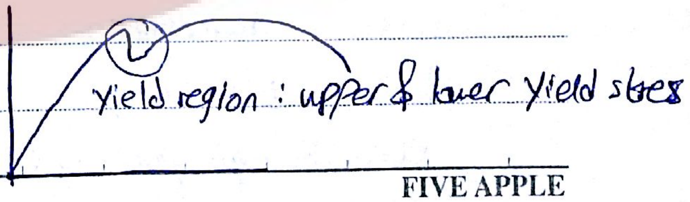
✓- some metals don't have yield Point.

✓- design according to yield point not ultimate strength. لان الفرق ليس كبيرا

✓- "Proof stress": for materials which don't have yield point.
نحن نحدد ال Stress ونطبق الخطوات بالعكس.

• in slide 20 → no yield Point / in ~~slide~~ this curve there is yield.





الساعة critical design ← لان ~~dlt times~~ عقارب اليوم, التاريخ, الساعة, ... يجب ان يكون clearance ← اقل مايمكن

عند ارتفاع درجة الحرارة ← expansion بتزيد والعكس صحيح

قرا

contraction 8 , extension

we don't want permenant delormation.

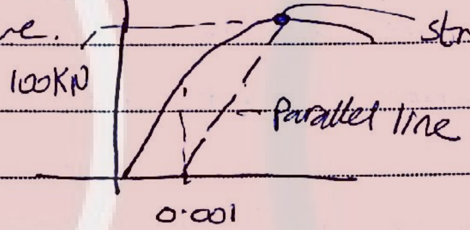
NO.

✓ if the design very critical → elastic region.

⊖ when there is deviation from linearity → plastic delamation starts

✓ I don't want permanent delomation > 0.001 "Proof"

90 to the curve.



stress value max. force = 100 KN

if the force was 90KN no plastic delomation, if 101 there will be.

19 ⊖ stress & high yield point

⊖ Mg because of ductility (low hardness)

✓ - polymers almost very low yield point (easilly plastic delomation).

✓ plastic: LDPF (for ?? dishes, ...)

engineering plastic such that P.C, Nylon

20 ✓ - elastic region: nothing to be noticed optically.

- highly hard because the line close to y axis.

✓ - Ultimate strength : if you exeed suddenly reduction in some ~~wh~~ where in cross sectional area.

قوة قصوى

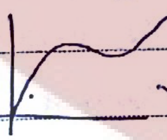
✓. You must not exeed ultimate strength to avoid fracture

✓. Very danger if you exeed.

✓ - on 80 stress if the material fracture?

وفعلياً الـ" curve طالع لفوق بس 80 عم نستخدم original Ac بينزل الأصل

قبل الـ ultimate المساحة ما بتتغير كتير لما بعد بتتغير.



→ true stress strain curve

if you measure gauge length inst. Ac منقدر نقيس

- من هيك الكسر من الصنف ؟؟ homogeneous structure

because it is alloy we don't know where the atoms توزعوا

even though pure metals there maybe there is imperfection.

NO.

26/11/2017

20 ✓ Necking just in ductile material
✓ In plastic - it is ~~[illegible]~~ مطاطيتك كبير

21 ✓ Ultimate stress → tensile ~~te~~ strength
✓ not all Polymers are ducble there is brittle materials
✓ e.g of composite is concrete
✓ composite mix. of polymer with < metals / ceramic

22 ⊙ representation how much deformation is produced
by two ways { elongation or compression . ↑ΔL for the same F ↑ ductility
✓ cross sectional area reduction or
RA & EL & compression سالبة كان انا بنعكسها } to have it +ve
in compression $\frac{A_f - A_o}{A_c} \times 100\%$

23 ✓ • Toughness & Resilience → in elasticity Just
↓ التحمل ↓ absorbed energy of material throug elastic deformation
✓ measurement of absorbed energy be the sample before the fructure point
integrated area ✓ بالعربي ملاحظة ؛ elongation
✓ generallay ductile metals have large toughness more than brittle material

24
✓ • You can measure it at $\frac{1}{2}$ x height x base because of linearity in elastic region.

25 tensile test نضع المادة في مقدمة plastic تجربها كمان .
✓ • Stress hardening in proof stress, near elasticity region -
✓ • As much you make tests the point of end of elasticity will increase "stress hardening" (increasing limit of proportionality).
✓ • Why ? rearranging according to the situation (recrystalliz. إعادة)
✓ • I must be in yield region only (in lower not upper).

✓• instead of 100 MN → 110 MN it is good.

26 ✓• Hardness → measurement of the surface strength.

✓• resistance of the surface to any permanent ...

✓• "المواد القاسية جداً" ما رح يكون في intendation

✓• indenter and applied force.

✓• indentation : تشويه للسطح خلال عملية الضغط من خلال indenter

✓• 3, 4 testing for measuring hardness (specified by standards)

• flat surface (Polished)

• diameter of the ball is standard also the load.

✓• surface of metal < surface of ball deformation on plate
steel ball with Al plate ✓ if opposite deformation will
occur on the ball.

✓ – ball made of tungusten carbide or diamond.

Imp. ✓ • ↑ diameter of deformation ↓ hardness no.
↑ indentation

✓ • Test يوجد شرط ال The restriction Point :–
d = D → repeat the test again with less load "Failed test"
– why? because if d = D I will not know the depth, maybe
the magnitude is more large

28 ✓ • Brinell is the most famous, easy, you just must know D d
✓ [P] kg P = mass of indentor + load of force in kg
not weight.

✓ d by calliper.

29 ✓ no body make true stress strain curve, it is hard to make

30 After certain limit you can't increase the hardness you will
inter plastic deformation region.

• كل الفحوصات السابقة عند درجة حرارة الغرفة لكن مثلاً" موتور السيارة ليس عند حرارة الغرفة
بالتالي ليست محاكاة للواقع. ← تم علاج ذلك : بوضع فرن عند العينة يعطي الحرارة عندها تصل ال
درجة الحرارة المطلوبة | مشان هيك نستخدم factor of safety ~~[illegible]~~ أكثر من الضعف الابعاد

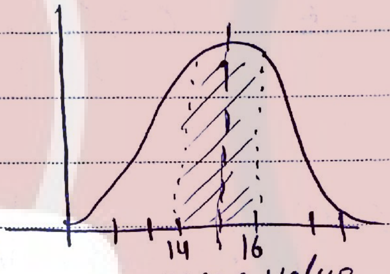
✓ ↑ Temp. ↑ rate of deformation & magnitued.

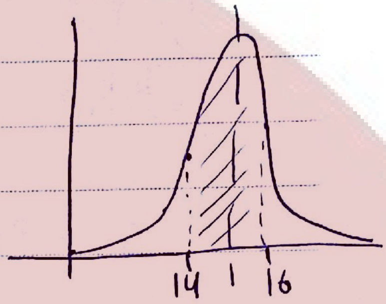
31 • 10 samples for each material, you have to exclude the highest and the lowest value if they are far away from the range (expectation) then you take the average value.

✓• كيف تحكم على النتائج ؟

by standard eviation
1 unit 5 S.d كم
from the mean
يعطيني ال bulk.

study





✓. I don't want wide curve.

⊙ working on 6 standard deviation is better than 1 للمصنع أحسن لكن
bigger variation للزبون العكس لأنه يكون

✓. narrow deviation → better representation of materials.

28/11/2017

31 ⊙ if εs ≠ does not make sense → error —

32 ✓. ultimate stress → higher value in engineering stress, dangerous it makes failure, after time further deformation "creep phenemenon"

✓. critical design → work on yield stress ordinary → ultimate

⊙ factor of safety → decreasing stress to half at min.

⊙ at least N = 1

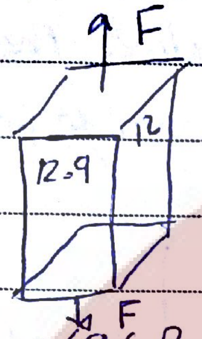
✓- yield stress of carbon steel
lower and upper yield if the material is hard.

All the previous are 1 Type of failure.

End. of ch.# 5

Sheet #2 NO. Solving suggested problems

① F = 35600 N material of construction : Al



strain ? $\varepsilon = \frac{\Delta L}{L_o}$ hokk's law can be applied.

$E = \frac{\sigma}{\varepsilon}$ $\varepsilon = \frac{\sigma}{E} = \frac{F/A}{E}$

$E_{Al} = 69\,GPa$

$$\varepsilon = \frac{35600\,N}{12 \times 12.9 \times 10^{-6}\,m^2 \;\big|\; 69 \times 10^{9}\,Pa} =$$

② $E_{Titanium} = 108\,GPa$ $D = 3.9 \times 10^{-3}\,m$ cylinder

elastic deformation F = 2000 N L_o? $\Delta L = 0.42 \times 10^{-3}$ max.

if $\Delta L = 0.5$ recovered 0.42
unrecovered 0.08

$\sigma = \frac{F}{A} = \frac{2000 \times 0.25}{\pi \times (3.9 \times 10^{-3})^2}$ this is the max. σ before permenant deformation.

$\varepsilon = \frac{\sigma}{E} = \frac{\Delta L}{L_o}$ ~~ΔL / ε constant Lo varies في السؤال [illegible]~~

~~if Lo~~ Lo is the minimum value

* if ΔL cons. ↓ [illegible] Lo if ε const ↑ [illegible] Lo

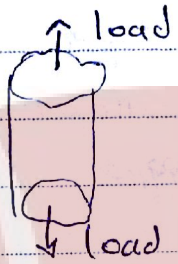
③ square Ac L = 0.02 m length = 0.1 m F = 8900 N

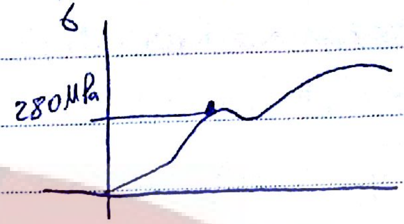
$\Delta L = 0.1 \times 10^{-3}$ elastic deformation E ?

$\varepsilon = \frac{\Delta L}{L_o} = \frac{\sigma}{E} \Rightarrow E = \frac{\sigma}{\varepsilon}$

$\sigma = \frac{8900}{(0.02)^2}$ $\varepsilon = \frac{\Delta L}{L_o} = \frac{0.1 \times 10^{-3}}{0.1} = 10^{-3}$

④ plastic delormation begins at 280 MPa





$E_{Bronze} = 115$ GPa.

$A = 325 \times 10^{-6}$

load?

$\sigma_{1\,max} = 280 \times 10^{6}$

ⓐ $F_{max} = 280 \times 10^{6} \times 325 \times 10^{-6} =$

ⓑ if $L_0 = 120$ mm ~~...~~ ~~tf?~~ ΔL_{max}?

$\varepsilon = \frac{\Delta L}{L_0} = \frac{\sigma_{max}}{E}$ $\quad \Delta L = L_0 \sigma_{max} \div E$

$= \frac{120 \times 280 \times 10^{6}}{115 \times 10^{6}}$

⑤ cylinder, copper $E = 110 \times 10^{9}$ $\sigma_{yield} = 240 \times 10^{6}$ load $= 6660$ N $L_0 = 0.38$

diameter? $\Delta L_{max} = 0.5 \times 10^{-3}$ ↘ in plastic delormat

You can't use Hokk's law.

ε according to this force $= \frac{0.5}{0.38}$

- assumpe we are at the elastic range

if $\sigma_{actual} < \sigma_{yield} \rightarrow$ elastic region

and vice versa.

Assum that 66600 N will not cause

plastic delormation ⇒ $\sigma = E\varepsilon = 110 \times 10^{9} \times \frac{0.5}{380} = 144.7 \times 10^{6}$

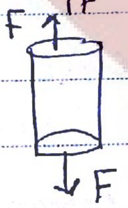
since σ in elastic

$\sigma\ ~~\varepsilon~~ = \frac{F}{A}$ $\quad A = \frac{F}{\sigma} = \frac{66600}{144.7 \times 10^{6}}$ $\quad A = \frac{1}{4}\pi d^{2}$

if it is in plastic you can't solve ج8 السؤال [illegible]

if $\sigma = 344.7$ $\quad \sigma - \sigma_{yield} \rightarrow$ plastic deformation.

3/12/2017



⑥ $\nu = \frac{\varepsilon_{lateral}}{\varepsilon_{longetudenal}}$ $\quad$ ~~...~~ $\varepsilon_{longetudenal} = -\varepsilon_{lateral} / \nu$

$\sigma = E\varepsilon_{longetudenal}$ $\quad F = \sigma A_0$ $\quad 3.25 \times 10^{4}$ N

⑦ $E = 1.705 \times 10^{11}$ Pa

"necking"

NO. Chapter #5

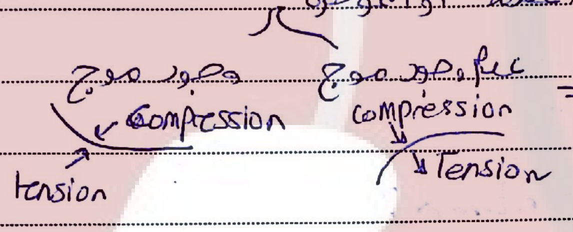
3/12/2017

1 - Previous we have studied two types of failure ⌐ Tension
compression

- 80% of failure because of Fatigue.
- ship example ... what is the reason of failure?

~~resen~~ reasons 3 Types: 1. Fatigue 2. Creep 3. impact

. بسبب الموجات التي ترفع السفينة من المقدمة أو المؤخرة



⇒ There is stress frequently occuring (below yield stress)

يوجد عدد محدود من ذلك ثم يحدث failure

very small stress frequently occuring. "Fatigue limit"
↓
how many cycles I need to make failure

- The chip is not failed but the wires because of heating & cooling
بسبب التمدد / يجب الأخذ بعامل القيد Tension ↙ ↙ compression
- Tension / compression ⌐ thermal (internal)
physical (external)
- Also if you make twisting & torsion (C.W & C.C.W)
or bending up & bending down.
- creep: at very low force for an interval of time.

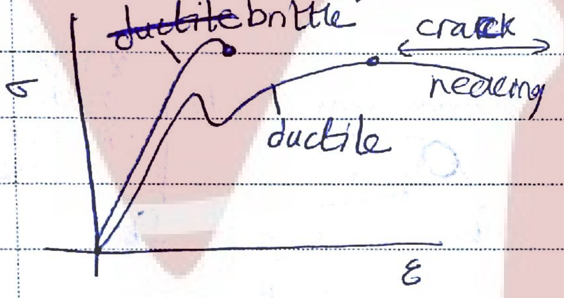
2 - Failure starts at spot (weak area) probagation of crack
- creep ← 1° areas with different rate of deformation
1° decreasing
2° constant
3° increasing.

3 - failure: seperation of component, not deformation
- there is fracture in brittle material.
- without crack (شرخ) formation no fracture internal crack → spot
لأسباب عديدة: سوء تصميم، ...
- slow probagation in ductile material (further crack probagation before fracture) until there is very small area resisting.
the brittle material is opposite.

- generally metals are ductile at room temp. (You can convert it by variation of temp.) ↓Temp. ductile → brittle
- glass transition temp. if ┌ Temp is bigger → ductile
  smaller → brittle (like glass).

if there is crack
[brittle is dangerouse]

- You must ceep the sample above glass transition temp.
- e.g Polycarbonate at room temp. is below glass transition temp. = 80°C
  if above 80°C it can be bend.
- Here we are talking in room temp.



4 - Toughness → one of the ways to differentiate between ductile & brittle
- some stress strain tests are in oven → stress strain curve not at room temp.

من اجل محاكاة الواقع.

5 ┌ very ductile material → A big difference in Fracture area, like tip big
↑reduction ↑ductility
no variation between initial & final cross sectional area → C
elastic deformation returns. Flat surface [90° angle of probagation]
there is reduction in cross sectional area → B [Cup & Cone] 45° "
the difference between C & B → surface of fracture   the reason

[5/12/2017]

6 - reduction of Ac at ultimate stress.
- b: internal crack
- d: ┌ ductile material → 45° → reason of cup & cone
  brittle
- c: all cracks begins at 90° almost negligible distance the as area (crack) increase the angle changes 90° → 45°

7 - crack of ductile material at grain boundaries.

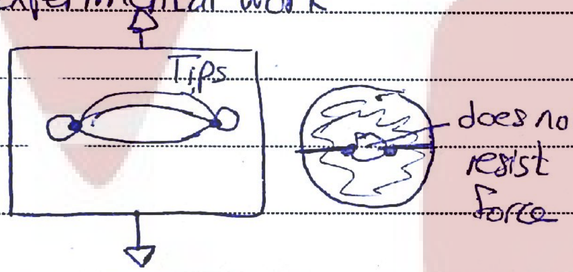
DANGER

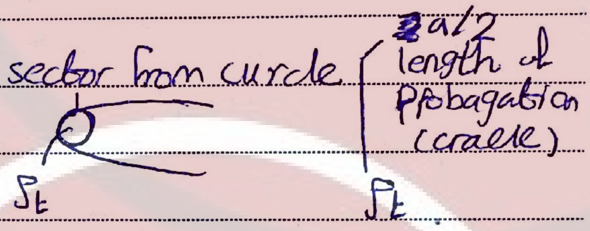
- But brittle material high probagation (higher than ductile) it begins at angle 90° and ends on 90° ← The reason of flat surface. & no necking, no noticable deformation of cross sectional area.
- in ductile you can notice necking.
- All types of defect maybe the cause of crack.

8 - There maybe exist breaking of crystals in brittle material.

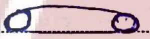
crystallographic planes [illegible]

10 - experimental work





- 3 values of stresses

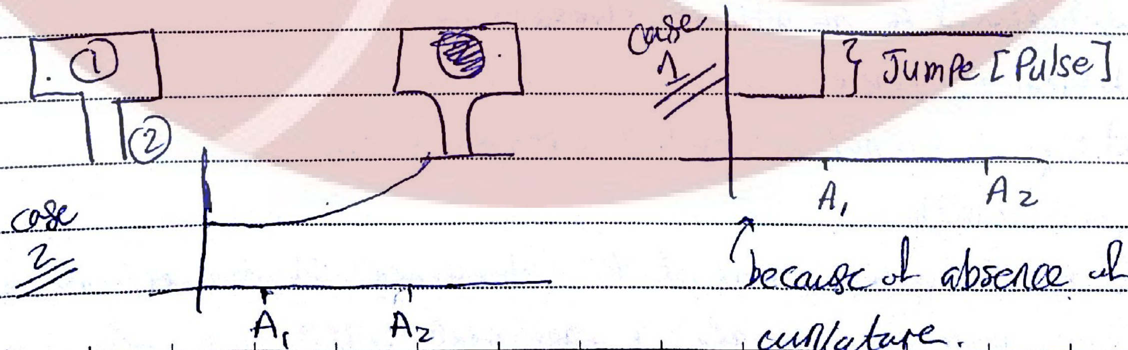
11 initially $\rho_t = a$. Then  $a > \rho_t$ ↘ σ_m will increase

(min). σ_m

But there is limit

$\sigma_0 = \frac{F}{A_0}$ & σ_m

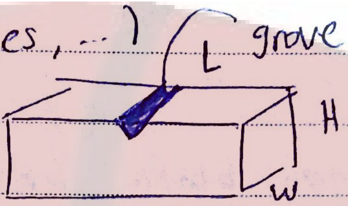
12 - don't make sharp reduction but make fillet to reduce stress. conc. You make it gradually from min. Area to max., if you make it 90° suddenly it will have failure faster ← Pulse نبض



because of absence of curvature.

- suddenly moving in stress → exist stress con. area at this point → Failure
  gradually → stress. conc. not at the point → Failure at the gauge length.
- avoid stress conc. area.

13 – For imp. applications (e.g. bottles, ...) grove according to STAM (standards)



– The sample is rectangular bar
grove to help for fracture
U or V shape.

1. Charpy 2. isode 3. free Falling.

grove بالعكس

عينة بتسقط على القطعة الموجودة على الأرض لتحتها

almost the same, the difference is the way of clamps.

قاعدة مثبتة بـ clamps بعدين بنعرف الارتفاع عشان Ep
و المفروض بس تنزل تخترق العينة اذا ما اخترقتها
Test خاطئ.

لازم البندول يكسر العينة و يرتفع الى ارتفاع آخر.

– The idea is the potential energy. $\rho g h$

– يجب ان تنكسر العينة عشان نعرف قديش بدها طاقة عشان تنكسر.

ΔE_p = energy absorbed by the sample. But there is Friction (احتكاك)
You can measure it in the absence of sample
(Friction من الهواء و الآلة)

– It is a comparative test.

– You know the area → You can calculate impact energy.

7/12/2017

14 some times the material is so much ductile
- convert it to brittle (cool it, or ↓ Temp. of environment) تفقد المرونة و لا تنكسر
- so brittle material تنكسر مباشرة
- increasing Temp. for certain period of time then immediately test it (take Temp. at the instant of test) increasing temp to make chains flexible.
  أما ↓ Temp. ⇐ freezing of chains (rigid).

تبريد في فريزر
NH_3 / N_2

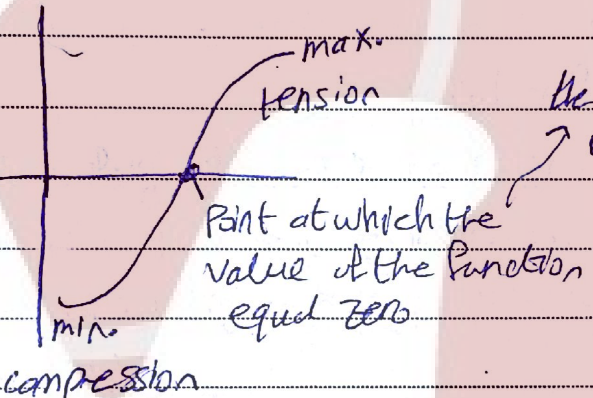
15 – room temp. doesn't mean ductile or brittle it depends on glass transition temp. (transition temp in which material changes it's behavior ~~from~~ brittle ⇌ ductile).

16 - value of stress below ultimate stress, if it is frequent the reason of failure → fatigue

fatigue اذا كان اقلّ
limit.

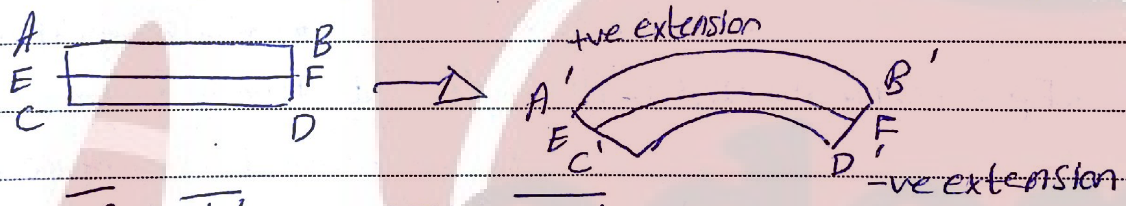
- "cyclic actions" +ve & -ve signs (bending up & dow, twisting right & left, tension & compression) كل مرة up واخرى down.

17



the is a layer does not elongate
"nuetral axis"
~~overall all~~

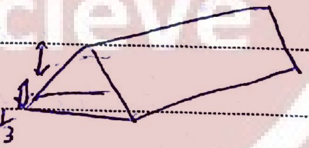
- uniform geometry → nuetral axis in the middle (symmetrical)

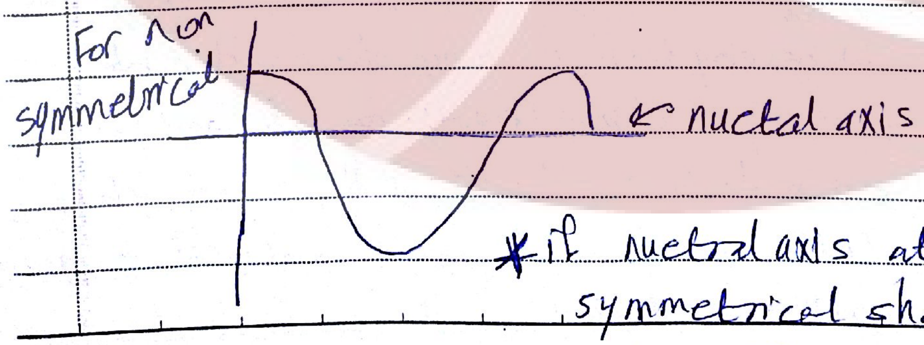


$\overline{AB} \neq \overline{A'B'}$ $\overline{CD} > \overline{C'D'}$
<

$\overline{EF} = \overline{E'F'}$ displacement = zero

- if the shape is not symmetrical nuetral axis not at the middle it is $\frac{1}{3}$ from base.





* if nuetral axis at zero line, symmetrical shape vice versa

17 - R ممكن تكون أكبر أو أقل من 1

- σ_{min} take it without the sign.

19

- ذراع متحرك و ذراع ثابت

counter → يعبر عدد اللفات تبع الموتور

- من اجل ان تكون هناك قوة تضع وزن على bearing ← force downward

و rotating يصير في tension & compress.

- every point on surface at time tension and then compression, frequently.

قد تؤدي او لا تؤدي الى fracture.

يجب زيادة الوزن حتى الوصول الى fracture، ذلك لا يعني انه لا

يوجد fatigue limit

- ↑ load ↓ عدد اللفات to reach fracture

- there are materials which don't have fatigue limit.

20 - this stress is below ultimate stress much lower than yield or ultimate. in elastic range.

21 - usually very ductile material → no fatigu material, at the end there is failure. vice versa.

السبب في اختلاف behavoir هو crack ← probagation ← neacing ↙
fracture.

22 - on the same surface just we make 1 force, but there is solving :

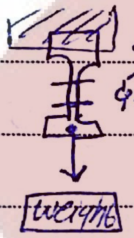
① tension & compression forces on the same surface at the same ~~is~~ instant "shoot peening" deformation under microscope, it make 2 forces. → تزيد من عمر المادة

② carburizing : rich source of carbon (for metals)

لا نمنع Fatigue لكن نحسّن.

10/12/2017

23 - creep eventhough less than ultimate stress
- as will as there is life weights there is creep.
- creep : failure under very small loads, which causes creep by the time less than U.S (even in elastic)
- ↑ load / ↑ Temp / material of construction ⇒ ↑ creep
- The sample shape similar to that of tensile but shorter



gauge length
extensometer (ΔL)
. $\Delta L = 0$ at time $= 0$ (supported before testing).
. initial tension → elastic strain.
⊛ → σ / E = height (ε)
F/A

- in the 3 tests you must approach the fracture.
primary : (decreasing rate of strain) until approach steady value
secondary : أولاً const. slope → cons. creep rate & ε increase-
مرحلة وسط بين الأمان وبين الخطر ، مرحلة أمان أيضاً".
time x slope = ΔL
tertiary : variable rate of strain (increasing)
most dangerous step , failure is possible.
- rate at the end of primary = rate of secondary → you can calculate the time.
- brittle → more time
- not on all loads there is creep
- limit value of force (if force is smaller → ليس بالضرورة الزحف creep).
- ΔL تزداد لكن معدل الزيادة يختلف حسب أي مرحلة - (معدل deformation)
24 - lead (Pb) is very ductile, very soft is used in labs.
- You don't want to exceed melting temp. /2
the factor of safety , Temp. = 0.4 * melting temp.

NO.

- ↑ Temp. ↓ Time to failure.
- as temp ↑ be aware of the load (eventhough small).

25- it is in secondary stage
- ↑ε ← ↑ ≠ σ

26 - it is similar to fatigue ~~brittle~~
- ductile material variation ΔL → very change in cross sectional area.
- same behavior of extension but constant σ with time varyating.
- brittle → fastly failure (no big deformation).
- ↑ Temp. ↓t_r (Lcons. → stress const.).

End of chapter

10 marks on first + second 30 on final material.

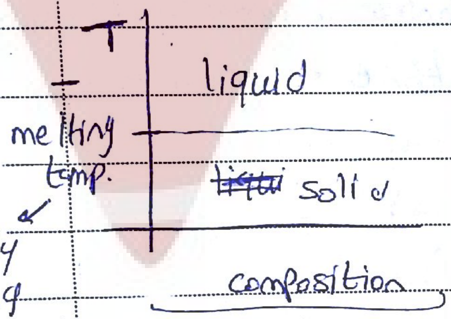
NO. Chapter #7

"Phase diagram"

1/ - phase diagram of metals changes as it changes for multi-component.

- alloy : at least 2 elements exist.
- metals may be a gas in special cases
  e.g mercury أكثر عنصر غاز في الحالة السائلة.

  apart from this metals exist in solid / liquid state.



- no phase diagram for pure metals.
- we'll take phase diagram for 2 elements in this course.

suddenly changing solid → liquid vice versa

"unary system" liquid or solid, no in ~~beta~~ between

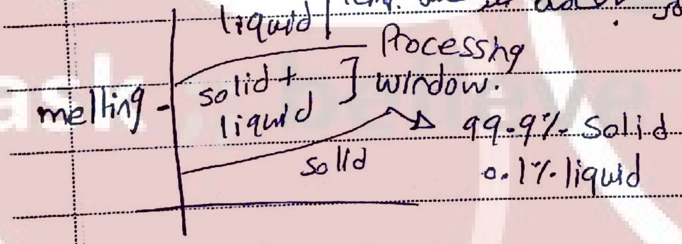
- 4 element you can't imagine phase diagram.

suddenly if it is pure material [Pure metals → sharp melting temperature]

but we don't have pure materials (there is impurities)

- apart from pure metals → we have alloy → range of melting temp.

Temp. من يبدأ بالانصهار ثم بالتدريج تنصهر بالكامل عند نفس



2/ - may be there is more than 1 phase in the same state (liquid / solid)

structure of metal

2 phases exist in solid state { e.g Fe & C when solidification Fe gives 2 phases structures : Ferrite, cementite

السمنتية تشكلت

- phase : microstructure.

NO.

- to have interstitial, substitutional impurities you must melt the material. (by any method). 12/12/2017

- quinshing, gradual, ... (methods of solidification).

3 - component : any element in the structure

- generally we deal with compounts not elements.

⇒ compounds : at least two elements but actually it is more.
Binary system لكن نتيجة صعوبة دراسة ذلك نتصورهم ثنائيين

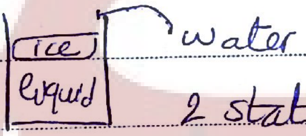
- ↑ # elements ↑ difficulty of representation (interpretation).

- no iron with ferrite (α) or cementite only it is mixed (bothe exist).
Perlite

2 Phases / solid state, we have 2 phases α & cementite
different composition of C & different struct.
so the properties differ.

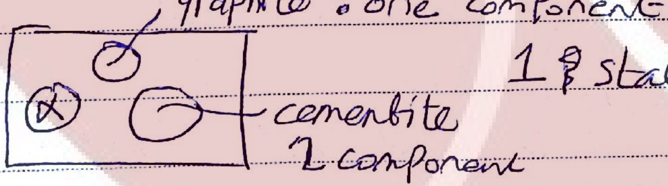
α alone uniform properties (phase)
in one state there is more than 1 phase

- e.g



2 states < solid → 1 phase, liquid → 1 phase

- e.g exess of C > 6.7% st



1 state 3 phases

5 - in isomerphous system can change - solvent ⇌ solvent

e.g Ni & copper they are compatable
at 50% composition solute & solvent not known.

e.g C & Fe α not isomerphous.

6 - by phase diagram you will Know the microstructure

7 - >902 BCC → FCC

cast iron ↑C composition & pearlite contain cementite more than Ferrite

↓ Phase diagram ال بيبين على

↓ ductility.

- I'm interested in the mix ~~=~~ proportionality of phases

You can't test 1 phase.

- C < 2.1% → steel > 2.1 → cast iron

9 - each material has final equilibrium state

- at certain temp. ratio of solid to liquid keeps constant

molten material then cooling (liquid → solid)

isothermal temp. "equilibrium state" not "final eq. state"

assume cons. pressure لو انا عيزنا الحرارة النسبة تتغير

- if Temp. changes phase, structure, — → metastable.

- at phase diagram we will be at metastable ← eqe الاتزان نسبي

at room temp. → equilibrium

14/12/2017

10 - controlling P, Temp. composition

almost constant

- we will Just deal with two components.

solid
molten
solidification (crystallization)
} 3 lines.

- metastable at final will be isothermal crystallization.

- 1 x axis you can read two compositions

11 - alloys melts at high temp.

- All pure components the same behavior

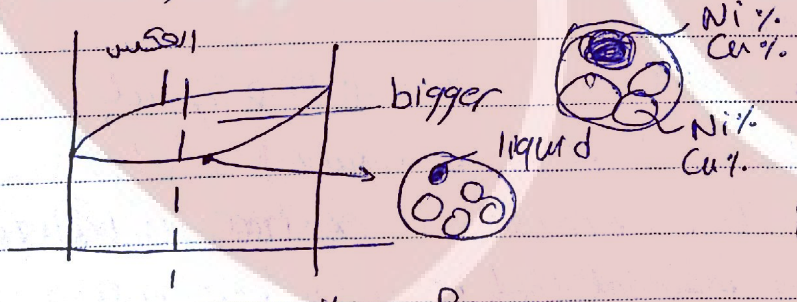
suddenly changing from ~~to~~ solid ⇌ liquid state

- some materials we are not interested which one is solute, solvent because of limited solubility does not exist "isomorphous"
  e.g Ni & copper they are compatable
- alloy → no sharp melting temperature
  at Temp. in between / not straight line between the 2 Temp.
  لايشبه بحرارة الجزء الاول ولا يشبه بحرارة الجزء الثاني
- "Processing window" of crystallization.
- impurities are in the building block of solvent , You can't distangish between solute & solvent
  solute
- gradually not sharp
  "Cored structure"
  مثل لون الملفوف (تغير اللون).
- same as solidification, crystallization every shell have different composition.
- The outer shell starts to melt then finally at core
  ↑conc. of cu ↑conc. of Ni

Not homogeneous

sharp melting temp. of the shell and the lower shell and so on until You reach the core are the same composition exactly the same behavior of pure component but it is not exist in industrial.

15 - portion solid & portion liquid → metastable equilibrium.
- no melting Temp. is for neithe the Two components, it is in between.

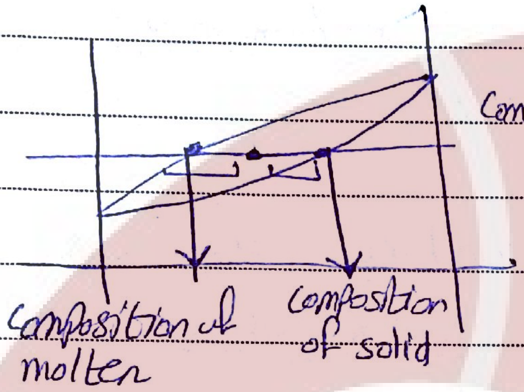


as long as Temp. is constant the composition is kept constant
what is the composition?
Lever rule الذراع

same composition of a long as we have 1 phase In the state But in solid liquid region Not the same composition

consump. Ni different than Cu

- Lever rule idea comes from a game (see-saw)



طول الذراع x الوزن = طول الذراع x الوزن.

الطول x composition = الطول x composition

عند زيادة درجة الحرارة تختلف الأطوال

↑Temp. ↑distance of solid

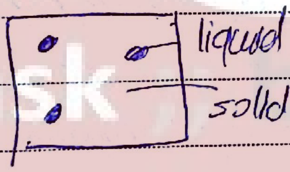
↑comp. of liquid.

*Lever rule is used whenever there is more than 1 phase
(solid liquid region)
You can use it in solid if there is more than 1 phase.

- in F-C 2phases in solid state → You can use Lever rule.
- You care about phase not state
- in liquid always 1 phase متجانسة homogeneous -
  الوحيدة لما منقدر نستخدم فيها lever rule

17 ممكن تقرأ المسافة بين الأرقام 17 / 12/2017

lever rule العكس weight of solid = balance of liquid = $\frac{\text{liquid distance}}{\text{total distance}}$

22


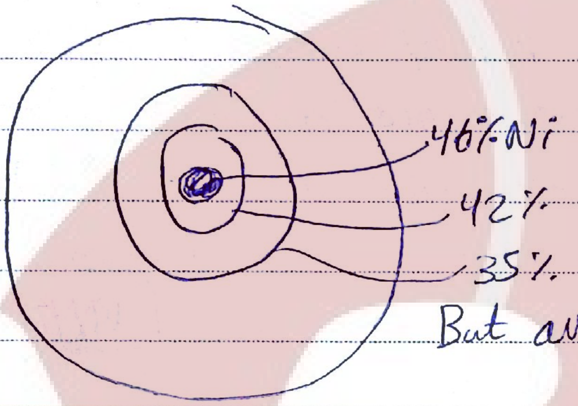
in liquid state 35%Ni 65%Cu
in solid state " "
both liquid & solid the total " "

- You can do it by vision
  arm of liquid → solid arm of solid → liquid.
- isomorphous 1 state, 1 phase in liquid & solid :
  2 states, 2 phases in existing solid & liquid.

23 ⊛ composition rich of material that have higher melting point
Almost ~~[illegible]~~ weigh fraction of solid is negligible.

① composition of shell
increase Ni in solid ~~state~~

② Latest shell composition.



35% موجودة بين liquid & solid.

آخر قطرة من liquid rich in copper because lower melting Temp.

But average weight fraction 35% Ni

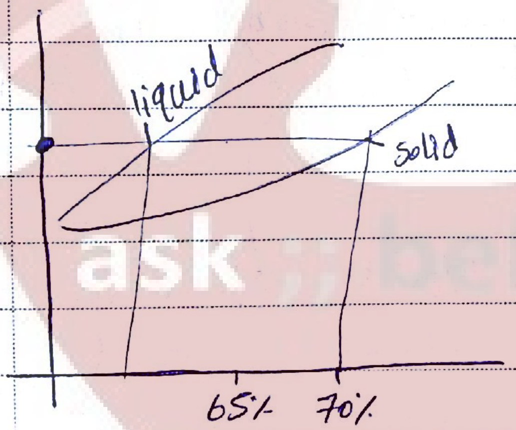
35% Ni ← 0.1 degree بـ solidus line عندما تصعد -

- استقطاب أكثر لـ Ni عند خفض درجة الحرارة.

≡ Isomorphos phase diagram the same microstructure, eventhough dillrent composition of materials.

- α phase ⇒ solid

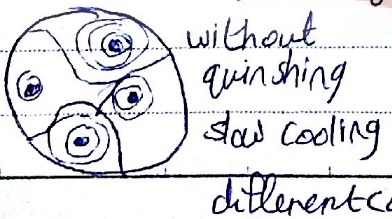
25 return to figure in slide 8 65% Ni



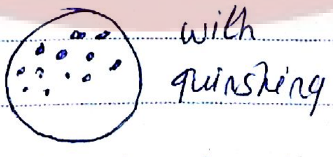
28 • ↑ dillusivity ↑ استقطاب المادة Growth rate / nucleation

• ↑ viscosity harder solidification.

- Industrially quinshing 1000 degree/min, like smechtic structure



different compositions of shell.



1, 2, shells d crystal Just

(isomerphous
second phase.

NO.

30 - For not compatable compounds (not isomerphous, not highly solubile in each other) it is a second phase

- Here 6 regions not 3 as previous.

- α high percentage of cupper. negligible Ag.
β rich with Ag (mainly Ag) negligible Cu.

- Eutectic composition → sharp ~~...~~ Temp. Cu
من غير ما تمر على منطقة L+β / أو L+α

[19/12/2017]

- β Cu in Ag

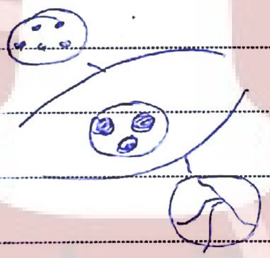
- α Ag in Cu

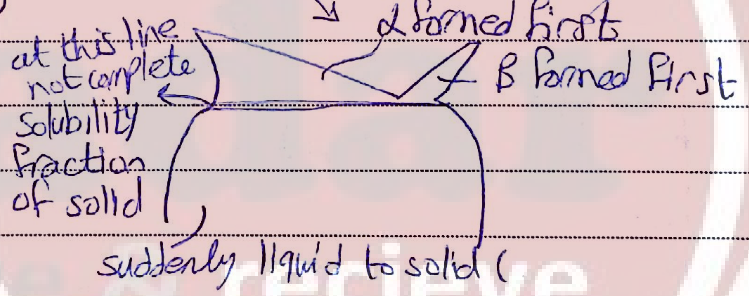
- below 400 Temp. at any Temp. two phases together exist in equilibrium

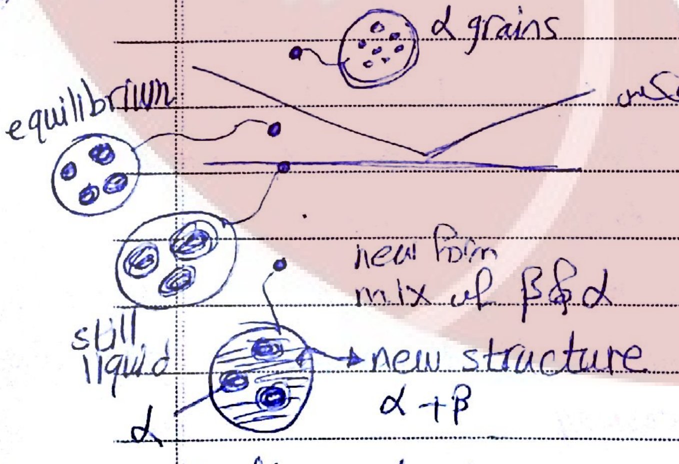
- Eutictic line : horizontal in phase diagram

- at 71.9 (CE) behave like Pure metals.
L+α more solid Fraction.

* Difference between isomerphous & eutectic





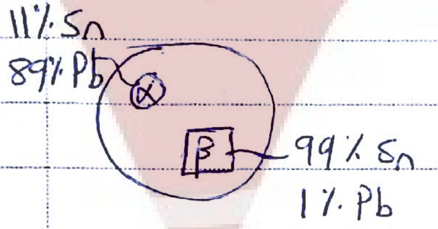


في الحقيقة
الأمر بالعكس

β after eutectic
old & new α

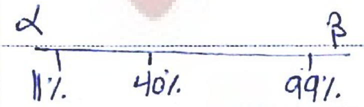
- Any region 2 phases you can apply lever rule to calculate fraction weigh in L+α / L+β / α+β regions.
- L α β exist together just at eutectic point.
- Solidis one phase solid from liquid
- Solvus solid to solid (α ⇌ β)

33 2-22 pb in sn solubility.
quantity of solubility of Pb in ~~Sn~~ Sn not the same as Sn in pb.



$$\alpha = \frac{99-40}{99-11}$$

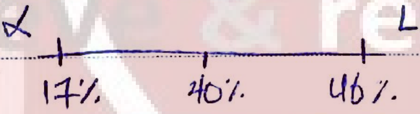
$$\beta = \frac{40-11}{99-11}$$



34 L + α المنطقة على الشمال
contain α + β (that will be formed below eutectic line)
- Two types of α — strong (befor eutectic)
weak (after eutectic).
- 2 phases, 2 states.

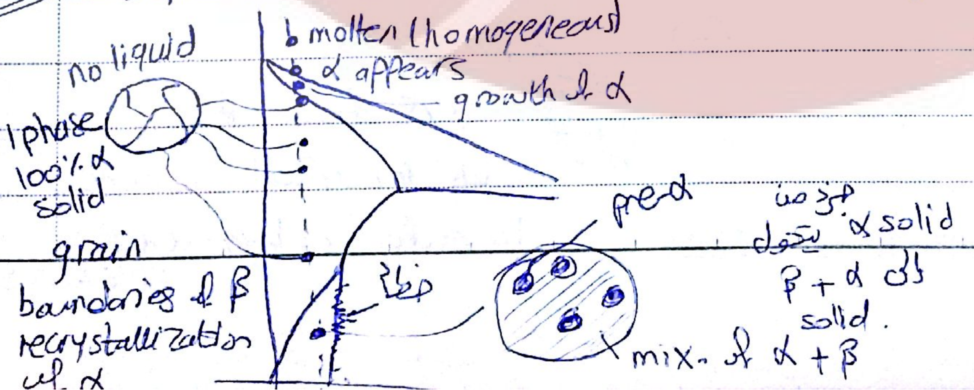
Boundaries.
[liquid or solid line = (نقط) لازم نفرق]
(الخطوط التي تفصل المناطق)

α 17% Sn 83% Pb
L 46% Sn 54% Pb
Total 40% Sn 60% Pb



There will not be generation, consumption of Sn, Pb

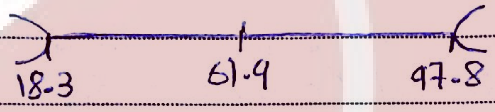
35 - 5 possibilities for solidification (5 regions)



at very low conc.
جزء بسيط جداً يتحول إلى β

<u>37</u> - at eutectic line suddenly liquid → solid $(\alpha+\beta)$
- uniform layers of $\alpha+\beta$ with different orientations, structure مرتب
قبل كان عشوائي (الحالة السابقة)

- Find concentration below eutectic line.
Just one eutectic composition

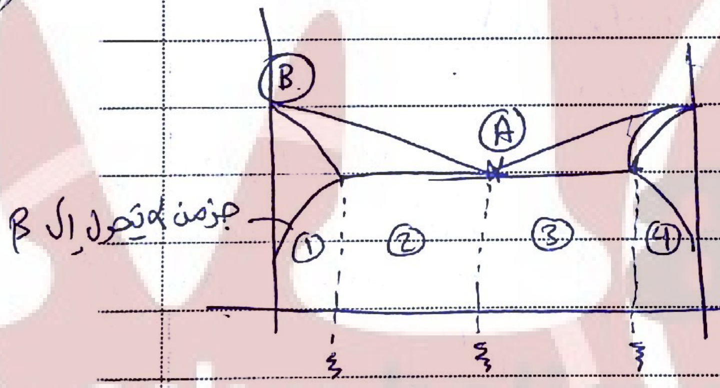


<u>39</u> At eutectic there is a fraction liquid
عندما يصل السائل يتحول ال eutectic composition

max. amount of pre α Just above eutectic line بيتسوى
max. amount of post β Just below
~~Post β - Pre~~ 100 - Post β = Pre + Post α
100 - Pre α = Post α.

L+β / L+α → 2 states , 2 phases

21/12/2017



Ⓐ

eutectic composition

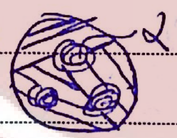
Ⓑ ① α+β layers

β on grain boundaries.
α is the origin

④

α on grain boundaries.
β is the origin.

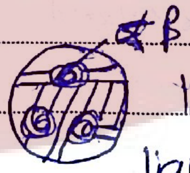
②



lines α+β layers.

liquid converted suddenly to eutectic

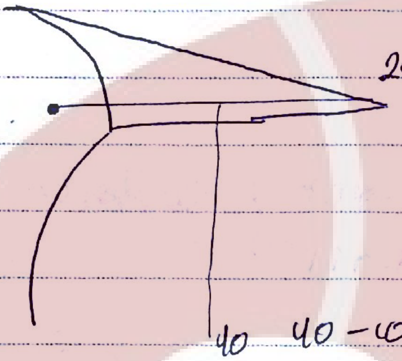
③



layers of α+β.
liquid converted suddenly to eutectic (layers α+β).

40 differ in physical & chemical properties.

41 2,2



20/2 = 10 ارقام افتراضية.

40 − 10 = 30.

42 - eutectic is the simplest graph of alloy (no intermetallic compound).

- بسبب تشكل وتكون جزيئات جديدة (intermettalic compound)

يجزئ Phase diagram is 8 أكثر من 2 أو يساوي 2

- This compound exist at room temp. at any composition.

new compound differ than components present previously.

45 - There is extension of this phase diagram.

- above 6.7 conc. → mix. with graphite → خربت خواص الحديد

- ② 2 states, 2 phases , L to eutectic composition ($\delta + Fe_3C$)

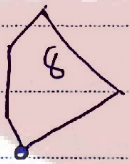
- α rich of iron, low composition of carbon.

- ↑α → near left position manufactured → flexible.

↓α → near right position manufactured → ↑ قساوة → cast iron.

- low carbon steel & high carbon steel

→ α → low → Fe_3C → high

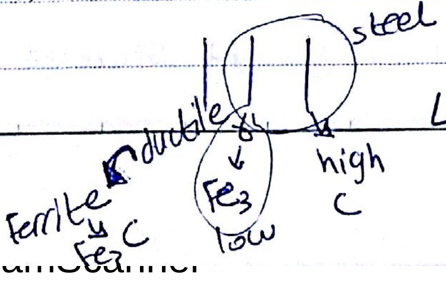


- δ → metastable ferrite α · (α+δ) same structure تأكد

- تأكد الحديد على حرارة أقل من 902 ← BCC لما يوصل منطقة γ ← FCC

بعد 1380 يتغير كمان مرة

- ductile iron all α (low conc.)



L → Fe_3C → cast iron (high c)

3 Types of Fe

α → Fe_3C ductile
γ → Fe_3C ~~hig~~ low
L → Fe_3C high

44 At A : definition of eutectic (L → S) } suddenly changing
At B : eutectoid (S → S) }
↘ (1 phase → 2 phases)

24/12/2017

- In iron, Ferrite & semintite ⇒ Perlite (below eutoid line).
- pre post ⟺ hypo hyper
above after

47 - reaching austenite (900°C) → changing structure
- at 1400 FCC → BCC } not stable
at 912 BCC → FCC } high temp.
- To have steel, the original structure must be austenite
(line in slide no. 46) γ من Fe_3C أساس
brittle iron ← L ← Fe_3C إذا كان أساس

49 - higher conc. in γ because of bigger voidage (FCC) than (BCC) in α

strong ← Phase يعني -

- steel is more flexible ↓ conc. of Fe_3C ↑ ductility
- high carbon steel → brittle → can't be bonded.

- mechanical prop. differs in different region in Phase diagram.

50 - not all types of steel is magnetic -
- magnetic ← liquid ← semebite أساس
↓ magnetic ← austanite
magnetic يكون انه ضروري مش كل stainless steal

hyper → Post

NO.

- cast iron + ferrite → The more magnetic.

51 - within the range of steel , low carbon steel

α 0.022% C   iron الباقي Fe_3C 6.7% C

Post Total $\alpha = \frac{6.7-0.4}{6.7-0.022} \times 100$ ①

Pe $\alpha = \frac{0.76-0.4}{0.76-0.022} \times 100$ ②   ① - ② → ferrite formed in pearlite

Phase diagram ← final معظم

End of chapter.

الحديد الخارج من phase diag. غير جاهز للاستخدام

↳ it needs further treatment, e.g annealing

removal of residual stresses in sample

be relaxation (↑ Temp not to melting)

then cooling in certain procedure

Cast iron fabricated سباكة

"casting" مثل موتور السيارة

فخار

من خلال clay (عكس النموذج) عند صناعة تجاويف ثم يتم تكسيره.

NO. Chapter 11

26/12/2017

3 - nonferrous limited because of low availability and استخلاصه صعب او مكلف.
-

4 - eutectic composition — high carbon → above
below → low carbon steel

- austenite → قاسي جداً
- Steel are not just iron, carbon.
- plain ⇒ 10 → no additives rather than carbon.

بشكل عام
الاستخراج
5 - Fe exist in carbonics in all types I want the oxide even
sulfide though sulfide I make it oxide
oxide

- fabrication of equipment
by lining طبقة عازلة external shell is steel
breaks as insulation

- they put large amount of C (as coal) with the material الخام
ignition of carbon crushing
give CO & CO2 I want CO for rxn
- emission of large quantities of CO مصانع الحديد مصدر للتلوث البيئي
- Limestone : تفصل الحديد عن غيره عند الانصهار
- slag : complex structure density <<< density of iron
two layer when melting (iron → molten) (slag → يطفو)
- molten iron rich in carbon, later there will be treatment
"big iron"

- CO source

9 - سكب → cast iron
ductile : more resistance to tension.

10 - annealing → recrystalization, another structure with another properties.

11 -You have to start with big iron (rich in C)

12 - meatastable zone ليست لفترة طويلة)

at isothermal temp. → crystallization

- Cooling is more importnant than the composition of additives.

13 - Disadvantages

-مصنع البوتاس كان يعاني من corrosion

-eventhough stainless steel there is corrosion but at room temp.

16 e.g Frame of windows (Al Fram), خزان سخانة الماء

- by forming plate with standard width, length and different thickness.

- at cold working ← (2 drum و درفلة من دون الصهر

او deformation

sometimes ↑Temp. of material (to become bliable) "die"

من خلال الضغط على الصفحة الساخنة وتخرج منها بان محدد الشكل.