

Exam Paper Materials & Processing ACMA4000

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Q1)

Requirements - Air tight, Water tight, Non toxic,
Non Corrosive, labels / printable,
cheap / low cost

Material - Plastic, Paper, aluminium Foil

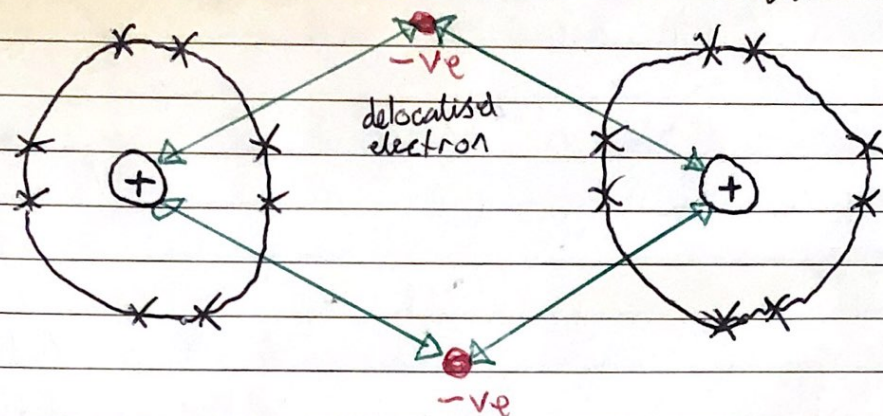
Plastic meets all the requirements, it can be printed with various designs, it is Air tight / water tight and non toxic. it is also low cost however single use plastic is not considered environmentally friendly as you can not recycle

Paper is an excellent choice as it meets all of the requirements and is considered good for the environment, paper is recycled and also biodegrades unlike plastic, there is an issue using natural materials, ~~the~~ paper comes from trees so will need to come from sustainably sourced forest. it may also need a small film of plastic to meet the air tight / water tight requirement.

Q2

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a) Metallic Bond Metal to metal

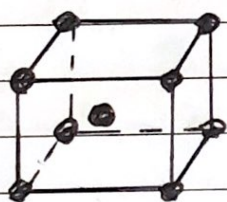


high Melting Point

The delocalised electrons are negatively charged and are free in the sea of electrons, there is an electrostatic attraction between the proton which is positively charged.

Metals with a valency are stronger because there is a greater electrostatic attraction as there is more negatively charged electrons.

B) Body centered cubic BCC



Packing Ratio = 68%
 2 atoms total 1 center
 8, $\frac{1}{8}$ in corners

Face centered cubic FCC



Packing Ratio 74%
 4 atoms total 8 $\frac{1}{8}$ th in Corner
 6 $\frac{1}{2}$ on Face
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Q2

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B) Hexagonal close packed HCP



Packing Ratio 74% (same as FCC)

6 atoms in HCP

C) PR HCP = 74%

PR BCC = 68%

PR

PR FCC = 74%

D) at 1800°C it will be liquid

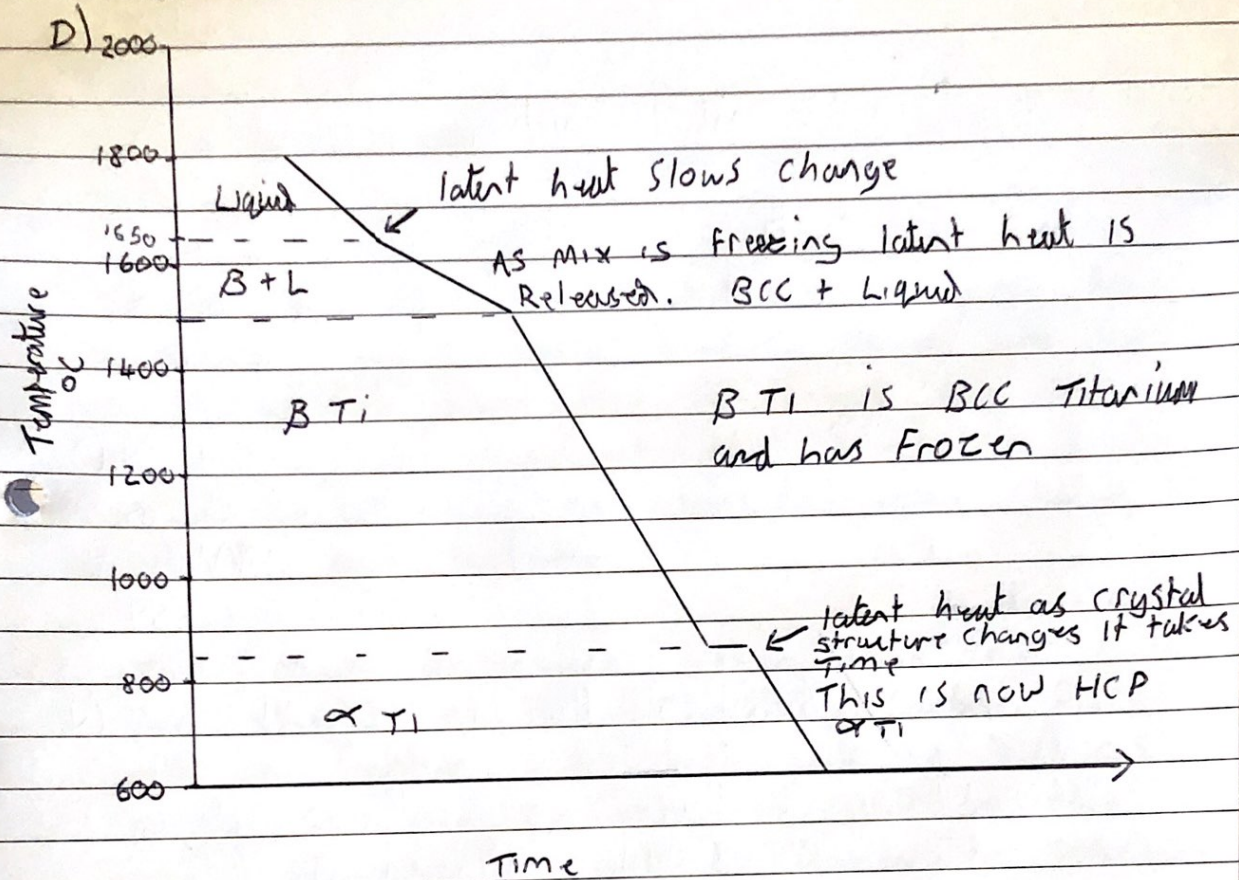
at 1650°C the liquid will change to a BCC
crystal Titanium β + Liquid

at 800°C the mixture will be αTi which is
a HCP crystal structure

at 600°C The mixture will be an α titanium
which is a HCP crystal structure

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Q2)



Q3)

- a) Material classes suitable For Race car chassis
- composites
 - Technical Ceramics
 - Metals

These materials should be considered due to their Excellent stiffness value over weight, Some materials will perform better than others but I believe these categories will be the most suitable

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B) classes that will not be considered

- Foams
- Elastomers
- Natural materials
- Polymers

These will not be suitable as they have a low modulus value making them not suitable as it ~~won't~~ have the stiffness required.

There is an argument that wood could be considered but due to manufacturing issues it would be not suitable

C) The main difference other than cost is the weight of the chassis, Carbon Fibre will be lighter but both will be just as strong so the performance will be the same, however it will be harder to machine and join parts which adds to the cost.

Other things to consider - cost

corrosion

Fatigue

manufacturing

machinability

D) During welding process it heats the material to melting point and therefore changes the property making it less ductile and more likely to reduce fatigue strength. Brazing is better as the filling material has a lower melting point than the joining metal so is reducing damage to material properties.

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Q3)

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e) Two other methods

Bonding and use of Fixing components

- Bonding is new but helps maintain material properties.
- fixings adds to the bill of materials but again suitable

Q4

$$P = 20 \times 10^6$$

$$L = 0.6 \text{ m}$$

$$d = 0.1 \text{ m}$$

Scuba diving cylinder requirements

machinable - threads

malleable -

corrosive resistant - in/out sea

non toxic - clean air

Fatigue strength - under water pressure

It will need to be non toxic to hold clean dry air, machinable for connecting hoses, resistant to salt water and corrosion with good fatigue strength as it works under pressure

B) Aluminium (6062) - light weight but has poor fatigue strength ~~so not suitable~~ due to no lower fatigue limit but not corrosive
Steel Alloy - good material, good ductility not corrosive resistant but can be coated

Q4 B

Stainless Steel - this is so Craig Petherbridge
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~~tough~~ it is a good choice as it is clean and non corrosive, it is very tough making it brittle so could crack if dropped

Carbon Fibre - light weight and stiff material could damage if dropped

I would choose Aluminium as its light and doesn't corrode and a good all round material

c) $P = 20 \times 10^6$

$$L = 0.6 \text{ m}$$

$$d = 0.1 \text{ m}$$

$$t = \frac{2 \times 20 \times 10^6 \times 0.1}{241 \times 10^6} = 0.0166 \text{ m}$$

$$\frac{2 \times 20 \times 10^6 \times 0.1}{510 \times 10^6} = 0.00784 \text{ m}$$

if you have higher yield stress you can have a thinner tank

Q4

D) i

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$$\frac{2 \times 20 \times 10^6 \times 0.1}{241 \times 10^6} = 0.0166$$

$$= 16.6 \text{ mm}$$

ii)

$$\text{Vol} = \pi r^2 h$$

$$\pi \times 0.05^2 \times 0.6 = 4.71 \times 10^{-3} \text{ m}^3$$

$$\text{Mass} = \text{Vol} \times \text{density}$$

$$4.71 \times 10^{-3} \times 2.7 \times 10^3 = 12.717 \text{ kg}$$

$$\frac{2.7 \times 10^6}{1000} = 2700$$

$$12.717 + 1 \text{ kg} = 13.717 \text{ kg}$$