

Lowri Williams

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Materials and intro to processing

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- 1) The material requirements for material properties labelling would be something which is eye catching. We would need to look into the chemical properties to see if it is corrosion resistant or it has to be subject to temp changes so this also links to thermal. It would have to be strong, durable, tough and able to withstand the low in price. I suggest using a plastic label as plastic would be water resistant. It's also rugged and safe. You can also print various colours onto plastic vinyl to make it eye catching and it's also an energy savings. Plastic is also a recyclable material. This material also has durable properties as it can withstand water up to 80°C. It will be subject to temperature and humidity variations which may result in weakening. Plastic is durable, plastic can be strong as steel in some circumstances. Plastic is also lightweight, sustainable, versatile and it's very cost effective. For the environmental impacts, plastic ~~needs~~ uses lesser energy and heavy chemicals requirements in manufacture because the material is lightweight. Plastic can be one of the materials with the least amount of environmental impacts when recycled properly. Even though plastic is a widely used material for packaging, its natural decomposition can't be that great. Instead of decomposing, we should recycle the material and make this obvious on the packaging. This material I'm using needs to be ductile, have good plasticity so

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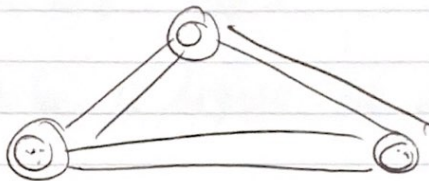
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It can be easily moulded and machined. It needs to have a good packing ratio as this can affect density. If the plastic isn't recycled, we need to take into account the greenhouse gases which are emitted. The materials which I would consider are adhesive, polyvinyl ~~chloride~~ chloride, paper and metallised film. Packaging is essential as it is used for the identification of products in marketing. Polyethylene is a flexible and perfect to use for packaging. It's commonly used, and this type of material is easily recyclable as previously stated. The packaging industry demands low-cost materials and therefore water based acrylic adhesives are used. We need to make sure we avoid over packaging, make the packaging reusable and educate the customers.

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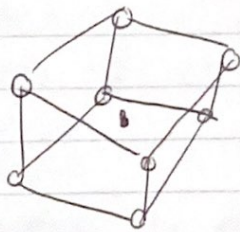
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- 2) a) Metallic bonds arise from electrostatic attraction force between conduction electrons.



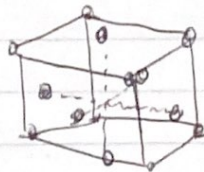
Each element has a valency and an electro negativity. Valency determines the number of ~~electrons~~ atoms reacting with each other in compound. It increases the electrostatic relationship. Elements with a valency of 2 are stronger because they have more electrons in the outer shell making them less reactive than 1.

b) BCC



Has atoms at each of 8 corners of the cube plus 1 in the middle. Total net of 2 atoms - 1 in centre, 8 eighths from the corners.

FCC



Atoms are arranged at corners and centre of each cube face of the cell.

HCP



The unit cell consists of three layers of atoms. The top and bottom contain 6 at corners of hexagon and 1 in the middle face of each hexagon.

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2c) ~~FE~~

$$H_{CP} = 0.74 = 74\%$$

$$BCC = 0.68 = 68\%$$

2d) It would be a liquid at 1800°C

1650°C

at this point, its still a liquid. It has gibbs energy and they co-exist together. Its close to another state change. Energy is released and holds temperature up. Latent heat is given out. Its a pure liquid.

800°C

At this point, the titanium metal is $\beta + L$ and starting to form. Its a mixture compound $\beta + L$ at its liquid.

600°C

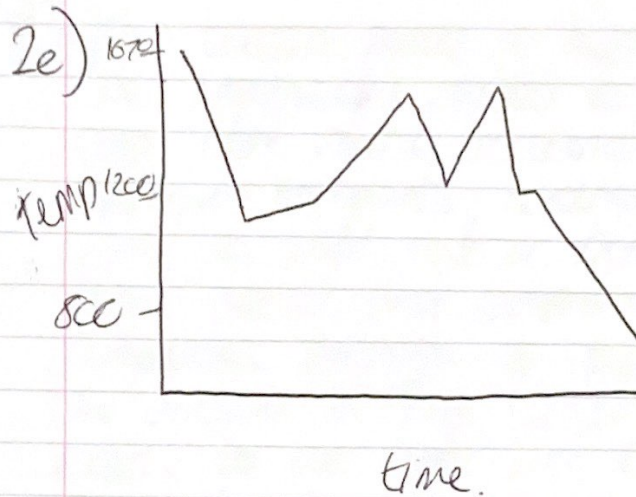
~~At this point~~ At this point the titanium liquid starts forming which can be the point in which liquid is frozen. There is a possibility for there to be a liquid at this point and they may exist together.

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Energy released
when phase changes.

rapidly cools at
around 1200°C.
and stops around
700°C.

What changes $\rightarrow$ Starting liquid then goes to B+L, ~~but then have a solid~~ it reacts at temperatures 1310 and 1380 where it rapidly heats and cools which can be a reaction in the material, and then rapidly cools again. It releases its energy quickly in transitions and then falls for cooling to a solid state.

Every phase transformation releases energy ("latent heat") keeping the substance warm as energy is extracted.

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3) a) this chassis needs to support the car, needs to be lightweight, needs to be corrosion resistant. and have many material properties such as fracture toughness, hardness, be machinable and able to weld, cast or bond. It needs to have high tensile and compressive strength, toughness, compressive strength as race cars can normally be subject to high compression in crashes. This needs to be high fuel efficient as the lighter the material, the faster and less fuel the race car will use. We would have to use a metal for this application as it can withstand heat.

and
Such as
Magnesium
Aluminium

We need to look at stiffness & density so it would be steel ^{also} used for this application as it has the ~~highest~~ highest Young's. Also W alloys can be used as they got the highest Young's modulus which would be great for the uses used above.

b) ~~would~~ I wouldn't consider foams or wood as the suspension system would need high tensile strength and it's also flammable and can't be machined. Ceramics also wouldn't be considered as they're brittle and you can't machine composites. All classes wouldn't be suitable for the suspension on my race car ~~as they~~ apart from metals as they all have tensile strength and toughness if they're to be used in a race car. They're also not rigid, durable, strong and

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In some cases, not lightweight. ~~They can also~~
They're also not ductile, corrosion resistant, formable
and can't withstand cyclic loading as where metal
can.

c) The merit function defines what you're trying to
maximise. We'd look at the stiffness/density.
Carbon fibre tubes have very high strength, a
lightweight material, corrosion resistant, high
fatigue strength and has ~~high~~ high machinability.
The merits of steel space frames are that they're
3 dimensional sturdy structures, aid loading,
capable of bearing heavy loading, transportation
costs are low, allow hassle free erection and
a geometric balance. They're also easily expandable.
Space frame chassis has a high stiffness and
density.

d) What happens to the base metal in welded
processes are that the base metal can result in
delamination when they're under transverse
tensile stresses during the welding. This base metal
as its the metal to be joined to another may
force residual stress which is the hot zone weld.
This can effect the ductility and fatigue strength.
It can be solved by cooling regimes and post weld.
It can then regain dimensional tolerances and
reduce distortion but we can't get back what we've
lost which is the tensile strength.

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Brazing joins 2 metals by 3rd low melting points. We would need clean surfaces and capillary action needed. Also good high dimensional control. This is normally used on joints as it reduces the effect on fatigue strength with the 3rd low melting point and the control through the whole process. It has a low power input and produces joints with minimal distortion and stress. You can also use dissimilar base materials for it.

3e) Two other alternative approaches which can be used to join members of the space frame chassis to each other are Bonding which is 2 materials which need a clean surface and good dimensional control. They're used in the area and different materials can be used. We can also use flux welding which needs a clean surface metal, joins fillers and metal, creates a protective barrier, helps heat transfer and deposits material from electrodes. Other alternative welding processes are Tig, mig, manual electrical, spot welding, electron welding and friction welding. These all can be used throughout joining members of a space frame chassis. Suitability depends on budget, material and shapes. Welded joints can adversely affect performance especially under fatigue. Bonding technology is improving equally and will eventually replace joining methods.

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4) a) Scuba diving material. Such as the cylinder needs material requirements such as Corrosion resistance so it doesn't ^{rust} in water, lightweight as we want the material to be dense as possible being used in water to prevent the diver from sinking, Compressive strength when they're being subject to high pressures down in water, Maximum tensile strength as it's going to be carrying lots of weight from the other equipment and be dense. It needs to be able to react appropriately with temperature changes which is a thermal property and possess engineering properties such as yield, fatigue, tough, hard and Young's modulus as the material will be subject to a lot of stresses under low water pressures.

b) Material choices analysis 4

6062 T6 Aluminium.

This material has an ~~ant~~ average yield strength and a very low density (lowest out of the 4!).

Being a lightweight material this is good for use such as aircraft, ~~more~~ mountain bike frames and ~~light~~ race cars. It's a durable material which makes it corrosion resistant and immune to harmful UV rays. It's flexible, lightweight, strong/hard, recyclable and has high thermal efficiency. This material is the most abundant metal in the earth's crust which makes it very soft. The disadvant-

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ages of this material is that its not the strongest of materials compared to steel - but for the scuba diving gear it needs to be as light as possible.

Steel alloy 1020-hot rolled

this steel has the lowest yield strength and the highest density. It wouldnt make for good scuba diving gear as its heavy, high maintenance cost and has a greater erection speed. This also is susceptible to buckling and can rust if not powder coated.

304 stainless steel.

It has a very high yield strength, same density as steel alloy, and used for storage tanks and cars. The material is strong and holds its shape, and the material can also be preserved at broad temperature ranges. Overall, its a reliable material which is good for my scuba diving gear but can also be greater erection speed.

Pre impregnated carbon fibre composite

this has the highest yield strength out of the 4 and the least dense. This is used for lightweight materials such as helicopters and wind turbines. Even though its an expensive material, its low weight, attractive appearance and a short series production. This material though is high cost, fragile and can be time consuming through the whole manufacture.

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Overall, I would choose 6062 T6 Aluminium as it possesses all the material property requirements I need for my scuba diving cylinder such as being lightweight, low density and considerably high tensile strength of 241mpa. This is also used in aircraft like material.

4c) ~~40mm~~

$$t = \frac{2 \times 20\text{mpa} \times 100\text{mm}}{241\text{mpa}}$$

$$16.5975\text{mm.}$$

4d) ~~40mm~~

$$M = \frac{W}{G} \quad \frac{2.7 \text{ cm}^3 \text{ to m}^3}{9.81} = \cancel{0.275} 264.87 \text{ kg}$$

4c) The appraisal of this that the rule to derive the thickness of the cylinder wall means that there's a factor of safety of 2. This means that the load may fail at twice the design load and so on. This determines that a value greater than 1 represents how much the stress is within the allowable limit. It's calculated by using ratio of ultimate load the allowable load for a model of structural design such as the scuba diving gear.