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Module Code: ACMA4000

Materials and Processing.

1. In terms of mechanical material properties, a good material choice for a Spindle would be high-nickel steel alloys. This would be a good choice as it has a low COE (coefficient of expansion). Although this material can be difficult to machine.

Another material choice could be Carbon Fibre. A Spindle is a very important component of machine. Carbon fiber reinforced Plastic (CFRP) improves the axial thermal displacement and dynamic stiffness. It improves thermal stability of the property.

Of course the Spindle has to be strong and fast. CFRP is both of these, it can help improve speed and acceleration, especially over longer distances. It is a stiff and lightweight material which makes them ideal for formula 1.

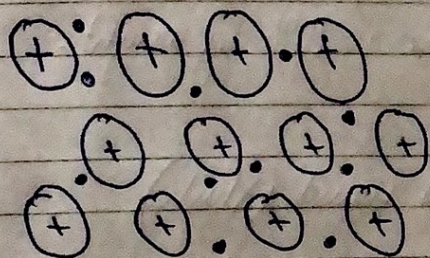
It is also very accurate and has great repeatability, for example, it can be set and then returned to the same location, operation after operation. It has a significant impact on productivity, and a reduction in weight.

Rotor materials are based on electrical steel laminations, the outer and inner parts are stamped at the same time to reduce waste. Soft magnetic materials are not recommended as they are designed for rotors.

Ni-based alloy are a good option, because of the good mechanical properties on elevated temperature. Although during manufacturing process there has been issues when cutting.

2.

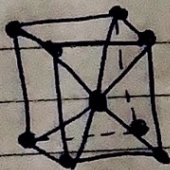
- a) If the valency was 1, there will only be 2 atoms in the cloud, if they have a valency of 2, there are 2 ~~atoms~~ each which equals to 4 ~~atoms~~ electrons in the cloud. This shows that more glue = more strength.



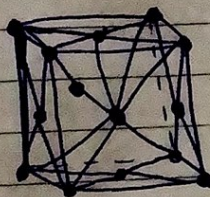
• = Delocalized (valence) electrons

⊕ Positively charged ions - held in a rigid lattice.

b) ~~BCC~~



BCC



FCC



HCP

BCC - Atoms are arranged at the corners of the cube with another atom at the cube center.

FCC - Atoms are arranged at the corners and center of each cube face of the cell.

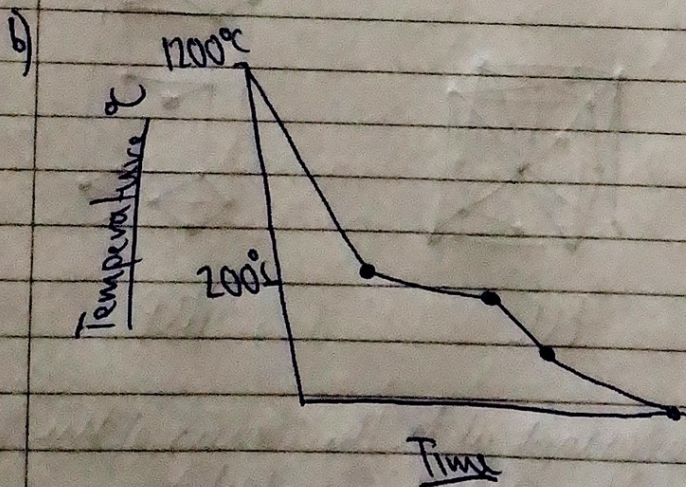
HCP - Visualized as a top and bottom plane of 6 atoms forming a regular hexagon around a central atom. In between is a half-hexagon of 3 atoms.

- c) The eutectic point is a invariant point. If the composition of the liquid or the temperature is changed, the number of phases will be reduced.

Therefore the temperature and composition at the eutectic point is $71.9 \text{ wt}\%$ and 790°C .

- d) A mixture of copper and silver is 20% by weight.

- a) $1200 = \text{Liquid}$
 $850 = \text{mixture of Solid and Liquid (Slush)}$
 $300 = \text{Solid}$



3.

- a) Embodied Carbon is the total greenhouse gas emissions that is generated to create a build asset. For example, emissions caused by extraction, transportation, manufacture and processing and assembly of every product/element in a asset.
- b) There are a number of material properties that are pertinent to scaffolding, for example they are porous structure to allow cell penetration, they must be biocompatible, this means they should be compatible without causing any toxic reactions and inflammatory response. Also they should be bioactive, being able to form strong bonding with the host bone. The biomaterials scaffolds are typically made from metal, polymer or ceramics.
- c) Bamboo is a reasonable choice as it is a natural material, which means it is cheap, and eco friendly. It is also strong as you can see in the diagram. It shows 95 MPa. Bamboo has a tensile strength higher than steel.
- c) Advantages - higher carrying ability as the tube is easy to adjust to length.
- Easy assembly and disassembly. Also a low investment cost!
- It's economical.

Disadvantages include - Easy to rust and corrosion. Making the steel tubing weaker.

- The parts and components can deform. Regular parts need replacing which causes safety hazards and a waste of money.

4.

a) Aluminium dive tanks are made mostly in a process called backward extrusion. It's a softer metal that requires thicker walls to contain the gas. These cylinders differ from steel as they tend to be negatively buoyant at the start of the dive.

b) 6062 T6 Aluminium has good machinability and is strong. Very high corrosion resistance. It's lightweight, almost one third the density of steel. Workability is great as it's easily formed, machined and welded.

Steel Alloy 1020 is low Carbon steel that has good formability. It is resistant to induction hardening and flame hardening.

304 Stainless steel is what I'd use as it's the most versatile, and it has great forming and welding characteristics. This steel is dominant in the manufacture of tanks.

Pre-preg carbon. This is a good material yet expensive, as it already has the activated resin matrix impregnated into the reinforcement. As you can see it's the strongest 1850 MPa yet the heaviest with a density of 1.74 g/cm^3 .

c) The factor of safety is the load-bearing capacity of a structure or component. It is needed to increase the safety of people and reduce the risk of failure of a material/product. Materials may not be as strong as we thought. We put more material in than needed to make sure with all our uncertainties that we will not blow up a cylinder and kill someone.