

Material and sustainability

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(2)

a) In ionic bonding it is seen that there is a direct transfer of electrons between the two elements. The electrons will be transferred to create balancing if possible to allow for a complete outer shell. The receiver of the electron becomes negatively charged and the donor becomes positively charged.

Covalent bonding differs to this as it does not permanently share the electrons. This process also most commonly occurs between elements that are the same or similar. It is also not often seen in metals.

Metallic bonding differs from the previous bonding types further as there is no transfer but instead electrons are lost from the outer shell, these can now move freely as they have become delocalized. A tightly packed lattice structure is created where the delocalized electrons fill the space & creating a stronger structure.

The valency of an atom is a grouping based upon how many hydrogen atoms the element can bond with.

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- b) 4 atoms/unit cell
 $a = 0.362 \text{ nm}$
 $R = ?$

$$\cancel{a = \frac{4R}{\sqrt{3}}} \quad a = 2\sqrt{2}R$$

$$\cancel{\sqrt{2}R} \quad R = \frac{a}{2\sqrt{2}}$$

$$\cancel{R = \frac{0.362}{4}} \quad R = \frac{0.362}{2\sqrt{2}}$$

$$R = \underline{\underline{0.128 \text{ nm}}}$$

$$\cancel{R = \frac{0.362}{4}} \quad R = \underline{\underline{0.128 \text{ nm}}}$$

- c) The first group of defects seen is point defects. These are broken into; Vacancies, which ^{caused by} ~~can~~ missing atoms in the structure further causing distortion in the other atoms. Self-interstitials are seen when an atom doesn't follow the pattern of the other atoms and is placed between the atom lines. The final type of point defect is substitutional which shows the introduction of a foreign atom affecting the overall structure.

The second defect ^{are} ~~is~~ line defects. The first ~~potential~~ effect is a dislocation in the structure, this is caused by slips of layers of atoms which even causes a permanent plastic deformation in the structure. ~~The~~ ^{second}

The final defect that occurs in the structure is area defects. ~~Grain boundaries~~ This defect occurs from the grain boundary of the structure as these are the spaces between the crystals in the material, movement can cause orientation change, this can help reduce dislocation.

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d) To reduce the speed of creep within the engine. The key would be to improve the thermal properties of the components. This can be done by introducing barrier coating with greater thermal properties. Another option is to introduce venting within the component to allow for greater heat dissipation.

(4)

a)

(i) The alloy introduced into 7XXX is zinc. This material allows for the alloy to be heat treated greatly increasing the materials strength however this does also cause the material to become more brittle, this means it is rarely used on it's own without other materials.

(ii) The first number being 4 shows that it is a carbon steel thus the third and fourth digits demonstrate it is a 0.45% carbon content.

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- b) There are 3 different composite classifications these are particle - Reinforced, fibre - Reinforced and Structural.

The first ~~sum~~^{classification} is particle - Reinforced. This makes use of macro, micro or nano particle that are placed within the structure. The particles are harder and stiffer than the standard material. particle-reinforced can be broken down further into large particle and dispersion strengthened. large particle simply shows that there is no interaction at an atomic level, this is most commonly seen in concrete, the particle distribution and size can directly affect the material properties. Dispersion strength uses particles far smaller that are evenly distributed throughout the matrix structure, this structure is most commonly seen in oxidizing materials be that metal or non metal. This provides strengthening which affects the movement in the structure, most prevalent at high temperatures.

The second category is fibre - Reinforced composites, this is most commonly seen in fibreglass and carbon fibre. The desired properties created from this process is to create the highest strength to weight ratio as possible, mainly aiming to improve the specific strength and modulus of the material. The obtained material property depends on the length of the fibres used in the structure.

Structural composites are a combination of composite and homogeneous materials this allows for the use of both materials properties. The composite material relies on the other material but also its construction.

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This category is most commonly used in multi-ply Carbon fibre and aluminium honeycomb. The structure of the ~~sa~~ material is made of faces and ~~a~~ cores.

The face is most commonly the composite material providing a large amount of strength to the material, the core is made up of the other material example being aluminium and is often arranged in a honeycomb, this provides bending resistance to the material.

c)

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①

- a) The two fuels found were hydrogen and biofuel. It can be seen that the hydrogen fuel is 30% more efficient than standard gasoline, this according to new regulations means the vehicle is classified as zero emissions. It means there is a distance of 100 - 200 km. The biofuel makes use of the breakdown of plant diversity extracting the energy absorbed from the sun.
- b) The introduction of ~~fuels~~ these renewable fuels means a large amount of benefits seen by the user. A key benefit is the reduction in running the vehicle as zero emissions means there would be reduction in both tax and initial purchasing, this initial purchasing however can be increased due to modifications needed to be made, this was stated in the review of the hydrogen fuel as the engine had to be upgraded to accommodate the increased heat generated during combustion. A seen added benefit is the ~~the~~ increased distance of travel before gasoline is needed within the vehicle.

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c) ~~The main aspect to~~

One of the key aspects needing to be input into the infrastructure would be the needed modification to vehicles, for both fuels this would be allowing the drivetrain to run of the desired fuel. In the case of hydrogen development would need to be made to the fuel tank to inhibit the risk of fuel loss, this technology would also have to be integrated into the fuel stations.

That previous points moves into the next key development needed which is the installation of the fuel pumps around all areas to make the use of the fuel viable.

To ~~also~~ reduce any environmental impact seen in the fuels production especially with hydrogen which is currently created from used diesel, an alternative process would need to be designed to further decrease any possible environmental impacts.

Finally the mass production of the system throughout the industry would be needed to reduce the direct initial purchase for the customer, this could gradually reduce over time as technology develops further.

