Topic 3 How Do Things Break?

1. The factors that govern how something breaks are firstly, how strong the bonds in the material are and secondly (and more importantly) what defects are present in the material.

2. Materials break as they are deformed past their breaking points. Deformation tends to occur by *dislocations* as defects are propagated. Polycrystalline materials are “stronger” (harder to break) than single crystals because the crystal grains are separated by grain boundaries (at random angles) and slip tends to be frustrated by these boundaries, ie you can’t keep deforming the object in a single direction. Unfortunately if you do break it, it tends to shatter along all of these boundaries!

3. Objects break along defects. A large object is more likely, statistically, to have a defect in a given direction than a small object.

4. The first 5 materials are: an ideal, or perfect, crystal, a crystal with a slip dislocation, a crystal with vacancies (holes), a polycrystalline material and a glass. The last 3 materials have significant empty space, this allows them to relatively easily deform slightly (as opposed to deform a lot, which would be hard because dislocation may be frustrated). The slip dislocation also makes deformation easy (even large deformation). To deform the perfect crystal, however, requires all of the bonds between two “layers” in the crystal to be broken, costing a lot of energy. So if we define “deformation” as *any* change in shape (even a tiny change) it will take the most energy to deform the perfect crystal.

5. Steel is stronger than iron because it contains impurities, Carbon atoms, that sit in the interstitial spaces in the iron crystal. The Carbon atoms prevent dislocations from propagating in the crystal (they “pin” the dislocations) making it very hard to deform steel, whereas it is relatively easy to deform iron. This steel is “stronger” than iron.

6. Glasses are amorphous (disordered) solids - they are like *frozen* liquids.

7. Glasses are formed by cooling liquids very quickly (eg the volcanic glass, obsidian, forms from lava as it cools extremely quickly).

8. You can see through glass because it has a random structure containing large holes (you see through the holes). Indeed you can see through most liquids for the same reason.

9. The length of the polymer backbone (or the average length, given that a polymer will contain a distribution of different chain lengths), the nature of any chemical groups attached to the polymer backbone (side groups), whether the polymer backbone is linear or branched, and whether the backbones of many polymer chains are “cross-linked” all effect the nature and properties of a polymer.

10. Good question....