

Quiz 1 Properties of Materials CME 300
September 28, 2011

- a) What crystallographic structure would you expect a collection of magnetic spheres to take? Explain why. Is this closer to the structure of CsCl or Cu?
- b) A direction lies in a plane if $hu + kv + lw = 0$ for (h,k,l) & $[u,v,w]$ for cubic systems. Show that this is the case by sketching a plane and a direction that is coplanar, writing the direction and plane using standard nomenclature and performing this calculation.
- c) Sketch and label the closest packed planes (or most densely packed planes) and closest packed directions for FCC, HCP, BCC and SC.
- d) Metals tend to be ductile while ceramics tend to be brittle. Explain why this is the case giving two reasons, one involving crystallography.
- e) There are two ways to stack cannonballs, one being less stable when subject to vibrations. Explain what these two stacking methods are and why one is less stable.

Answers Quiz 1 CME 300 September 28, 2011

a) Magnetic spheres for a simple cubic lattice since the north and south poles need to align as closely as possible. This is closer to the CsCl structure which is also simple cubic and basically for a similar reason, i.e. polarity of the molecules.



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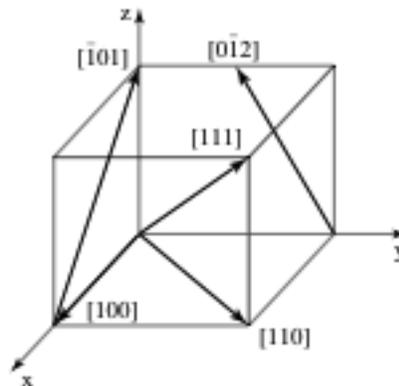
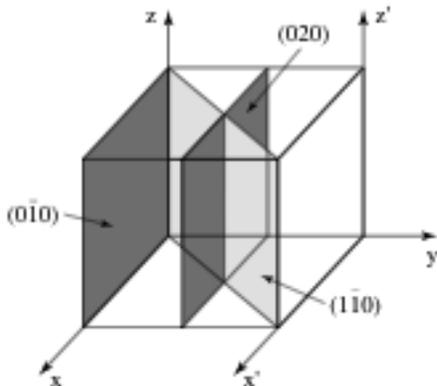
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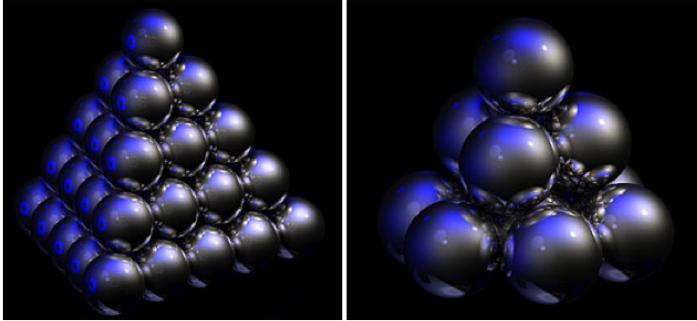
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b) $[-101]$ is coplanar to $(0-10)$. $0 + 0 + 0 = 0$ so these are coplanar.



- c) FCC $\{111\}\langle 110\rangle$
 HCP $\{0001\}\langle 1000\rangle$
 BCC $\{110\}\langle 111\rangle$
 SC $\{100\}\langle 100\rangle$

d) Ionic bonds are less forgiving since they can break to form ions. Metallic bonds are more flexible since there is a sea of electrons that are shared by many nuclei. Metals display a wider variety of energy absorbing mechanisms through crystalline defects introduced along densest packed planes and densest packed directions. These slip systems allow for the absorption of energy prior to failure of the crystal making the material ductile. In ceramics, ionic bonds do not allow for slip systems so these energy absorption mechanisms are not available.



e)

(http://en.wikipedia.org/wiki/Close-packing_of_spheres)

FCC is to the left and HCP to the right.

FCC has 12 slip systems since it has four $\{111\}$ planes and three $\langle 110 \rangle$ directions in each of these planes. HCP has one $\{0001\}$ plane and three $\langle 1000 \rangle$ directions so three slip systems. The greater number of slip systems would make the FCC structure less stable to vibrations which would activate the slip systems.