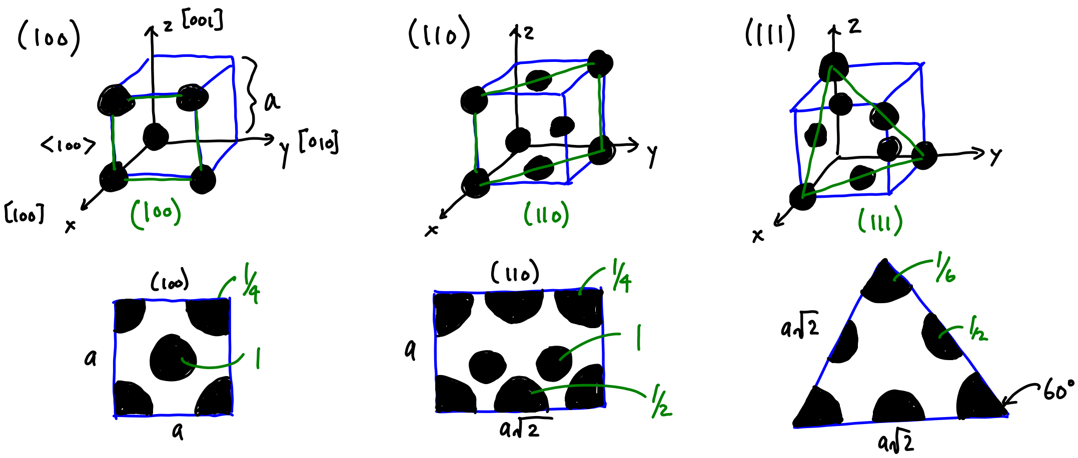
Chapter 2 Solutions (selected problems)

1. N/A

2. The three planes are drawn as follows:



From simple geometry, the distance between the crystal planes are

$$(100): 5.43\times10^{-8} \text{ cm}$$

$$(110): 3.83\times10^{-8} \text{ cm}$$

$$(111): 3.13\times10^{-8} \text{ cm}$$

To find the surface (or planar) density, first find out the number of atoms in each plane and divide by the area:

$$\text{surface atomic density} = \frac{\text{number of atoms}}{\text{area}}$$

(100):

$$\#\ \text{atoms} = 4 \times \frac{1}{4} + 1 = 2$$

$$\text{area} = a^2 = \left(0.542\ \text{nm}\right)^2$$

$$\text{surface atomic density} = 6.78 \times 10^{14}\ \text{atoms/cm}^2$$

(110):

$$\#\ \text{atoms} = 4 \times \frac{1}{4} + 2 \times \frac{1}{2} + 2 = 4$$

$$\text{area} = \sqrt{2}a^2 = \sqrt{2}\left(0.542\ \text{nm}\right)^2$$

$$\text{surface atomic density} = 9.59 \times 10^{14}\ \text{atoms/cm}^2$$

(111):

$$\#\ \text{atoms} = 3 \times \frac{1}{6} + 3 \times \frac{1}{2} = 2$$

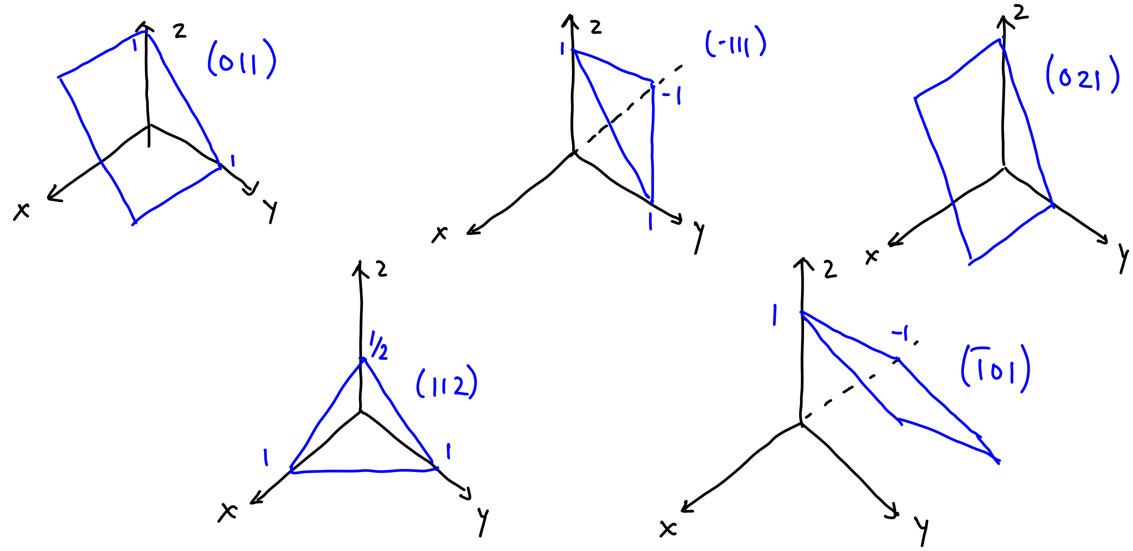
$$\text{area} = \frac{\sqrt{3}}{2}a^2 = \left(0.542\ \text{nm}\right)^2$$

$$\text{surface atomic density} = 7.83 \times 10^{14}\ \text{atoms/cm}^2$$

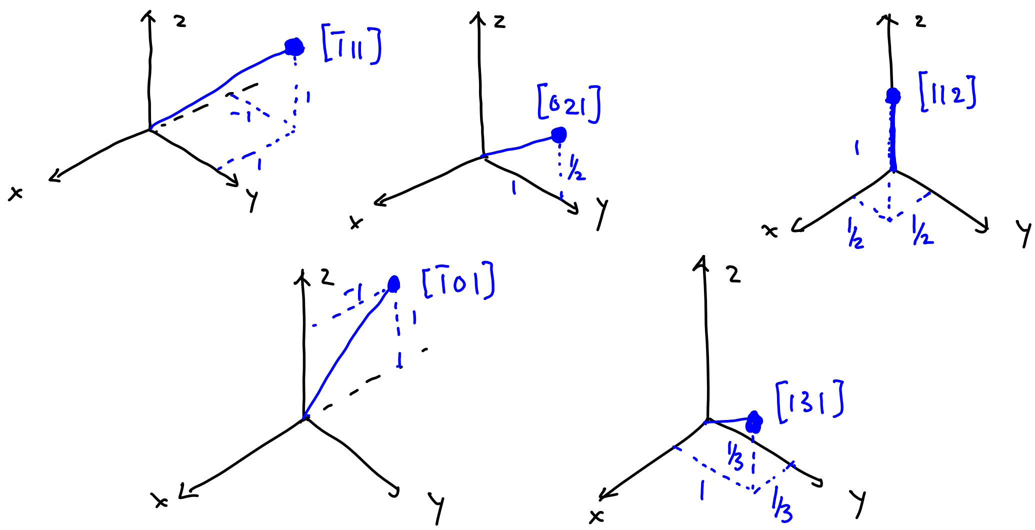
The (110) plane has the highest packing density.

3.

(a)



(b)



4. A thermal mismatch exists between silicon and standard soda-lime glass as shown in the following data. Pyrex 7740 is designed to match the TCE for silicon over a specific temperature range and aids the anodic bonding process.

Soda Lime (0-300°C): $TCE = 8.36\times10^{-5}\ ^{\circ}C^{-1}$

Silicon (0-300°C): $TCE \approx 3\times10^{-6}\ ^{\circ}C^{-1}$

Pyrex 7740 (0-300°C) (borosilicate glass): $TCE = 3.25\times10^{-6}\ ^{\circ}C^{-1}$

5. Thermosets are polymers with covalent cross-links that limit the ability of the material to

undergo large-scale deformations. Thermoplastics can go through multiple melt-freeze cycles in which the material softens when heated and hardens when cooled. Thermoplastics consist of linear chains that are loosely connected through covalent bonds

6. Qualitatively speaking, polymers at temperatures below their glass transition temperature tend to be hard and glassy (solid-like) and at higher temperatures, they are rubbery (liquid-like). Above T_g, noncrystalline polymers have enough thermal energy for long segments to move randomly. Below T_g, motions cease. The glass transition temperature is the temperature at which forces holding polymer segments together are overcome by thermal-induced motions, allowing large-scale molecular motions to occur. Processing and operation of polymer devices must take the glass transition temperature into account so as to achieve the intended polymer behavior and device results.

7. Partial answer: Young's modulus for Si: 1.9×10^{12} dyne/cm^2.

   Young's modulus for stainless steel: 2.0×10^{12} dyne/cm^2.

8. N/A

9. Devices are classified according to the risks they present. Class I devices pose no risk to life and thus no clinical testing or performance standards are required. They do require premarket notification (510k), good manufacturing practices, and design control.

   Class II devices fall under special controls meaning that additional rules exist to ensure that the device is safe. For example, performance standards are mandatory. The manufacturer tests the device and submits the results for FDA as premarket notification (510k). If the product is cleared by the FDA, it can be sold.

   Class III devices pose the greatest risk and are thus subject to the most regulation. These include life-sustaining or life-supporting devices and implantable devices. New devices that fall outside of Class I and II are usually categorized Class III. These devices require premarket approval (PMA) by the FDA. Clinical trials are usually required as part of the PMA process.

   EndoSure is an example of a Class II device.