Group Member Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Ceramics, Polymers, & Electronic Properties**

**Activity I: Ceramics**

Ceramic impurities are determined by charge neutrality. For the additions of impurities listed below determine allowed changes.

1. Si4+ is substitutionally added to CaO ­ →
2. Al3+ is substitutionally added to TiO2 →

1. Al3+ is substitutionally added to CaO →

Indicate correct/incorrect for each of the following student statements? Then, if it is incorrect, correct it.

1. Be is substitutionally added to Li2O → One Be is added for each Li.
2. Ca is substitutionally added to TiO2 → One Additional Ca for each Ti
3. Sr2+ is substitutionally added to CaF2 → One Sr for each Ca

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**Activity II: Polymers**

1. Polyethylene [C2H4]n forms a covalently bonded polymer chain with 109o between the main carbon bonds in the chain.
2. Draw an atomic picture of the bonding of a few sets of carbon and hydrogen atoms.
3. A polymer chain is often drawn as a random looking squiggly line. Why does the line look random if the carbon atoms are all 109o apart?
4. The stress strain plot for a polymer is shown below. What causes the increase in the measured stress seen after point A? Explain

2

3

4

6

ϵ

20

40

60

A

**Activity III: Electronic Properties**

1. The fundamental difference in band structure between a metal and a semiconductor is that metals have no band gap and semiconductors have a band gap. Explain what a band gap is, and why it is important to the differences in conductive properties of metals and semiconductors.
2. Draw a picture or graph which illustrates what a band gap is.
3. Which statement(s) is/are true about holes with respect to a semiconductor band structure? Explain.
   1. In a semiconductor, holes accumulate and form a zone in the band structure called band gap.
   2. Holes are found below the band gap and are missing valence (bonding) electrons.
   3. Holes are found in the conduction band and are missing conduction electrons.
   4. Holes are the electrons removed by a vacancy. They have nothing to do with a band structure.
4. Which statement(s) is/are true about holes with respect to a conduction? Explain.
   1. Since holes occur in the conduction band, they contribute to conduction.
   2. Since holes occur in the valence band, not the conduction band, they cannot contribute to conduction.
   3. Although holes occur in the conduction band, they do not contribute to conduction.
   4. Although holes occur in the valence band, they contribute to conduction.
   5. The fact that holes scatter and annihilate conduction electrons decreases conductivity.
5. In silicon, like in metals, the mobility of electrons and holes decreases with increasing temperature. This should imply a decreasing conductivity with increasing temperature. However, intrinsic (undoped) silicon has a conductivity that increases with increasing temperature. What is causing this? Explain.

1. Explain the effect on the conductivity of adding small amounts of boron to
2. Metals
3. Silicon.