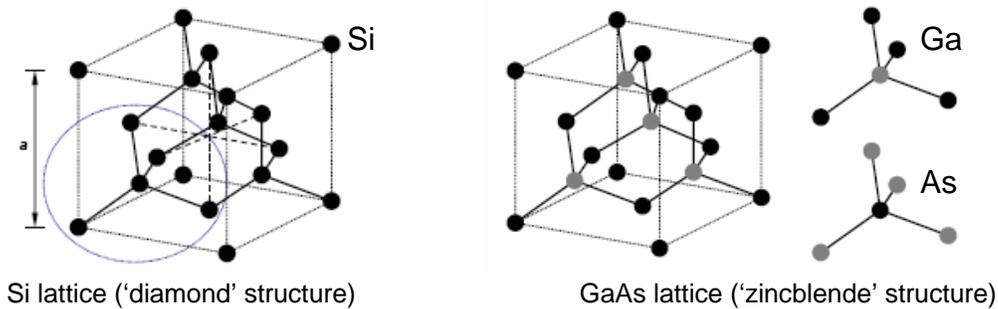


3.46 PHOTONIC MATERIALS AND DEVICES

Quiz 7—April 10, 2006

Below are the crystal unit cell structures for Si and GaAs. These structures can be visualized as two inter-penetrating Face Centered Cubic (FCC) lattices, displaced from each other by $\frac{1}{4}(1,1,1)a$, where a is the length of the unit cell (also referred to as its lattice constant). For GaAs, the Ga atoms reside on one FCC lattice, the As atoms reside on the other FCC lattice.



If one studies the shape of these two structures, one can come to the conclusion that the Si structure is centrosymmetric and the GaAs structure is non-centrosymmetric.

- (1) What does it mean for something to be centrosymmetric or non-centrosymmetric? Which of these materials is a Pockels medium, and which is a Kerr medium?
- (2) A Pockels medium $\chi^{(2)}$ may also be a Kerr medium $\chi^{(3)}$, but the Kerr effect will always be much smaller. Typically, how much smaller is $\chi^{(3)}$, in comparison to $\chi^{(2)}$?
- (3) You want to design an electro-optic modulator. Do you want to use a Pockels or Kerr medium? Which of these two materials would you choose?
- (4) You want to design an all-optical modulator. Do you want to use a Pockels or Kerr medium? Which of these two materials would you choose?

Name: _____