

ECE 231 Review (Midterm)

1) Crystal Structures

- corner atoms are $1/8^{\text{th}}$ of the total atoms (since eight cube corners will touch when cubes are stacked, so the corner atom will be divided into eighths).
- face atoms are $1/2$ of the total atom (since two faces of the cube will touch when stacked, so the face atoms will be divided into two).

- a) **Simple Cubic:** Has eight corner atoms only, hence it has one atom per unit cell.
- b) **BCC:** The Body-Centered Cubic has eight corner atoms with one central atom, making it two whole atoms per unit cell.
- c) **FCC:** Face-Centered Cubic has eight corner atoms and 6 face atoms, making it four whole atoms per unit cell. The main lattice atoms can be thought of existing at $[0, 0, 0]$, $[\frac{1}{2}, \frac{1}{2}, 0]$, $[0, \frac{1}{2}, \frac{1}{2}]$, $[\frac{1}{2}, 0, \frac{1}{2}]$, creating four total atoms (these are coordinates, well Miller indices, on the FCC cell. If they don't make sense, review this concept on the next page talking about Miller indices. If it still doesn't make sense, review it from ECE 109!).
- d) **Diamond Lattice:** The diamond lattice can be viewed as two interpenetrating FCC lattices, shifted relatively by $[\frac{1}{4}, \frac{1}{4}, \frac{1}{4}]$.

***Note:** Additional lattice examples are in the course notes, page 1. Refer to these for Zincblende, Rock-salt, Wurtzite, and Hexagonal close-packed.*

2) Lattice and Reciprocal Lattice

Unit Cell: A unit cell is a component of a crystal that, once tacked together with pure translational repetition, reproduces the whole crystal.

Primitive Cell: The smallest, irreducible unit cell.

Basis: The group of unit cells that form the microscopic crystal by infinite repetition is called the basis.

Basis Vectors: Any fundamental lattice must be defined by 3 primitive translational vectors. This means that a position in the crystal can be described by $\mathbf{R} = n_1\mathbf{a} + n_2\mathbf{b} + n_3\mathbf{c}$, where \mathbf{a} , \mathbf{b} , \mathbf{c} are the translational (or basis) vectors and n_1 , n_2 , n_3 are integers. These vectors define the unit cell of the lattice!

Reciprocal Basis Vectors: The basis vectors of the reciprocal lattice. The exact formula for calculating \mathbf{a}^* , \mathbf{b}^* , \mathbf{c}^* is given in the notes (omitted here, since the midterm is concepts only). The reciprocal lattice of an FCC lattice is BCC and vice versa!

Bravais Lattice: The basis is formed in such a way that it forms a Bravais lattice. Every point of a Bravais lattice is equivalent to every other point (i.e., the arrangement of atoms in a crystal is the same when viewed from different lattice points).

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