

Fundamentals of Electronics Devices

Unit-1

Lecture-5

Cubic lattices

- The simplest three-dimensional lattice is one in which the unit cell is a cubic volume, such as the three cells.
- The *simple cubic* structure (abbreviated sc) has an atom located at each corner of the unit cell.

- The *body centered cubic* (bcc) lattice has an additional atom at the center of the cube, and the *face-centered cubic* (fcc) unit cell has atoms at the eight corners and centered on the six faces.

- As the atoms are packed into the lattice in any of these arrangements, the distances between neighboring atoms will be determined by a balance between the forces that attract them together and other forces that hold them apart.
- We shall discuss the nature of these forces for particular solids.

- For now we can calculate the maximum fraction of the lattice volume that can be filled with atoms by approximating the atoms as hard spheres.
- The packing spheres in a face-centered cubic cell of side a , such that the nearest neighbors touch.

- The dimension a for a cubic unit cell is called the *lattice constant*.
- For the fcc lattice the nearest neighbor distance is one-half the diagonal of a face, or $\frac{1}{2}(a\sqrt{2})$.
- Therefore, for the atom centered on the face to just touch the atoms at each corner of the face, the radius of the sphere must be one-half the nearest neighbor distance, or $\frac{1}{4}(a\sqrt{2})$.

Exercise

- Find the fraction of the fcc unit cell volume filled with hard spheres.
- Hint:

Each corner atom in a cubic cell is shared with seven neighboring cells; thus each unit cell contains $1/8$ of a sphere at each of the eight corners for a total of one atom.