### University of Arizona

# Materials Science and Engineering

## MSE 110: Solid State Chemistry

##### Crystalline structures based on packing of hard spheres

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##### Cieran Wong

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**Introduction**

There are many different types of crystalline structures which change the properties of different kinds of solids. For example, carbon can adopt different types of structures and that changes the type of substance produced, diamond, coal, or graphite. Three types of crystalline structures that will be explored are FCC, BCC, and HCP. BCC is a less dense structure compared to FCC and HCP and this allows the atoms to not be as closely packed compared to FCC and HCP which have very dense, tightly packed atomic structures. These three types of structures are typically found in metals. As stated above, crystalline structures can dictate the properties of a material and manipulating the structure to best suit a certain purpose will maximize the capabilities of said material.

###### Experimental Procedure

Materials used:

* Lattice pattern for each structure: FCC, BCC, HCP
* Lattice from to hold the plastic marbles
* Plastic marbles representing an atom each
* Ruler to measure cell parameters.

Steps:

1. For each structure type, use the respective lattice pattern and set up at least two or three layers of the marbles to be able to effectively see the patterns.
2. After finishing a build, place the marbles back into the tray before trying a new pattern.

###### Experimental Results and Discussion and Conclusions

**FCC**

3. Basic FCC unit cell: cube, atom in center of each face. Cubic unit.

4. Lattice constant, in millimeters: 18mm from center to center.

5. Lattice constant for d = 0.5 inches (12.7mm): 12.7mm (2) ^1/2 = 17.96 mm.

6. Planar Filling Factor: 0.785 mm

7. Direction is the highest atomic density: (c) across center of cube.

8. Coordination number: 12

9. # of atoms in each unit cell: 14

10. Packing factor: 0.74

**HCP**

3. Basic HCP unit cell: hexagonal.

4. Lattice constants, a0= 12.7 mm, c = 21 mm

5. Direction is the highest atomic density: (c) along the a axis

6. Coordination number: 12

7. # of atoms in each unit cell: 6

8. Packing factor: 0.74

9. Planar filling factor: 0.785

10. HCP resemble: FCC

**BCC Lattice**

3. Basic BCC unit cell: Cubic

4. Lattice constant, in millimeters: 14.5 mm

5. Lattice constant for d = 0.5 inches (12.7mm): 14.66 mm

6. Direction is the highest atomic density: (c) across body diagonal

7. Coordination number: 8

8. # of atoms in each unit cell: 2

9. Packing factor: 0.68

10. Planar Filling Factor: 92.14