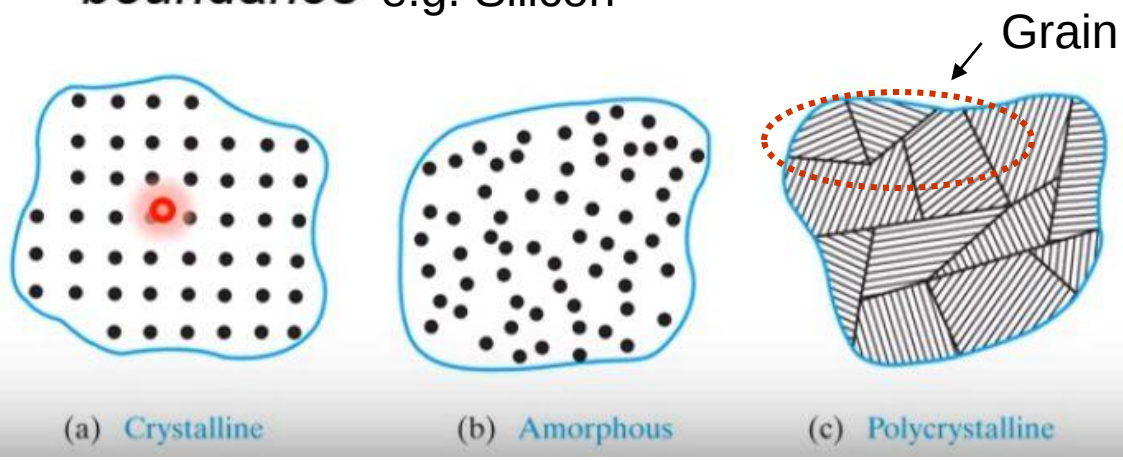
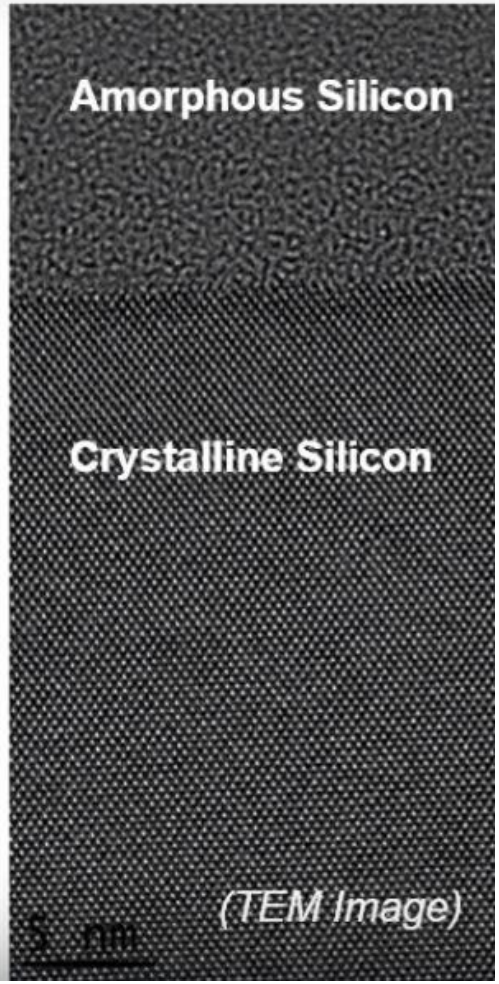
TYPES OF SOLIDS

- **Crystalline**: repeating arrangement of atoms e.g. Salt, Diamond
- **Amorphous**: random arrangement of atoms e.g. Steel, glass
- **Polycrystalline**: has regions of crystallinity separated by *grain boundaries* e.g. Silicon





Crystalline electrical properties are superior to those of a non-single crystal material.

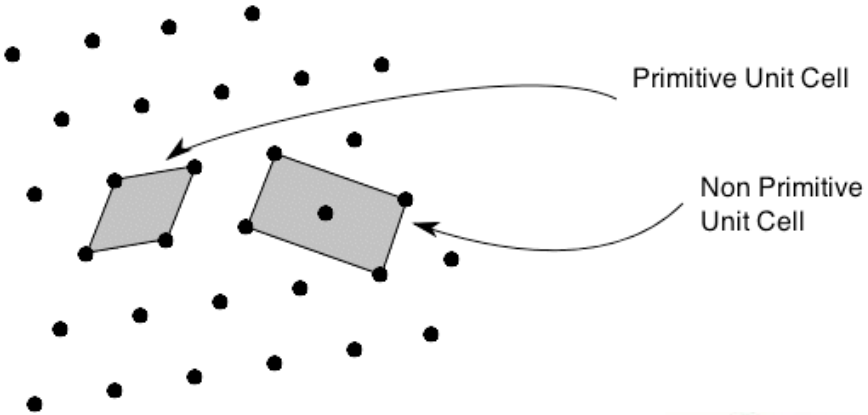
Polycrystalline grain boundaries tend to degrade the electrical characteristics.

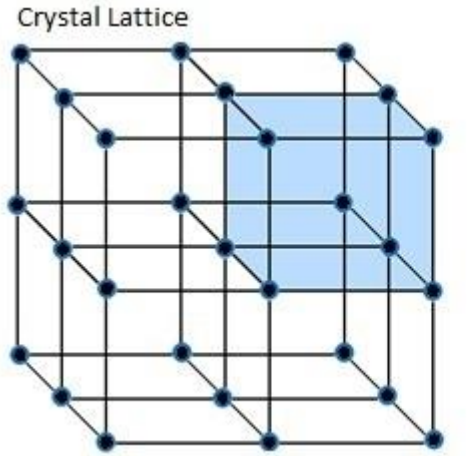
UNIT CELL

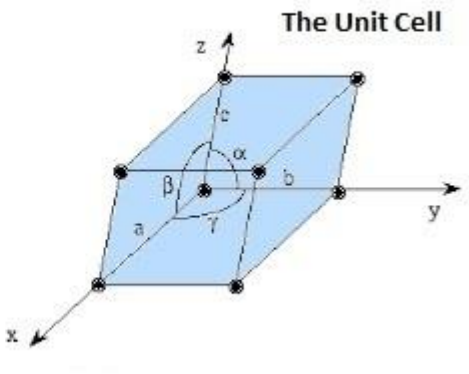
The structure of a crystal can be seen to be composed of a repeated element in 3D. This repeated element is known as the **unit cell**. It is the building block of the crystal structure.

There are two distinct types of unit cell: **primitive** and **non-primitive**. Primitive unit cells contain only one lattice point, which is made up from the lattice points at each of the corners. Non-primitive unit cells contain additional lattice points, either on a face of the unit cell or within the unit cell, and so have more than one lattice point per unit cell.

TYPES OF UNIT CELLS

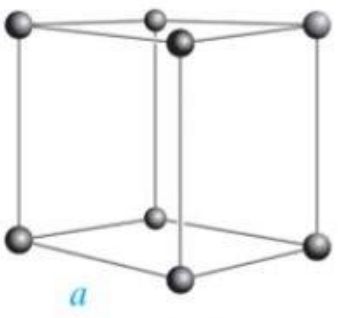




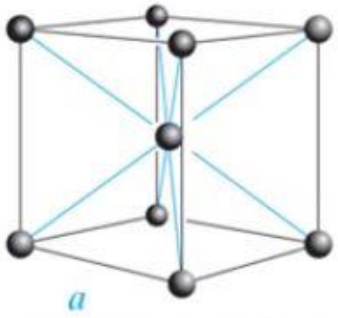


TYPES OF UNIT CELLS

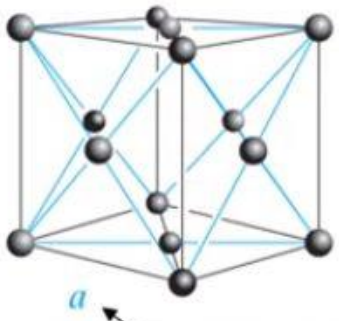
- Crystalline materials are typically made of repeating structures. The smallest repeating unit is called a **unit cell.**
- There are 3 basic types of unit cells in most crystalline materials



Simple cubic



Body-centered cubic

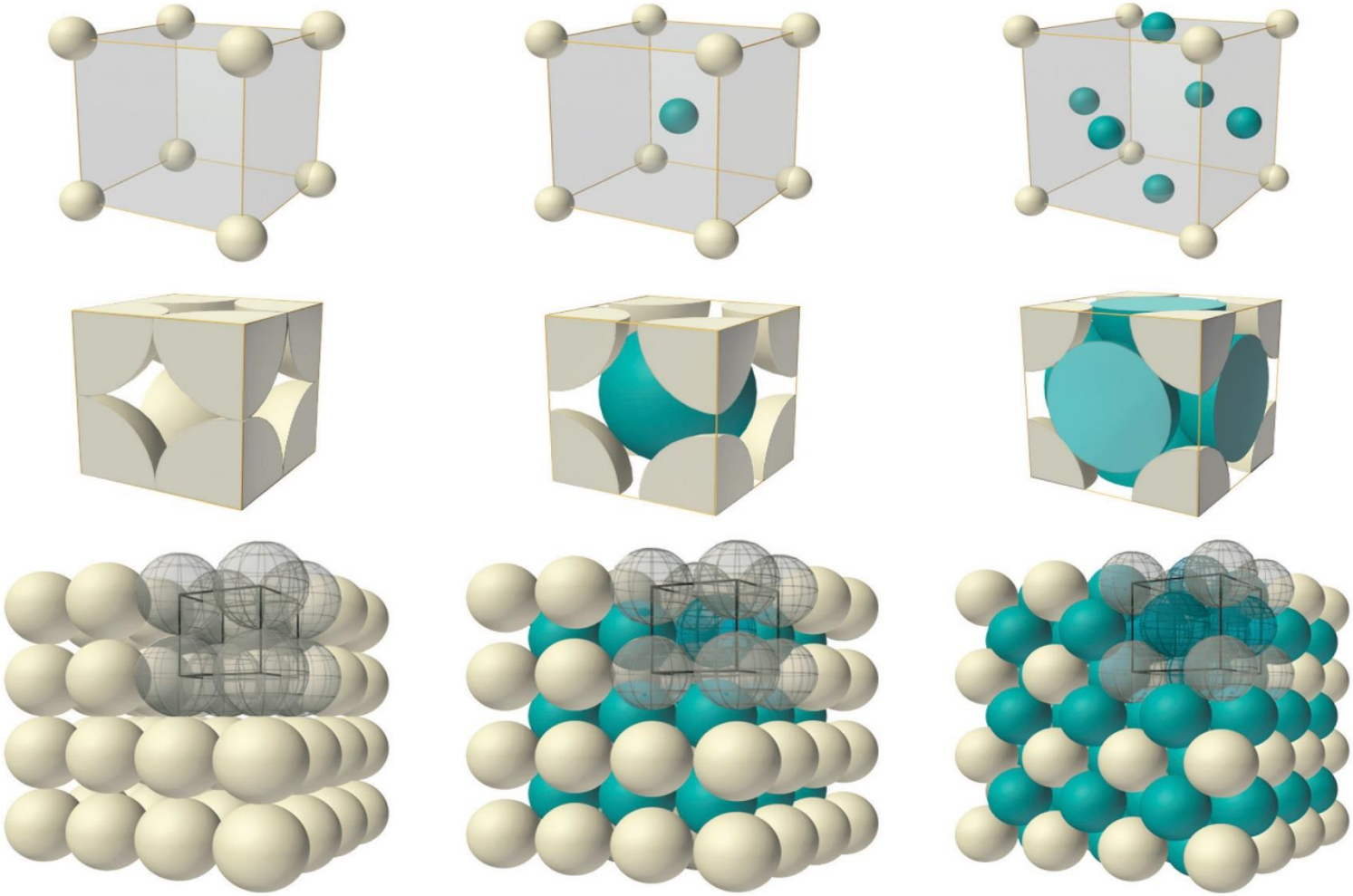


Face-centered cubic

- 3D VR models of each these lattices:
  - http://www.ibiblio.org/e-notes/Mview/Cubic.htm
  - http://www.ibiblio.org/e-notes/Cryst/Cryst.htm

a = Lattice Constant

TYPES OF UNIT CELLS CONT..,



(a) Simple cubic (b) Body-centered cubic (c) Face-centered cubic

WHAT IS SEMICONDUCTOR?

Semiconductors are a group of materials having electrical conductivities intermediate between metals and insulators

Conductivity of these materials can be varied by

- Temperature
- Optical excitation
- Impurity content

High ← Conductivity → Low

Conductor/Metal | Semiconductor | Insulator

Elemental

Group IV of periodic table

- Silicon (Si)
- Germanium (Ge)
- Carbon (C)

III	IV	V
B	C	
Al	Si	P
Ga	Ge	As
In		Sb

Compound

Combinations of Group III and Group V Elements

- **Binary:** Two elements
  e.g. GaAs, AlAs, AlP,GaN, GaP, InP etc.
- **Ternary:** Three elements
  e.g. AlGaAs, InGaAs, InGaP etc.
- **Quaternary:** Four elements
  e.g. InGaAsP

Combinations of Group IV and Group IV Elements

- SiC, SiGe etc.

Silicon is the most common material for ICs.

Table 1–1 Common semiconductor materials: (a) the portion of the periodic table where semiconductors occur; (b) elemental and compound semiconductors.

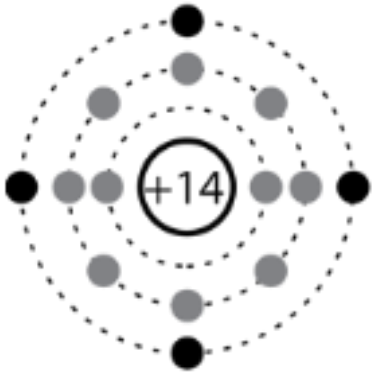
(a)	II	III	IV	V	VI
		B	C	N	
		Al	Si	P	S
	Zn	Ga	Ge	As	Se
	Cd	In		Sb	Te

(b)	Elemental	IV compounds	Binary III–V compounds	Binary II–VI compounds
	Si	SiC	AlP	ZnS
	Ge	SiGe	AlAs	ZnSe
			AlSb	ZnTe
			GaN	CdS
			GaP	CdSe
			GaAs	CdTe
			GaSb	
			InP	
			InAs	
			InSb	

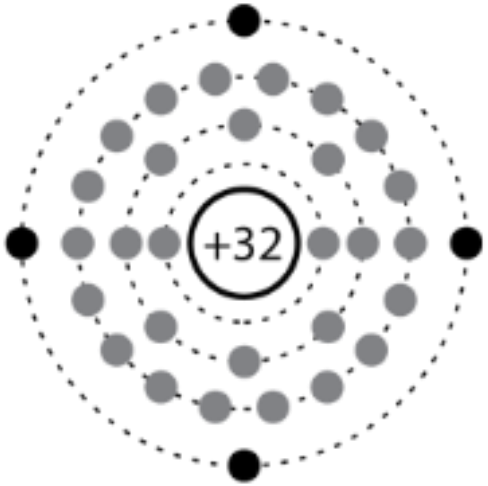
Elemental Compound - Diamond Lattice

LEDs: GaAs, GaN
LASERs: GaAlAs

Binary Compounds - Zinc Blende Lattice



Silicon



Germanium

COVALENT BONDING