

# Glossary

**AFM**

atomic force microscope; an instrument that can image atoms and operates by sensing the force between the surface atoms of a sample and an atomically sharp probe tip

**Alloy**

a solid solution composed of two or more elements

**Atom**

the smallest unit of a chemical element

**Austenite**

high temperature phase

**Band**

a collection of orbitals, each delocalized throughout the solid, that are so closely spaced in energy as to be nearly continuous

**Band gap**

the energy separation between the top of the valence band and the bottom of the conduction band

**Biasing**

applying a voltage, often done to alter electrical and optical output of a device

**Body-centered cubic**

a type of unit cell

**Bragg diffraction**

a condition for constructive interference, often described in terms of reflection from parallel planes of atoms, because the angle of incidence equals the angle of diffraction; the equation describing this condition is  $n\lambda = 2d\sin\theta$ , where  $\lambda$  is the wavelength of the electromagnetic radiation,  $d$  is the separation between crystallographic planes,  $\theta$  is the angle of the diffracted electromagnetic radiation, and  $n$  is an integer.

**Colloid**

a dispersion of particles from 1 nm to 1000 nm in a fluid medium

**Conduction band**

a band that when partially occupied by mobile electrons, permits their net movement in a particular direction

**Coordination number**

number of nearest neighbor atoms in a structure

**Crystal Structure**

the repeating arrangement of atoms comprising a solid

**Defects**

irregularities in the packing of atoms

**Density**

mass per unit volume

**Diffraction**

the scattering of light from a regular array, producing constructive and destructive interference

**Doping**

process by which atoms in a semiconductor are replaced with other atoms having more or less valence electrons, which leads to an excess of mobile electrons or holes, respectively

**Electrical Resistance**

opposition to the flow of electric current

**Electromagnetic radiation**

radiant energy that exhibits wavelike behavior and travels through space at the speed of light in a vacuum

**Electronegativity**

the attraction of an atom for electrons in a bond

**Empirical formula**

information that gives the simplest ratio between the atoms of the elements present in a compound

**Energy band**

a collection of orbitals, each delocalized throughout the solid, that are so closely spaced in energy as to be nearly continuous

**Fermi Energy**

energy at which the probability of finding an electron is 0.5; below the Fermi energy, orbitals are largely filled with electrons and above the Fermi energy, the orbitals are largely unfilled with electrons.

**Ferrimagnetism**

a phenomenon in which the internal magnetic moments of multiple spin

sets of unpaired electrons within the domain of a solid do not cancel and thus leave a net spin

**Ferrofluid**

a colloidal suspension of a magnetic solid in a liquid that responds to an external magnetic field

**Ferromagnetism**

a phenomenon in which the internal magnetic moments of unpaired electrons within a domain of the solid are aligned and act cooperatively

**Fraunhofer Diffraction**

a type of diffraction in which the condition for constructive interference is given by  $n\lambda = d\sin\theta$  where  $\lambda$  is the wavelength of light,  $n$  is an integer,  $d$  is the spacing between features, and  $\theta$  is the angle of the diffracted light.

**Hole**

an empty site in a crystalline solid

**Insulator**

a type of material that is a poor conductor of electricity

**Isoelectronic**

containing the same number of electrons

**Lattice**

the pattern of atoms in a crystal

**LeChatelier's Principle**

when a system at equilibrium experiences a stress, the property that equilibrium shifts to try to relieve that stress

**LED**

acronym for light emitting diode; a semiconductor p-n junction that is optimized to release light of approximately the band gap energy when electrons fall from the conduction band to the valence band under forward bias

**Magnetic domain**

regions where unpaired electrons strongly interact with one another and align, even in the absence of a magnetic field

**Magnetite**

the common name for  $\text{Fe}_3\text{O}_4$

**Martensite**

low temperature phase

**Metal**

a material with a partially filled energy band

**Molecular formula**

a formula that indicates the actual number of atoms of each element in one molecule of a substance

**Nanoparticle**

a very small particle on a scale of nanometers ( $10^{-9}\text{m}$ )

**Nitinol**

alloy containing nearly equal amounts of nickel and titanium; an acronym for NiTi that stands for **N**ickel **T**itanium **N**aval **O**rdnance **L**aboratory, where the material's unusual properties were originally identified

**Optical transform experiment**

a method of scaling atomic arrangements to a macroscopic level to illustrate diffraction effects using visible light

**Orbital**

a region of the atom where electrons are most likely to be found when they have a particular quantum state and energy

**Phase**

a physical state of matter

**Piezoelectric material**

material that distorts when a voltage is applied to it or exhibits a voltage in response to mechanical deformation

**Rastering**

scanning back and forth across the surface of a material

**Reciprocal Lattice Effect**

the phenomenon whereby diffraction patterns are inversely related to the sizes of the arrays that create them

**Semiconductor**

a substance conducting only a slight electrical current at room temperature, but showing increased conductivity at higher temperatures

**Smart material**

a substance that can respond to stimuli in its environment

**Solid solution**

a homogeneous solid in which one type of atom (or ion) has substituted for a similar atom (or ion) in a structure

**Spike**

a pattern of uplifted particles that results from placing a magnet near a ferrofluid

**STM**

acronym for scanning tunneling microscope; an instrument that can image atoms by the quantum mechanical tunneling of electrons between a substrate and an electrically conducting, atomically-sharp tip

**Stoichiometry**

a word describing the relative amounts of reactants and products in complete reactions

**Surfactant**

a substance that surrounds particles and isolates them from the attractive forces of their neighbors

**Transition temperature**

the temperature at which a phase transformation occurs

**Tunneling effect**

the movement of an electron through a classical barrier due to its quantum mechanical wave nature

**Unit cell**

a 3-D parallelepiped that, when shifted along each edge by the length of the edge, creates the entire structure of atoms in a crystal

**Valence band**

the highest energy filled band that lies at the bottom of the band gap

**van der Waals forces**

weak forces of attraction between molecules

**X-ray**

electromagnetic radiation with a wavelength of about the size of an atom



