

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 λ is the wavelength of the electromagnetic radiation, d is the separation between crystallographic planes, θ 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 λ is the wavelength of light, n is an integer, d is the spacing between features, and θ 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 Fe_3O_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}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

