Alloys

Alloys are metallic materials prepared by mixing two or more molten metals. They are used for many purposes, such as construction, and are central to the transportation and electrics industries. Some common alloys are present in the following table.

Compositions of typical alloys

Alloy	Mass percentage composition
brass	up to 40% zinc in copper
bronze	a metal other than zinc or nickel in copper (casting bronze: 10%Sn and 5% Pb)
cupronickel	nickel in copper (coinage cupronickel: 25% Ni)
pewter	6% antimony and 1,5% copper in tin
solder	tin and lead
stainless steel	more than 12% chromium in iron

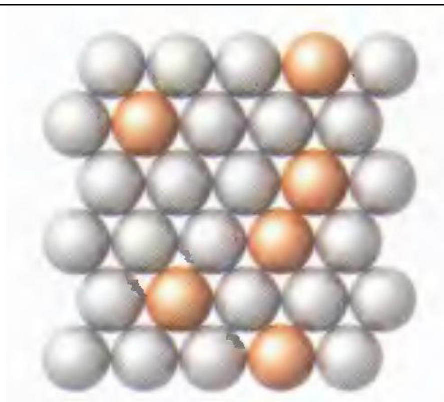
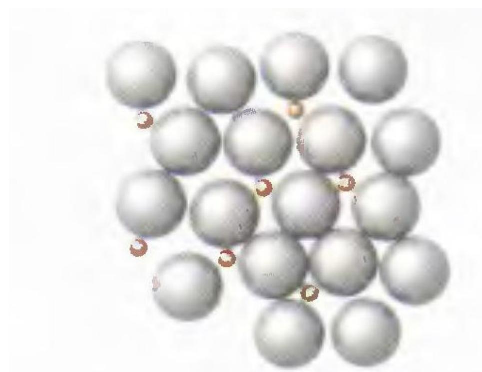
In **homogeneous alloys**, atoms of the different elements are distributed uniformly. Examples include brass, bronze, and the coinage alloys. **Heterogeneous alloys**, such as tin-lead solder and the mercury amalgam sometimes used to fill teeth, consist of a mixture of crystalline phases with different compositions.

The structures of alloys are more complicated than those of pure metals because they are built from atoms of two or more elements with different atomic radii.

Because the metallic radii of the d-block elements are all similar, they can form an extensive range of alloys with one another with little distortion of the original crystal structure. An example is the copper-zinc alloy used for some “copper” coins. Because zinc atoms are nearly the same size as copper atoms and have similar electronic properties (they belong to neighboring groups), they can take the place of some of the copper atoms in the crystal. An alloy in which atoms of one metal are substituted for atoms of another metal is called ***a substitutional alloys***.

Elements that can form substitutional alloys have atoms with atomic radii that differ by no more than about 15%. Because there are slight differences in size and electronic structure, the less abundant atoms in substitutional alloy distort the shape of the lattice of the more abundant atoms of the host metal and hinder the flow of electrons. Because the lattice is distorted, it is harder for one plane of atoms to slip past another. Therefore, although a substitutional alloy has lower electrical and thermal conductivity than pure element, it is harder and stronger.

Stell is an alloy of about 2% or less carbon in iron. Carbon atoms are much smaller than iron atoms, and so they cannot substitute for iron in the crystal lattice. Indeed, they are so small that they can fit into the interstices (the holes) in the iron lattice. The resulting material is called ***an interstitial alloy***. For two elements to form an interstitial alloy, the atomic radius of the solute element must be less than about 60% of the atomic radius of the host metal. The interstitial atoms interfere with the electrical conductivity and with the movement of the atoms forming the lattice. This restricted motion makes the alloy harder and stronger than the pure host metal would be.

	
A substitutional alloy	An interstitial alloy

Some alloy are softer than the component metal. The presence of big bismuth atoms helps to soften a metal and lower its melting point, much as melons would destabilize a stack of oranges because they just do not fit together well. A low-melting point alloy of lead, tin, and bismuth is employed to control water sprinklers used in certain fire-extinguishing systems. The heat of the fire melts the alloys, which activates the sprinklers before the fire can spread.

Alloys of metals tend to be stronger and have lower electrical conductivity than pure metals. In substitutional alloys, atoms of the solute metal take the place of some atoms of a metal of similar atomic radius. In interstitial alloys, atoms of the solute element fit into the interstices in a lattice formed by atoms of a metal with a larger atomic radius.

Thermal analysis is a valuable tool in elucidating the thermal events involved in solid to liquid transformations. In the case of alloy solidification, the data generated by thermal analysis are very useful for a qualitative or quantitative description of the active solidification mechanisms.