The Structure of Metals

1. Close-packed structures

Many metallic elements have close-packed structures, because the bonds between the atoms have little directional covalent character.

a. Hexagonal close packing (hcp). e.g.: Be, Cd, Co, Mg, Ti, Zn.
CN: 12, Stacking pattern: ABAB……., Occupied space: 74%

b. Cubic close packing (ccp) or face centered cubic (fcc). e.g.: Ag, Al, Au, Ca, Cu, Ni, Pb, Pt.
CN: 12, Stacking pattern: ABCABC……, Occupied space: 74%

The kinds of the common close-packed polytypes that a metal adopts depends on the details of the electronic structure of its atoms, the extent of interaction between second-nearest-neighbors, and the residual effects of some directional character in their bonds.

2. Non-close-packed structures

There are also some other packings with a lower space filling.

a. Body centered cubic (bcc). e.g.: Ba, Cr, Fe, Alkali metals.
CN: 8+6, Stacking pattern: ABAB……, Occupied space: 68%
This arrangement is sometimes referred as the "tungsten type".

b. Primitive cubic (cubic-P). e.g.: α-Po
CN: 6, Stacking pattern: AAA……, Occupied space: 52%

A phase transition of a close-packed metal (e.g. at higher temperature) can also lead to a less closely packed structure.

3. Holes in close-packed structure

a. Octahedral holes: Octahedral hole lies between two planar triangles of spheres in adjacent layers. For N atoms forming a close packed structure there exit N octahedral holes.

b. Tetrahedral holes: is formed by a planar triangle of touching spheres capped by a single sphere lying in the next layer. For N atoms forming a close packed structure there exit N octahedral holes.

4. Polymorphism of metals:

The ability to adopt different crystal forms under different conditions of pressure and temperature. e.g. white tin (β-Sn) undergoes a transition to gray tin (α -Sn) below 14.2 °C.

Reference:

Inorganic Chemistry, third edition, Shriver and Atkins, Oxford University Press, 2002