Segregation:

The nonuniform composition produced by nonequilibrium solidification is known as segregation. Fig (7) shows the development of interdendritic segregation or microsegregation, some times known as coring, which occurs over short distances between small dendrite arms. Dendritic growth is typical during the solidification of solid solution alloy, even when no thermal undercooling occurs.

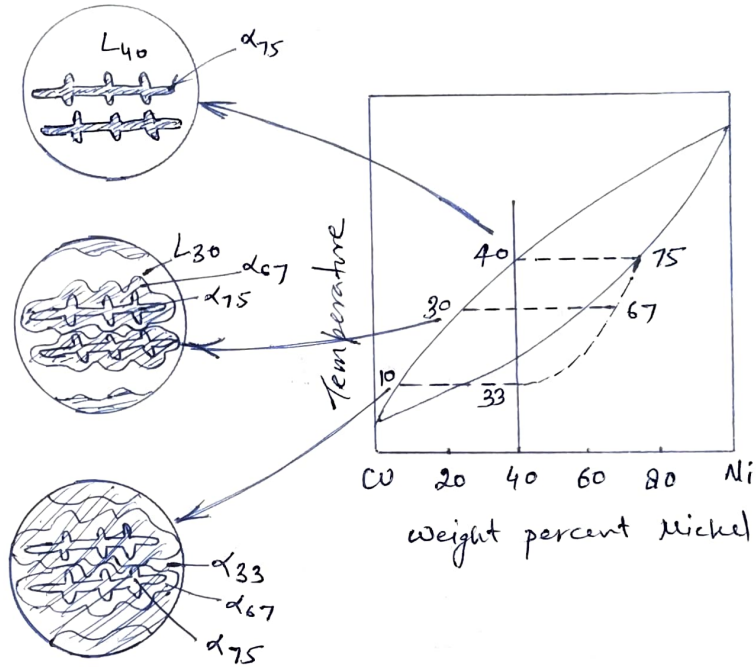

Fig 7: Development of interdendritic segregation during solidification.

Because of nonequilibrium ~~seg~~ solidification, the centers of the dendrites, which represent the first solid to freeze, are rich in the higher melting point element in the alloy.

The regions between the dendrites are rich in the lower ~~f~~ melting point element, since these regions represent the last liquid to freeze.

Although we still have just one solid phase α, with an FCC structure, the composition and properties of α differ from one region to the next.

We would expect the casting to have poorer properties as a result.

Hot Shortness: Microsegregation can cause hot shortness, or melting of the lower melting point interdendritic materials at temperatures below the equilibrium solidus.

when we heat the Cu – 40% Ni alloy to 1225°C, below the equilibrium solidus but above the non equilibrium solidus, the low nickel regions between the dendrites melt.

Homogenization:

We can reduce the interdendritic segregation and problems with hot shortness by using a homogenization heat treatment.

If we heat the casting to a temperature below the non equilibrium solidus and hold at that temperature for a long time, diffusion occurs (fig 8).

The nickel atoms in the centers of the dendrites diffuse to the interdendritic regions, copper atoms diffuse in the opposite direction.

Since the diffusion distances are relatively short, only a few hours are required to eliminate most of the composition differences.

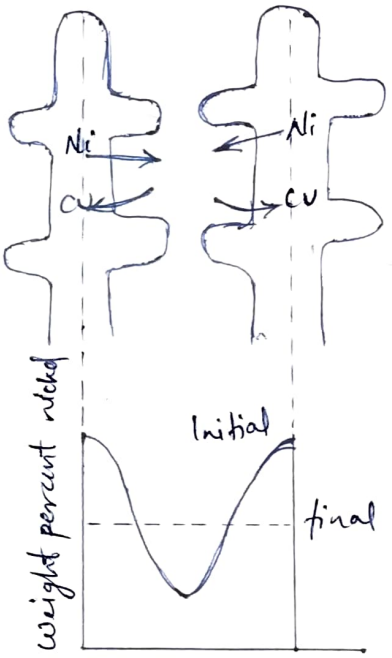

Fig 8 : Microsegregation between dendrites can be reduced by a homogenization heat treatment counterdiffusion of nickel & copper atoms may eventually eliminate the composition gradients and produce a homogeneous composition.