

# SOLID STATE FABRICATION OF METAL MATRIX COMPOSITES

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**Solid state fabrication of Metal Matrix Composites** is the process, in which Metal Matrix Composites are formed as a result of bonding matrix metal and dispersed phase due to mutual diffusion occurring between them in solid states at elevated temperature and under pressure.

Low temperature of solid state fabrication process (as compared to Liquid state fabrication of Metal Matrix Composites) depresses undesirable reactions on the boundary between the matrix and dispersed (reinforcing) phases.

Metal Matrix Composites may be deformed also after sintering operation by rolling, Forging, pressing, Drawing or Extrusion. The deformation operation may be either cold (below the recrystallization temperature) or hot (above the recrystallization temperature). Deformation of sintered composite materials with dispersed phase in form of short fibers results in a preferred orientation of the fibers and anisotropy of the material properties (enhanced strength along the fibers orientation).

There are two principal groups of solid state fabrication of Metal Matrix Composites:

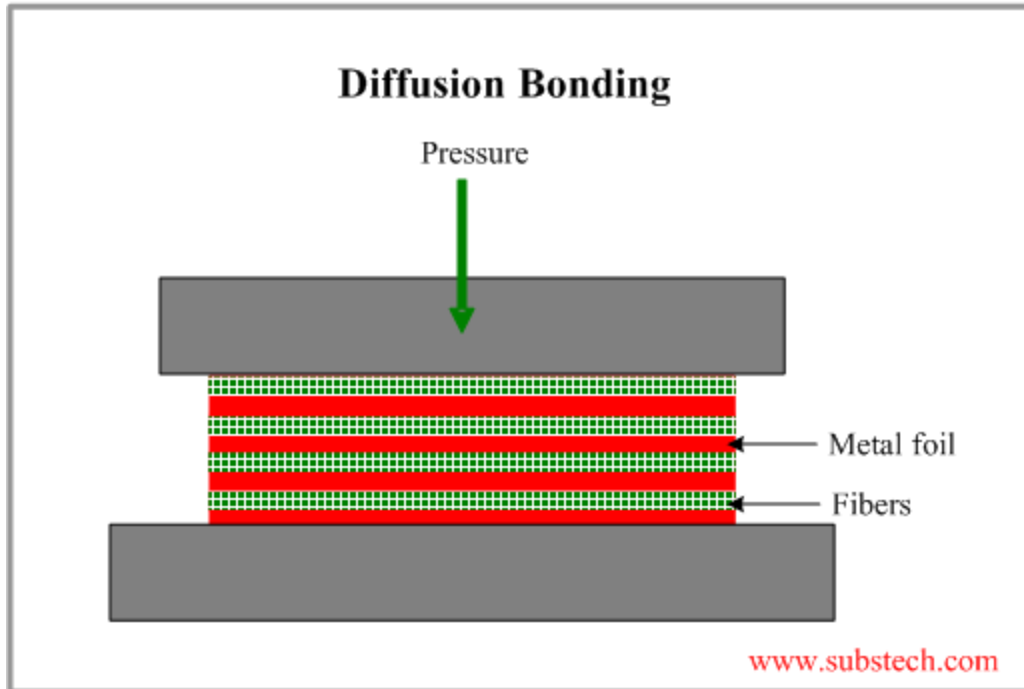
- **Diffusion bonding**
- **Sintering**

## Diffusion Bonding

**Diffusion Bonding** is a solid state fabrication method, in which a matrix in form of foils and a dispersed phase in form of long fibers are stacked in a particular order and then pressed at elevated temperature.

The finished laminate composite material has a multilayer structure.

Diffusion Bonding is used for fabrication of simple shape parts (plates, tubes).



Variants of diffusion bonding are roll bonding and wire/fiber winding:

**Roll Bonding** is a process of combined Rolling (hot or cold) strips of two different metals (e.g. steel and aluminum alloy) resulted in formation of a laminated composite material with a metallurgical bonding between the two layers.

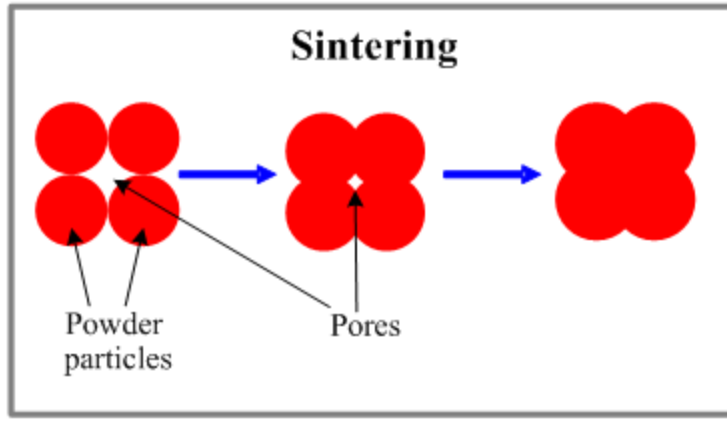
**Wire/fiber Winding** is a process of combined winding continuous ceramic fibers and metallic wires followed by pressing at elevated temperature.

## Sintering

**Sintering fabrication of Metal Matrix Composites** is a process, in which a powder of a matrix metal is mixed with a powder of dispersed phase in form of particles or short fibers for subsequent compacting and sintering in solid state (sometimes with some presence of liquid).

**Sintering** is the method involving consolidation of powder grains by heating the "green" compact part to a high temperature below the melting point, when the material of the separate particles diffuse to the neighboring powder particles.

In contrast to the liquid state fabrication of Metal Matrix Composites, sintering method allows obtaining materials containing up to 50% of dispersed phase.

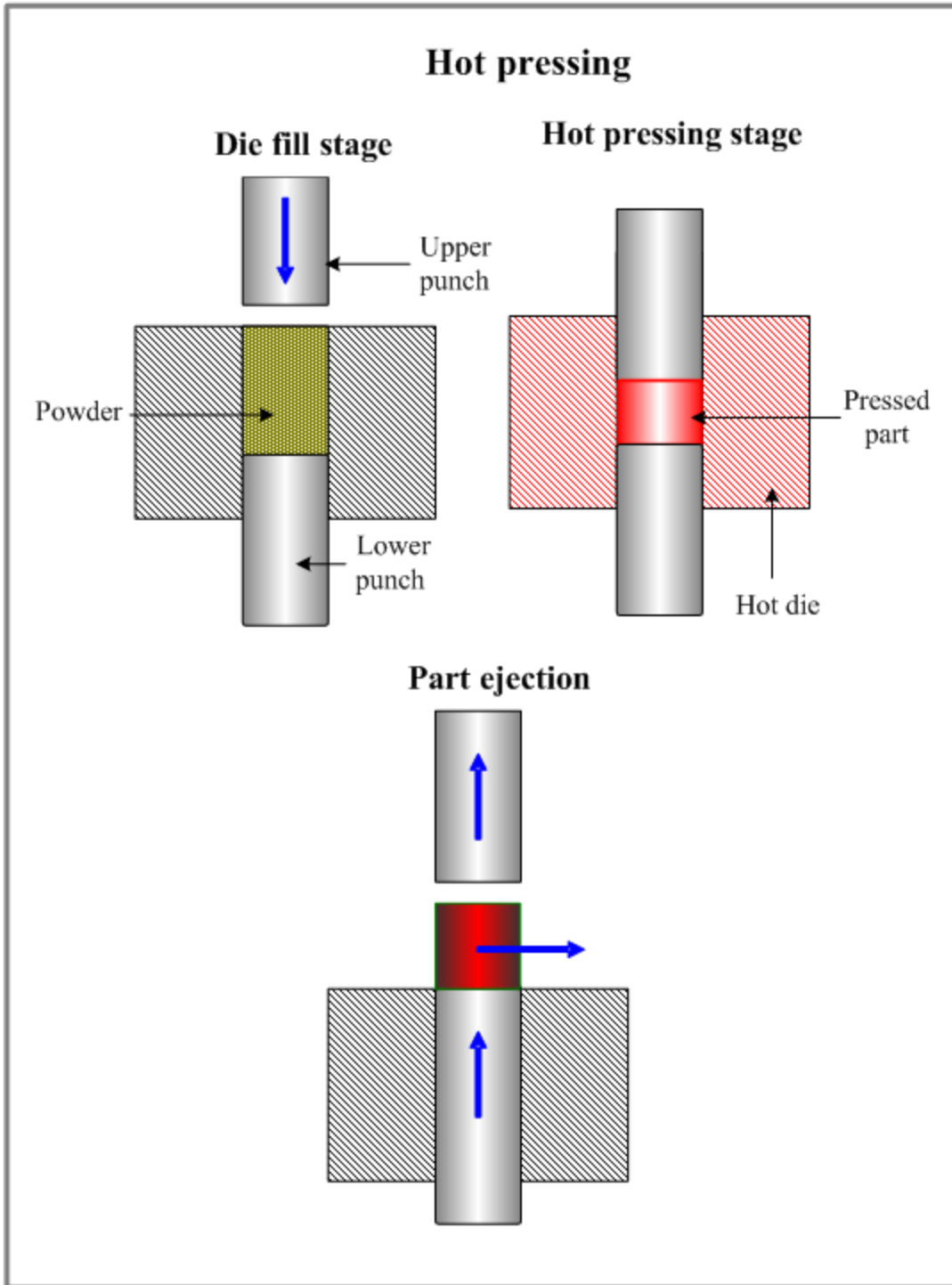


When sintering is combined with a deformation operation, the fabrication methods are called:

- **Hot Pressing Fabrication of Metal Matrix Composites**
- **Hot Isostatic Pressing Fabrication of Metal Matrix Composites**
- **Hot Powder Extrusion Fabrication of Metal Matrix Composites**
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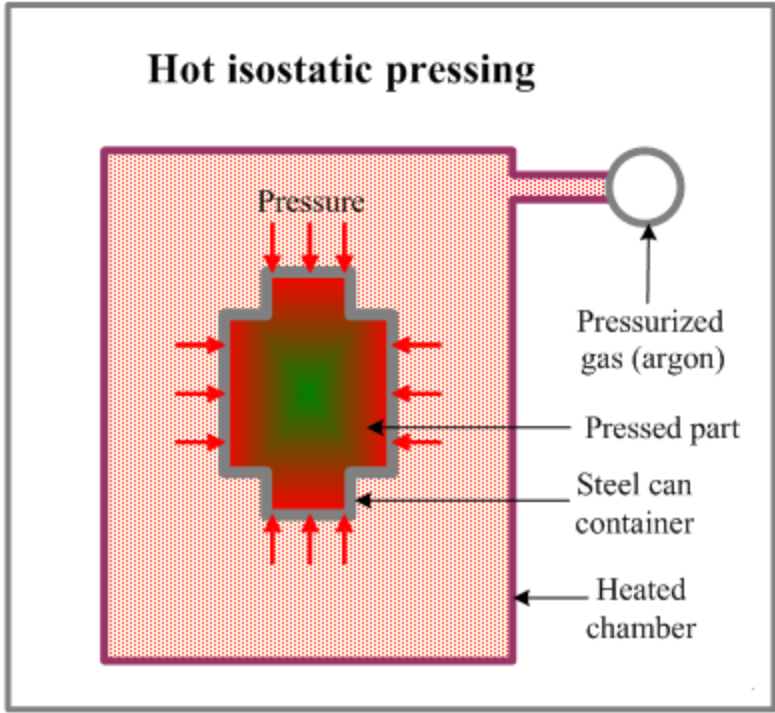
Hot Pressing Fabrication of Metal Matrix Composites

**Hot Pressing Fabrication of Metal Matrix Composites** – sintering under a unidirectional pressure applied by a hot press;



### Hot Isostatic Pressing Fabrication of Metal Matrix Composites

**Hot Isostatic Pressing Fabrication of Metal Matrix Composites** – sintering under a pressure applied from multiple directions through a liquid or gaseous medium surrounding the compacted part and at elevated temperature;



Hot Powder Extrusion Fabrication of Metal Matrix Composites

**Hot Powder Extrusion Fabrication of Metal Matrix Composites** – sintering under a pressure applied by an extruder at elevated temperature.

