Manufacturing prcesses II.

Materials Engineering
(BMEGEMTAMM1)
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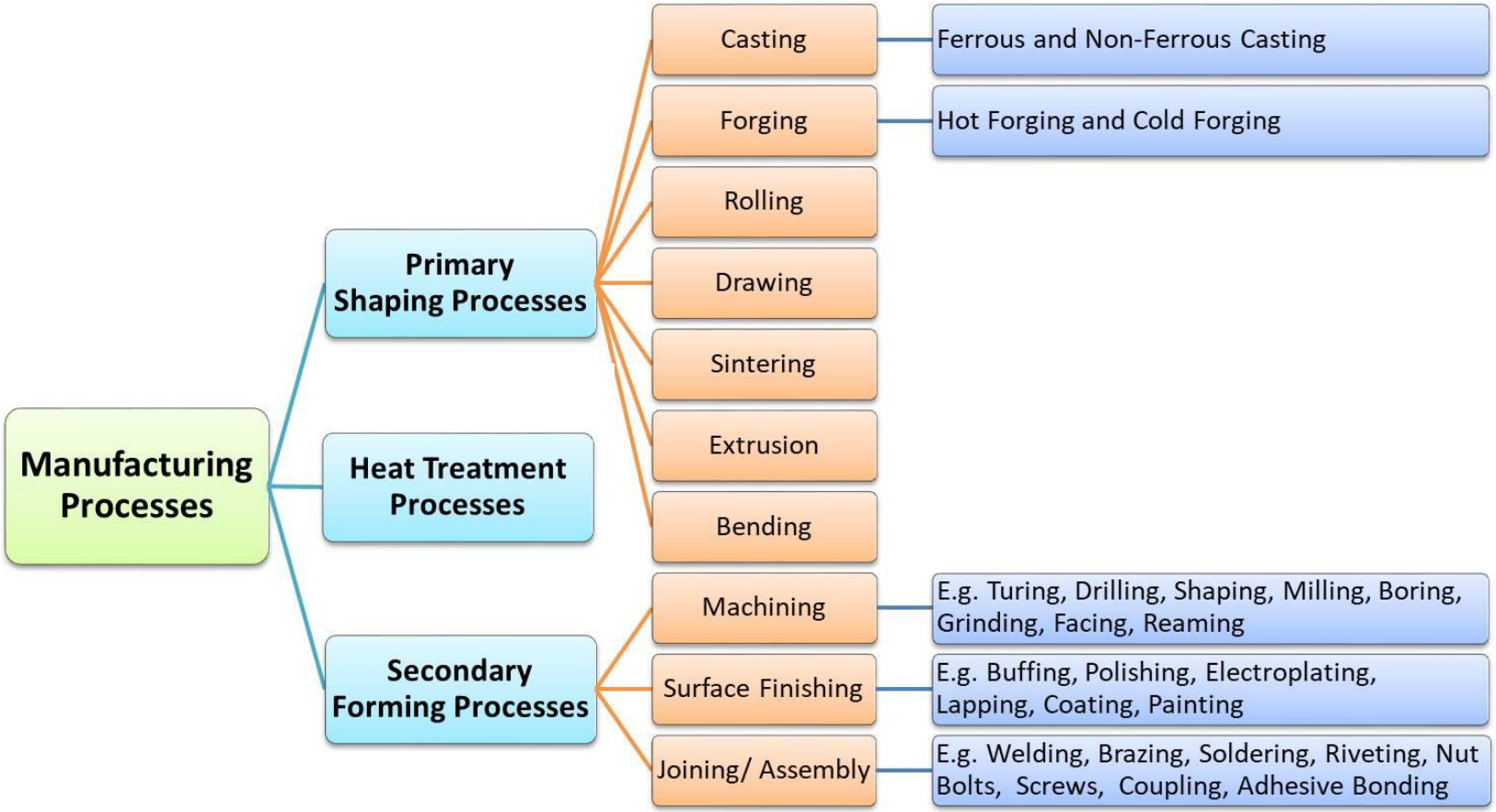
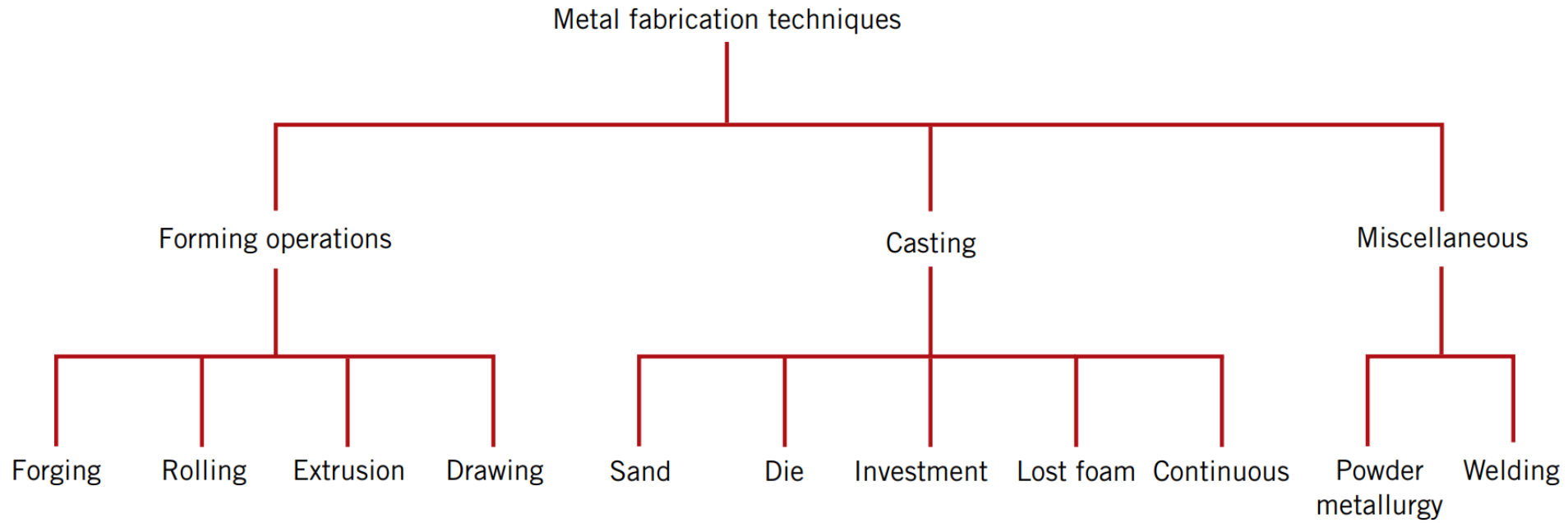
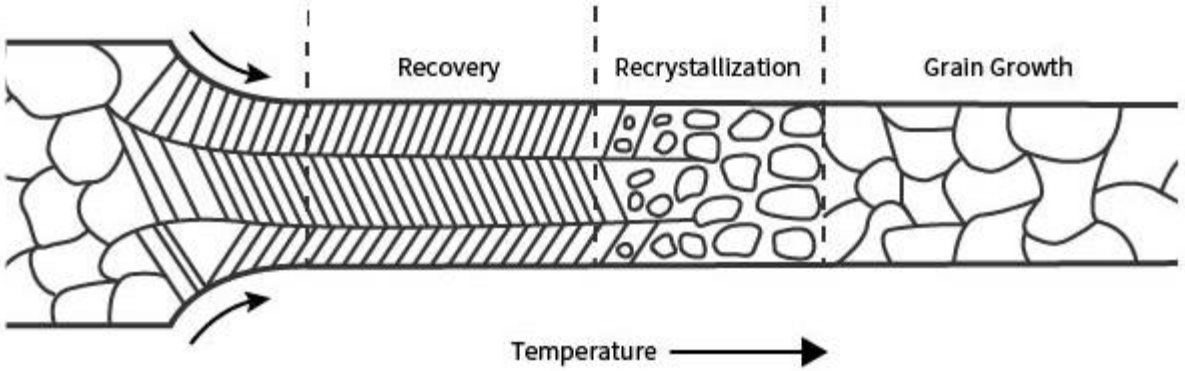
MANUFACTURING PROCESSES TYPES




Metal fabrication techniques
Forming operations
Casting
Miscellaneous
Forging
Rolling
Extrusion
Drawing
Sand
Die
Investment
Lost foam
Continuous
Powder metallurgy
Welding

Recrystallization

The formation of a new set of strain-free grains within a previously cold-worked material; normally, an annealing heat treatment is necessary.



The recrystallization temperature is between 1/3 and 1/2 of the melting point: $0.5*T_{op} = T_{re}$

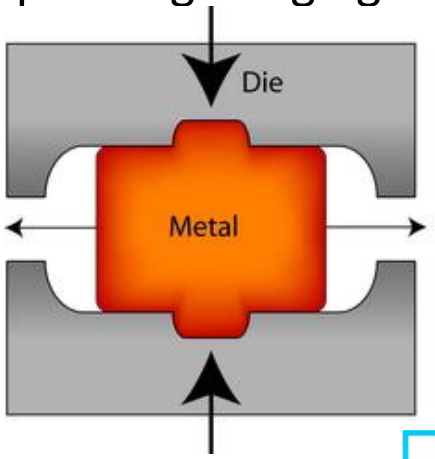
The forming processes under the recrystallization temperature **($T < T_{recryst}$)** are called **cold forming (cold work)**, above the recrystallization temperature **($T > T_{recryst}$)** are called **hot forming (hot work)** and the forming processes near the recrystallization temperature are **semihot forming ($T \approx T_{recryst}$).**

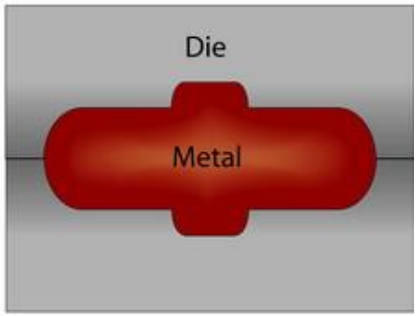
Recrystallization

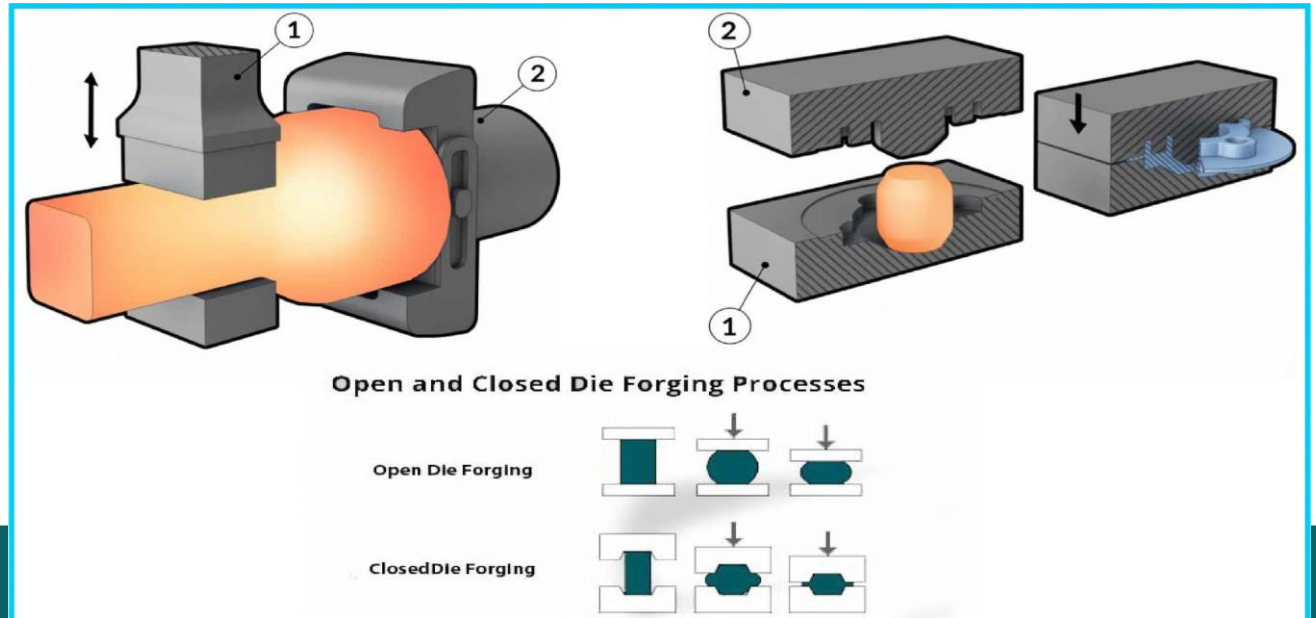
Name	$T_{recryst}$ (°C)	$T_{melting}$ (°C)
Pb	-4	327
Sn	-4	232
Zn	10	420
Al 99,99%	280	660
Cu 99,99%	120	1085
Brass (Cu60Zn40)	475	900
Ni	370	1455
Iron	450	1538
W	1200	3410

Forging

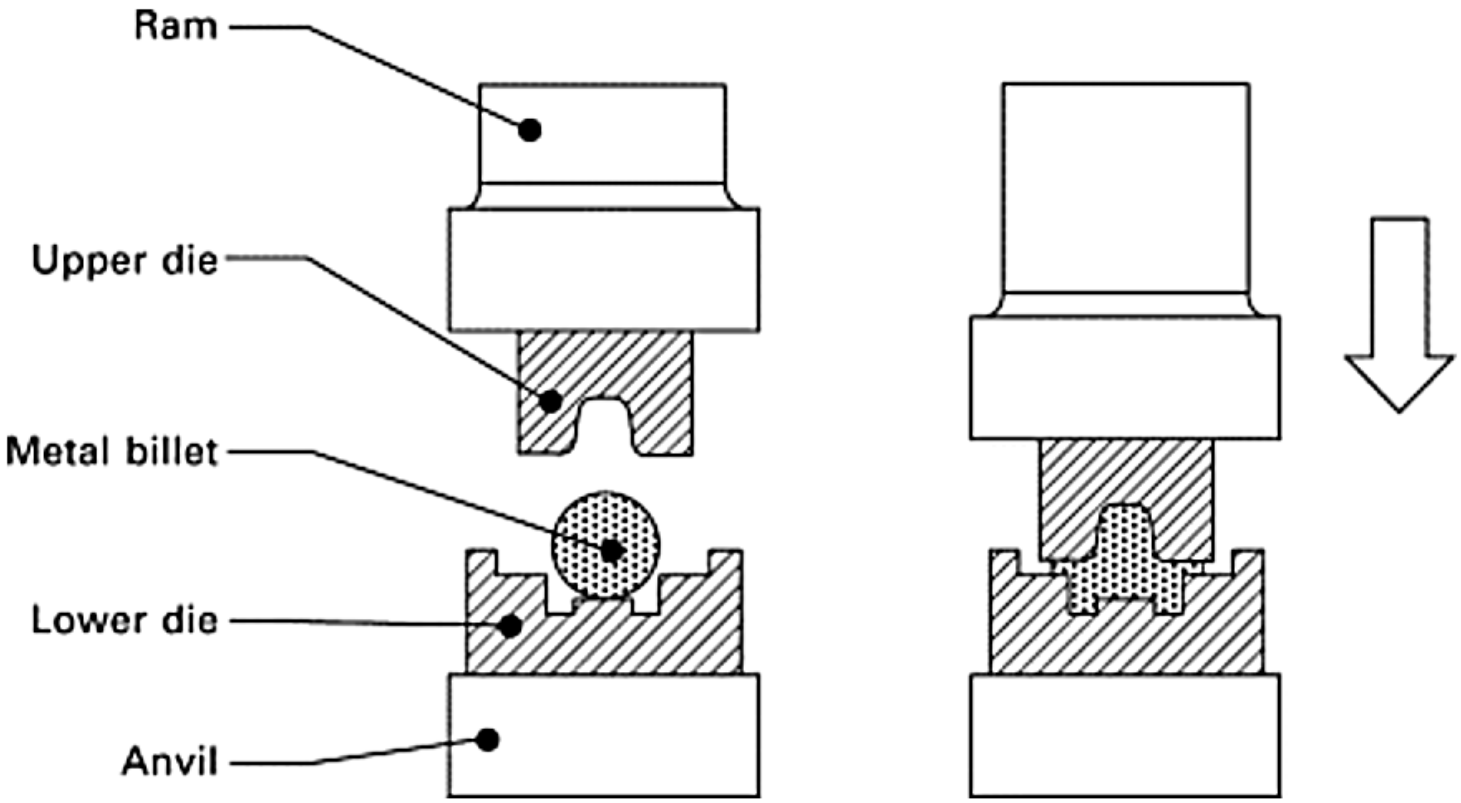
Forging is **mechanically** working or **deforming** a single piece of a usually **hot metal**; this may be accomplished by the application of successive blows or by continuous squeezing. Forgings are classified as either closed or open die.



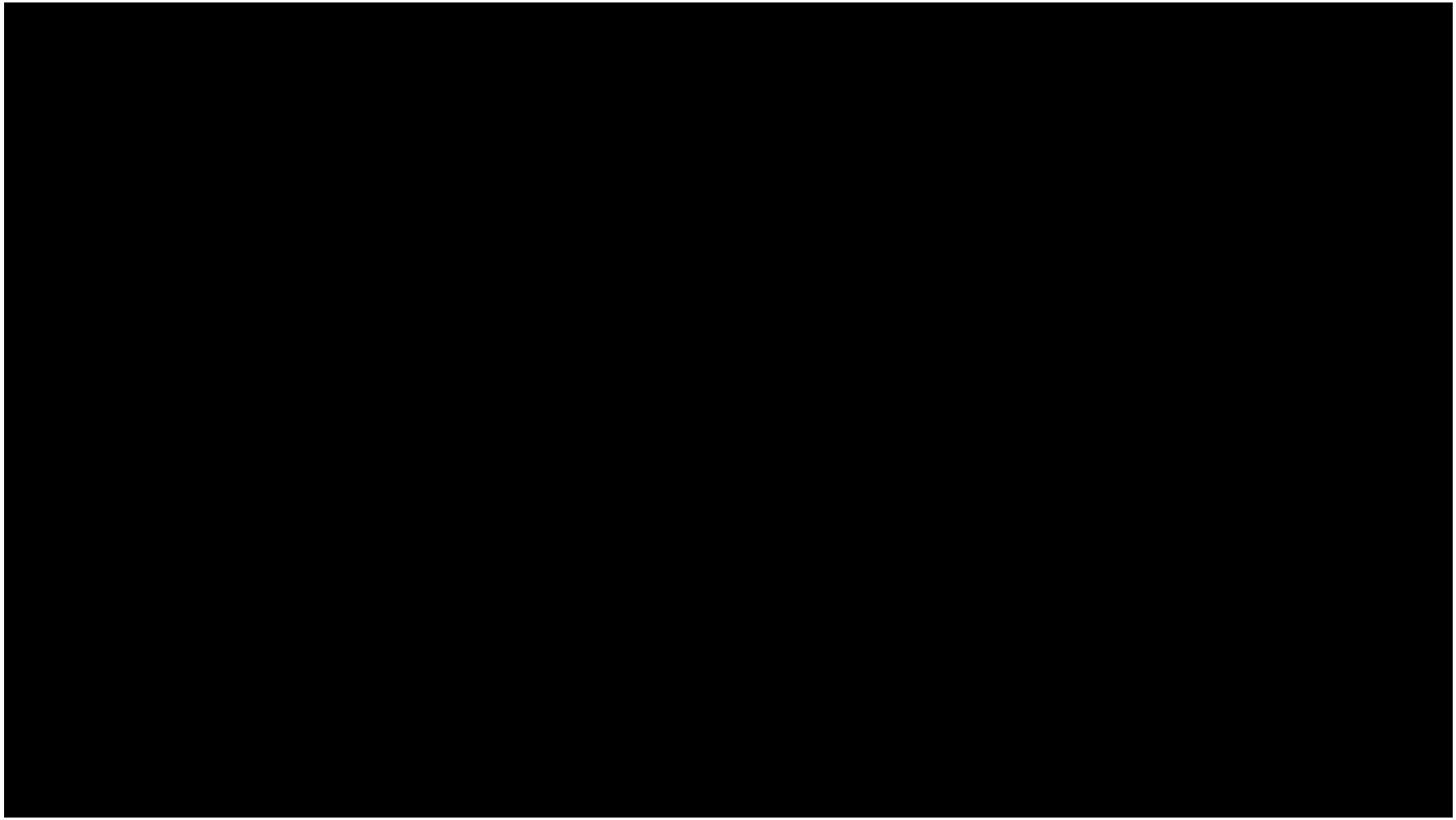




Forging



Open die forging



https://www.youtube.com/watch?v=SUCVWTcoY1M

Closed die forging

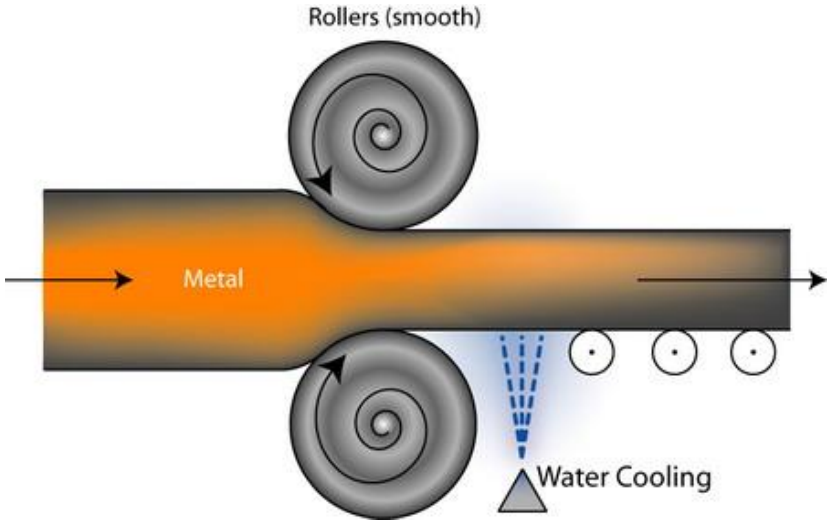
https://www.youtube.com/watch?v=nBspuKqG9Sw

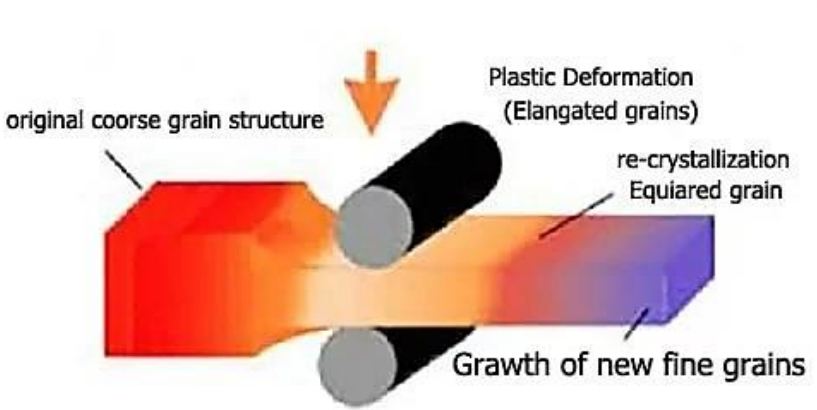
Forged products

Industry	Applications
Automotive	Crankshafts, connecting rods, axle beams
Aerospace	Landing gear, turbine disks, structural components
Oil and Gas	Valves, flanges, drilling equipment
Power Generation	Turbine blades, generator shafts, power generation components
Heavy Machinery	Construction equipment, mining machinery, industrial gearboxes

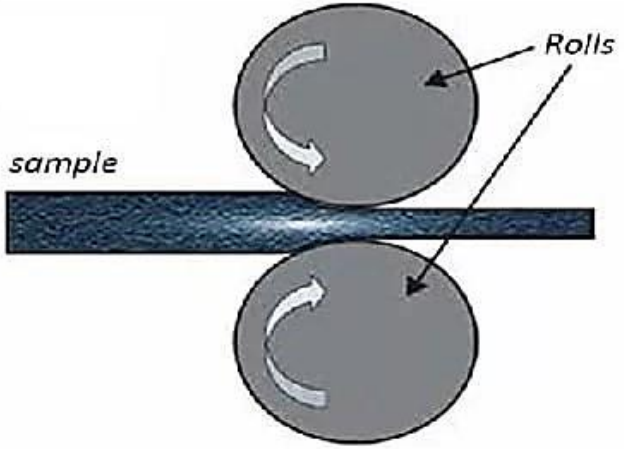
Rolling

Rolling, the most widely used deformation process, consists of **passing a piece of metal between two rolls**; a reduction in thickness results from compressive stresses exerted by the rolls.





Hot Rolling Process

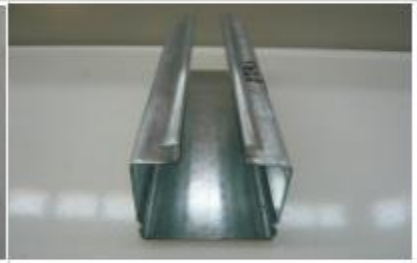
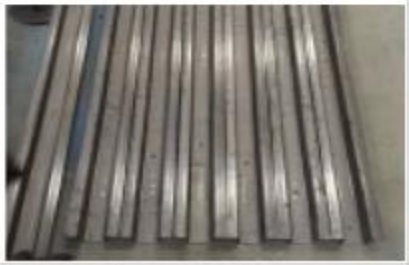


Cold Rolling Process

Rolling

https://www.youtube.com/watch?v=O5nsUPppITw

Rolled products

Section Profiles Via Cold Roll Forming Machine			
			
Roller Shutter	Window Frame Profiles	Z Profile	Cable Tray
			
V Profile	Frame Profile	Bumper Beam	C Profile
			
Photovoltaic Support	E Profile	Bumper Beam	L Profile

Extrusion

For **extrusion**, a **bar of metal is forced through a die** orifice by a compressive force that is applied to a ram; the extruded piece that emerges has the desired shape and a reduced cross-sectional area.

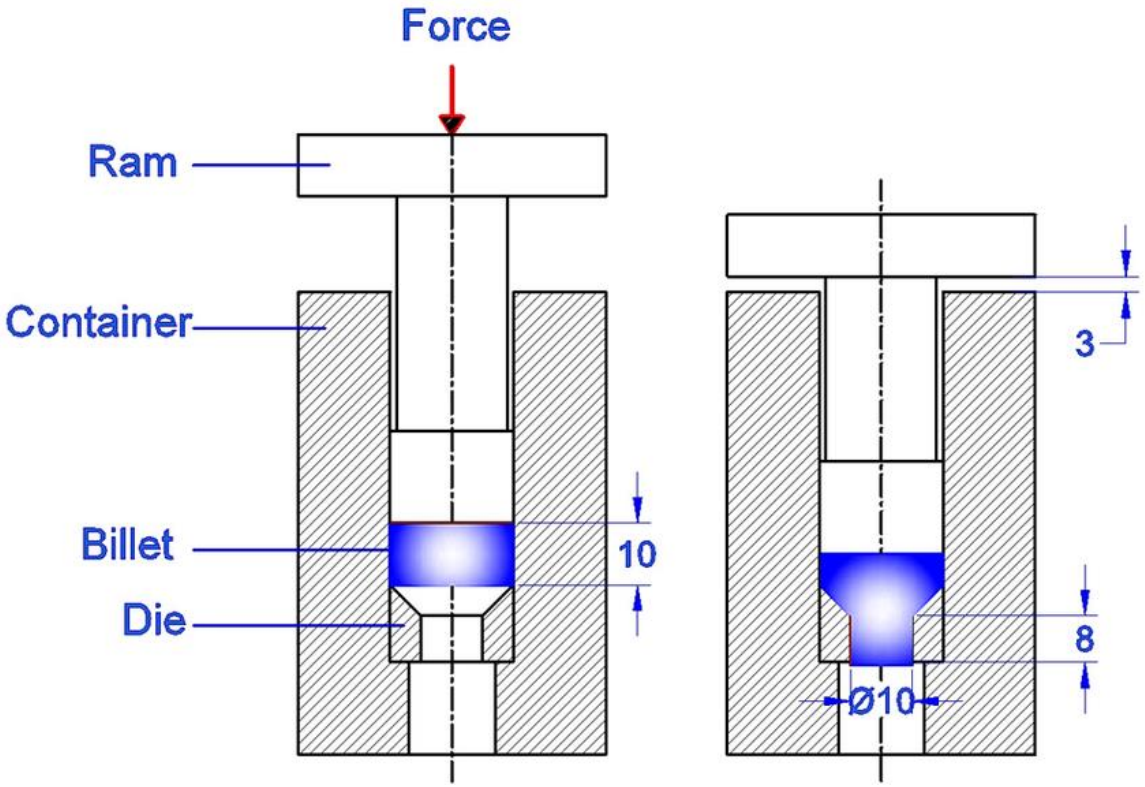
Forward extrusion

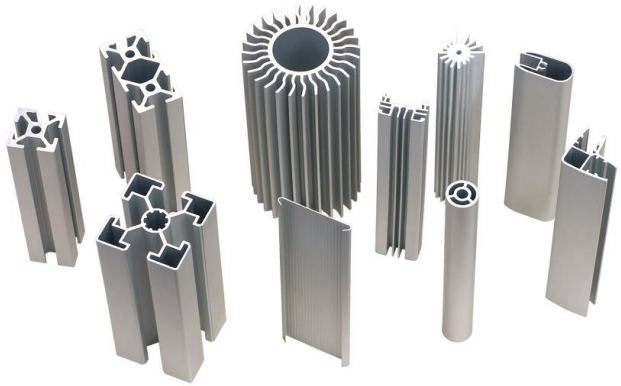
Direct extrusion, also known as forward extrusion, is the most common extrusion process. It works by placing the billet in a heavy walled container. The billet is pushed through the die by a ram or screw.

Backward extrusion

In indirect (impact) extrusion, also known as backwards extrusion, the billet and container move together while the die is stationary.

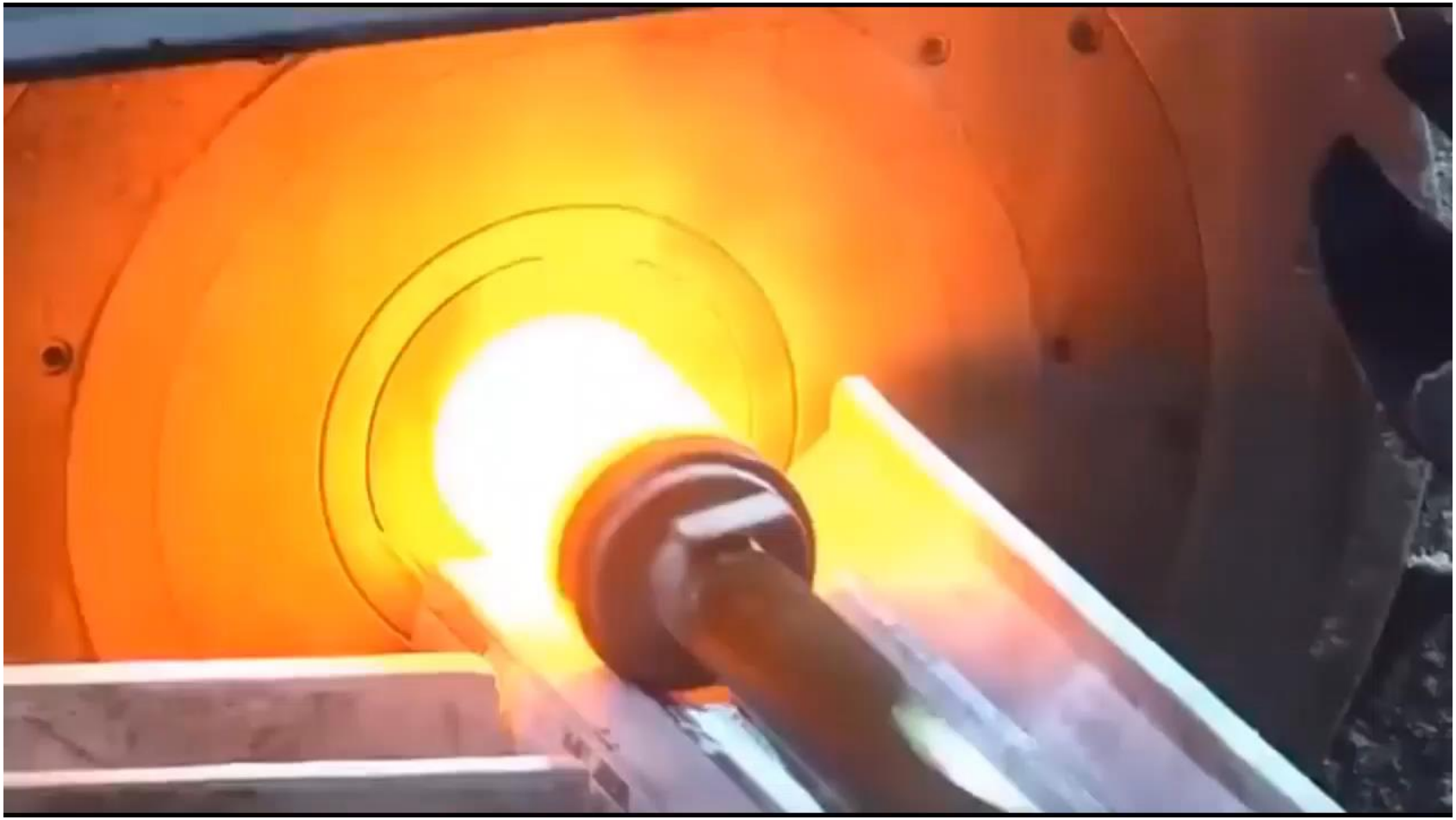
Forward extrusion





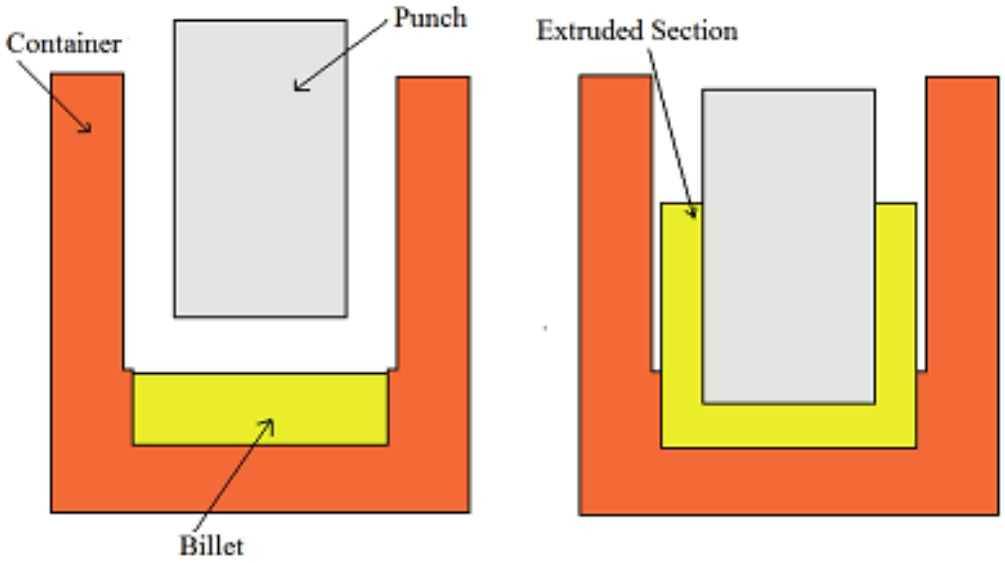
Pins, axles, and shafts
Cylindrical solid parts for gearboxes, drives, or bearing technology
Fasteners and precision connectors with high dimensional accuracy
Sleeves, bushings, and stepped shafts in the **electrical or medical technology**
Rotational parts with variable diameters

Forward extrusion



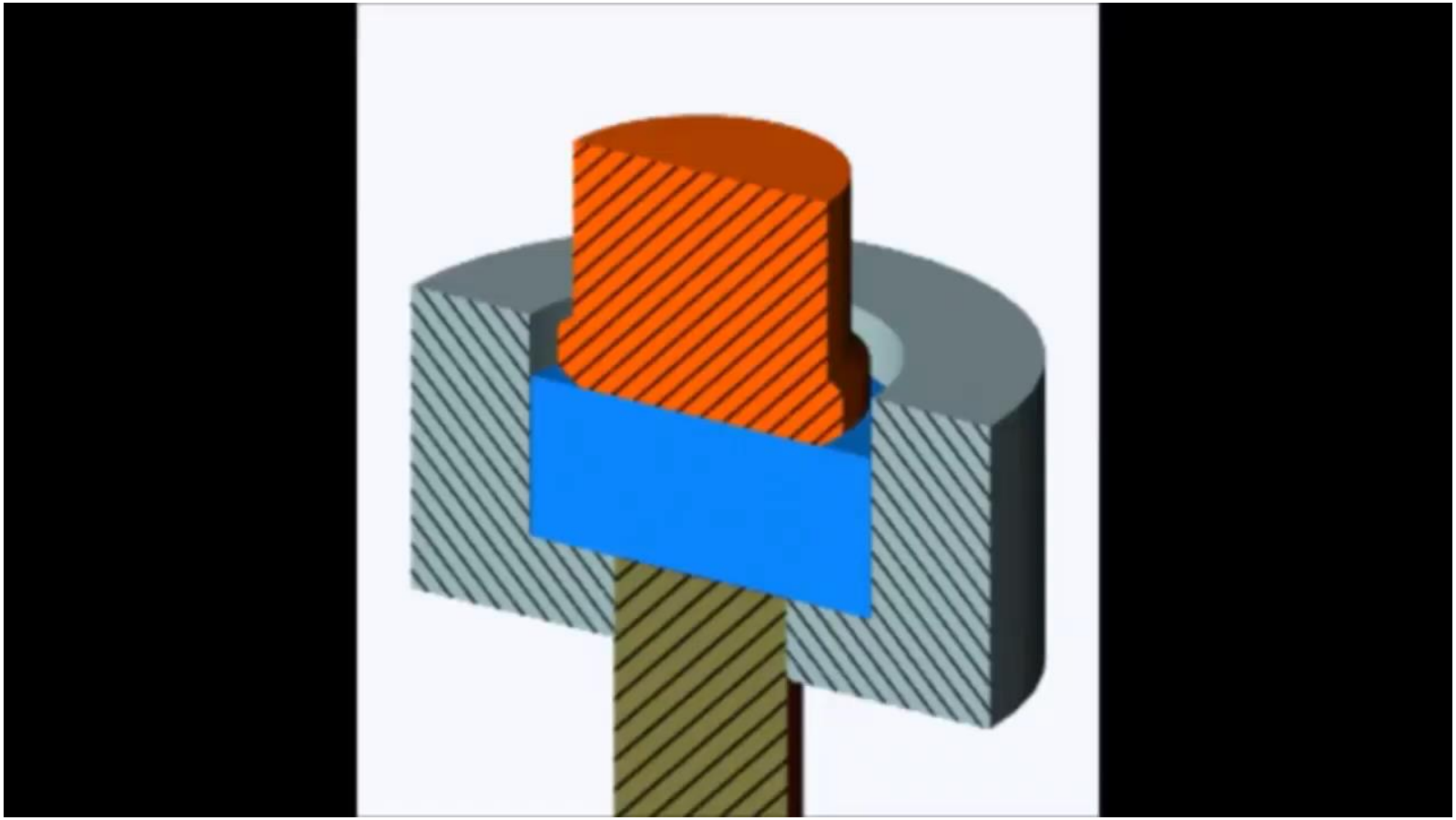
https://www.youtube.com/watch?v=ETz2WiX6tMI

Backward extrusion



Sleeves and bushings
Cup or cap shapes with internal geometry
Hollow cylinders for electrical connectors
Tubular segments or sealing components
Hollow parts for medical devices or sensor housings

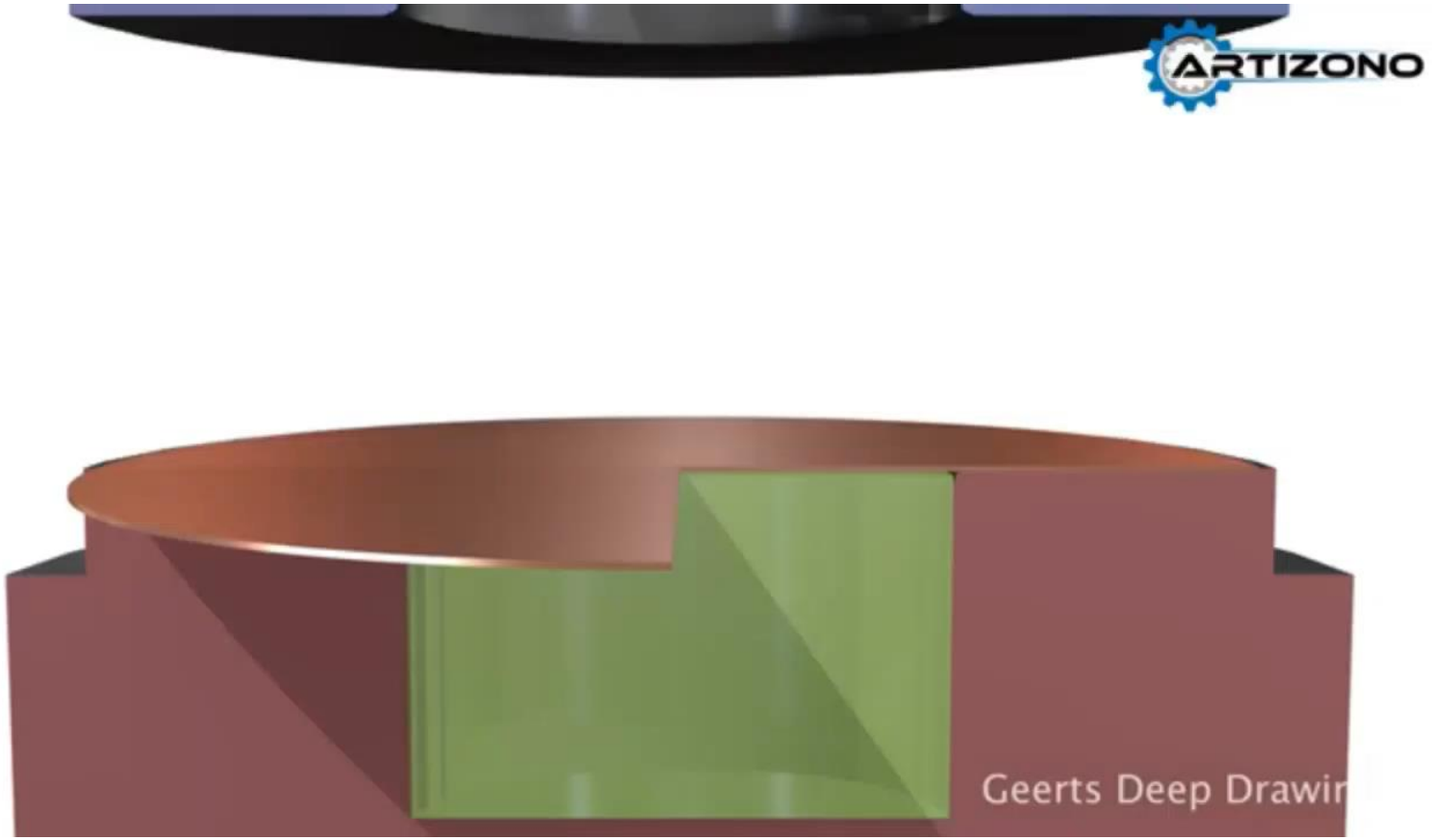
Backward extrusion



https://www.youtube.com/watch?v=x-G0ToKpVIM

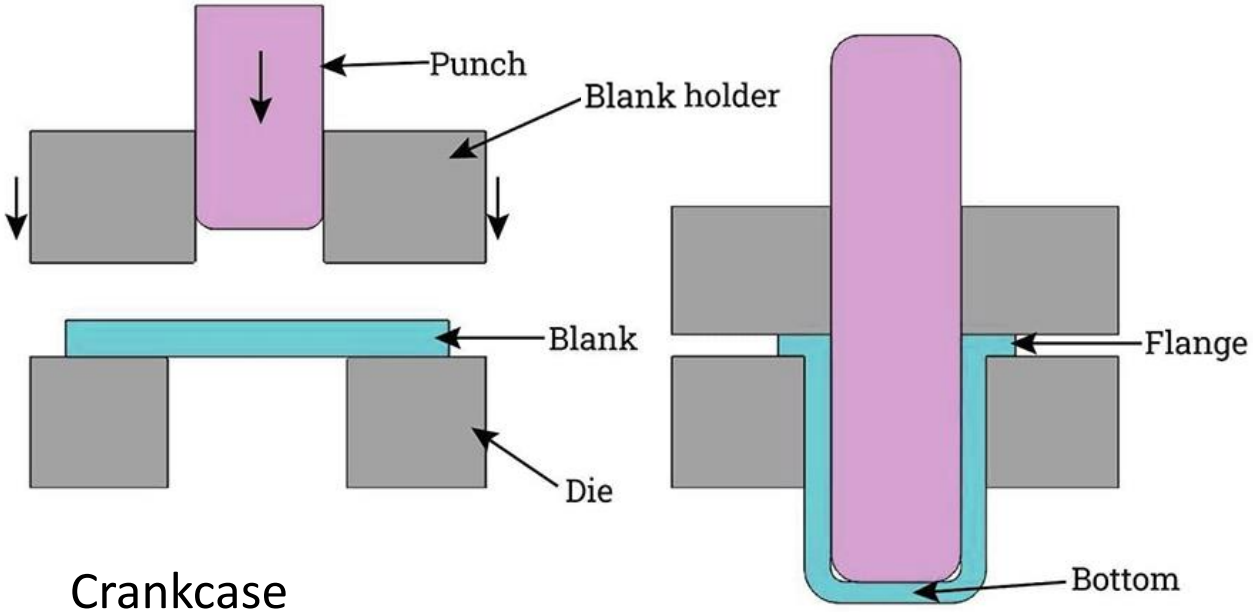
Deep drawing

Drawing is the **pulling of a metal piece through a die** having a tapered bore by means of a tensile force that is applied on the exit side.



https://www.youtube.com/watch?v=2KZRQSI8GkQ

Deep drawing



- Crankcase
- Gas tanks
- Mudguards
- Suspension arms
- Container lids
- Cups
- Bowls
- Containers
- Tanks

Casting

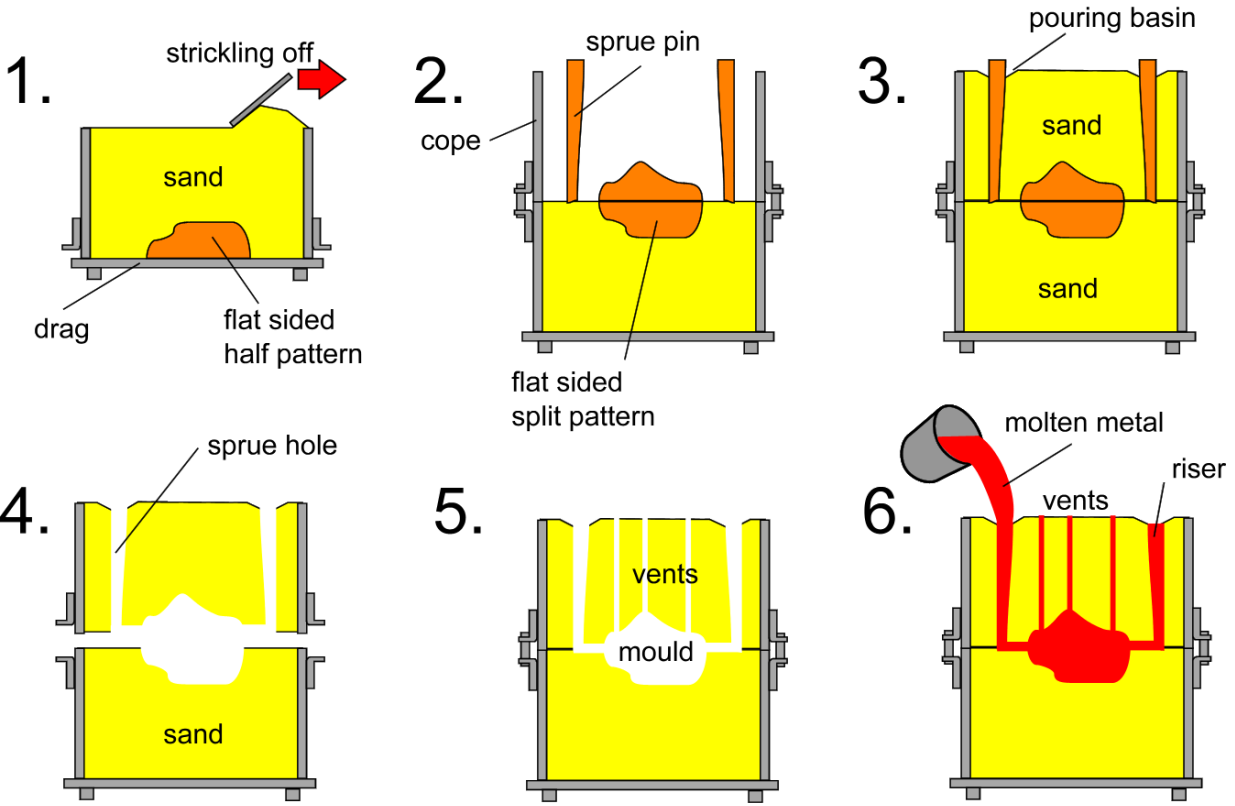
Casting is a fabrication process in which a completely molten metal is poured into a mold cavity having the desired shape; upon solidification, the metal assumes the shape of the mold but experiences some shrinkage.

- By gravity
  - Expendable mold
    - Sand casting
    - Investment casting
  - Permanent mold
    - Die casting
    - Continuous casting
- By pressure
  - Pressure die casting
  - Centrifugal casting

Sand casting

Sand is used as the mold material. A two-piece mold is formed by **packing sand around a pattern** that has the shape of the intended casting. A *gating system* is usually incorporated into the mold to expedite the flow of molten metal into the cavity and to minimize internal casting defects.

Sand-cast parts include automotive cylinder blocks, fire hydrants, and large pipe fittings.

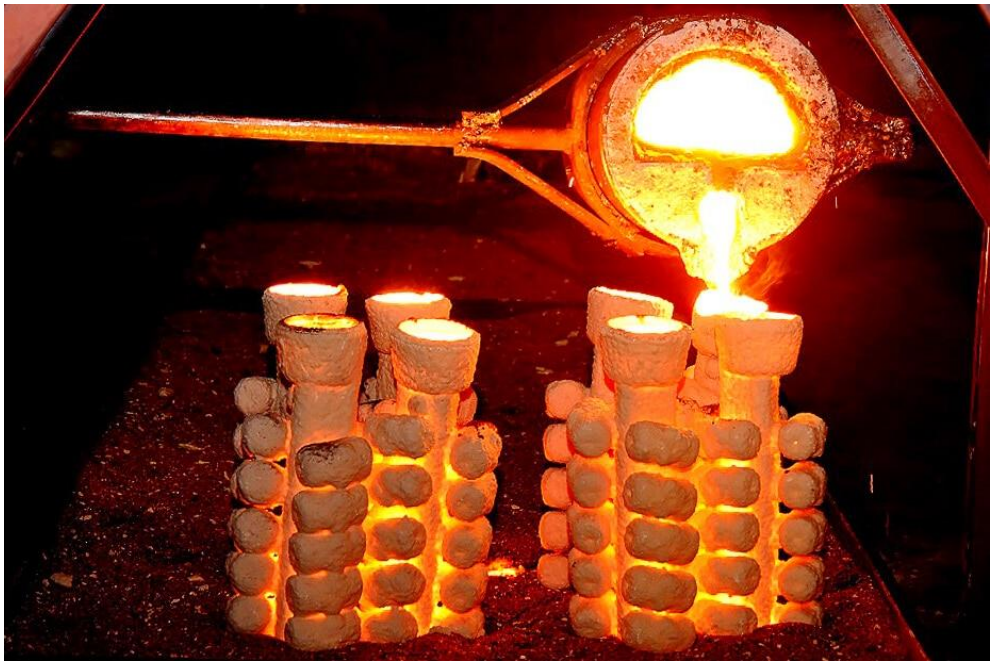


Sand casting

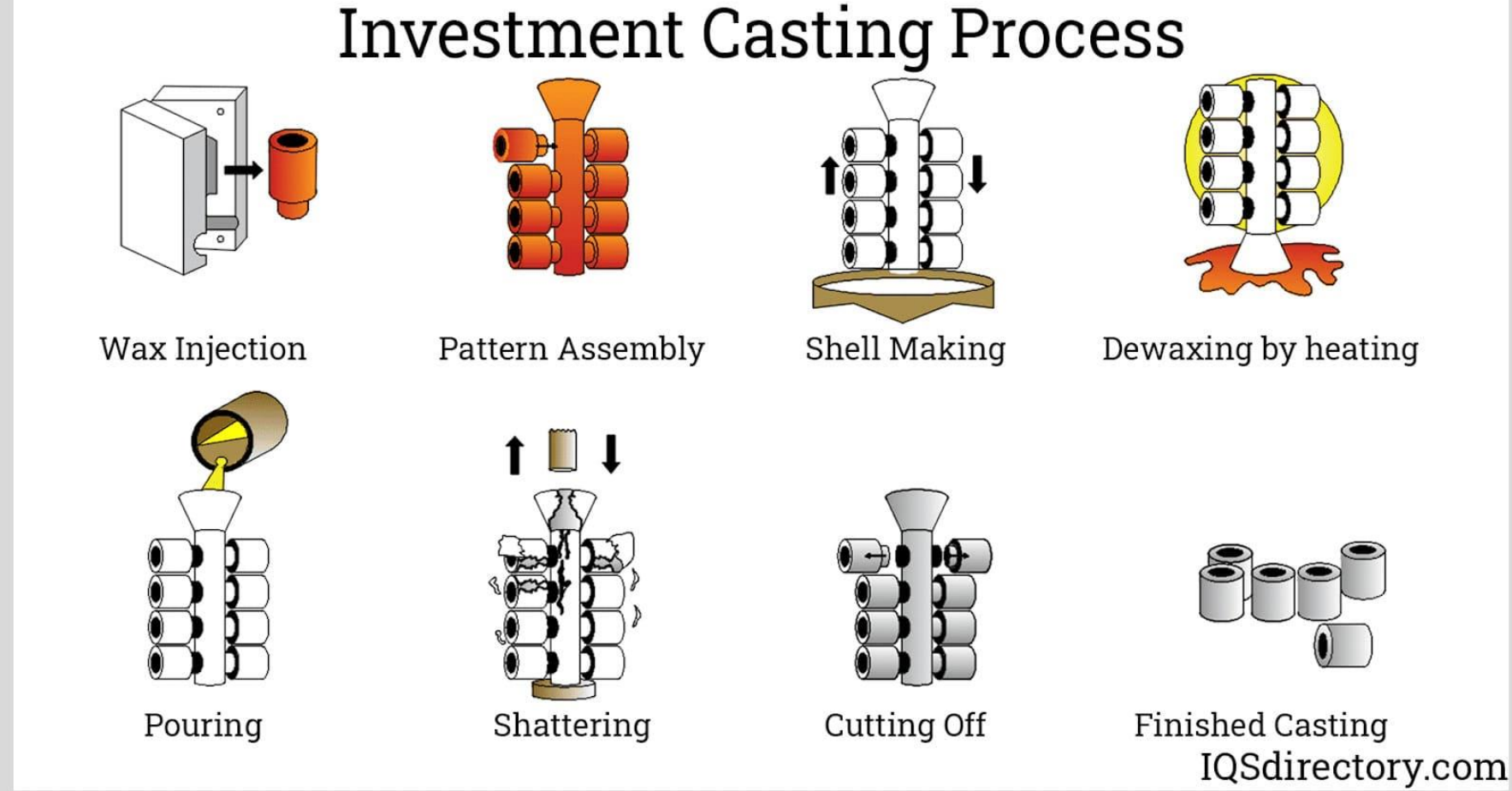
https://www.youtube.com/watch?v=1x3uJ-KSyjY

Investment casting

For **investment** (sometimes called *lost-wax*) **casting**, the pattern is made from a wax or plastic that has a low melting temperature. Around the pattern a fluid slurry is poured that sets up to form a solid mold or investment; plaster is usually used. The mold is then heated, such that the pattern melts and is burned out, leaving behind a mold cavity having the desired shape.



Investment casting

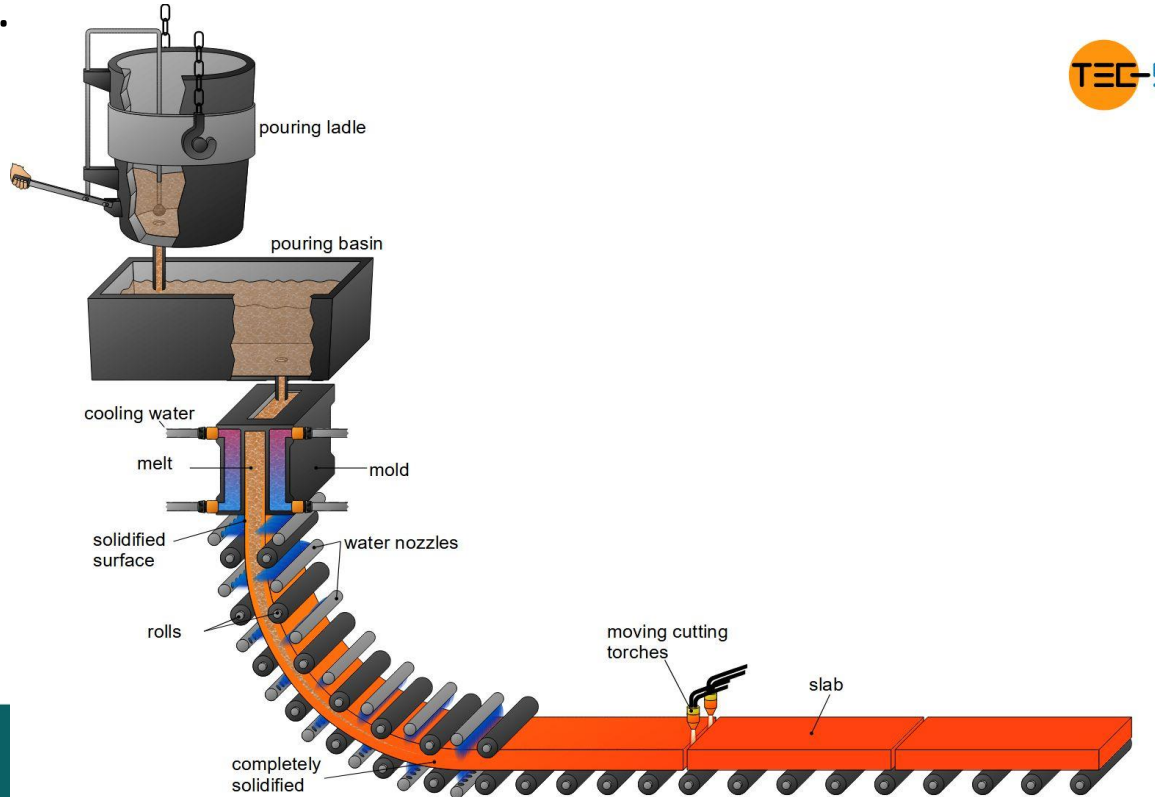


Investment casting

https://www.youtube.com/watch?v=TVsJlWEzZY8

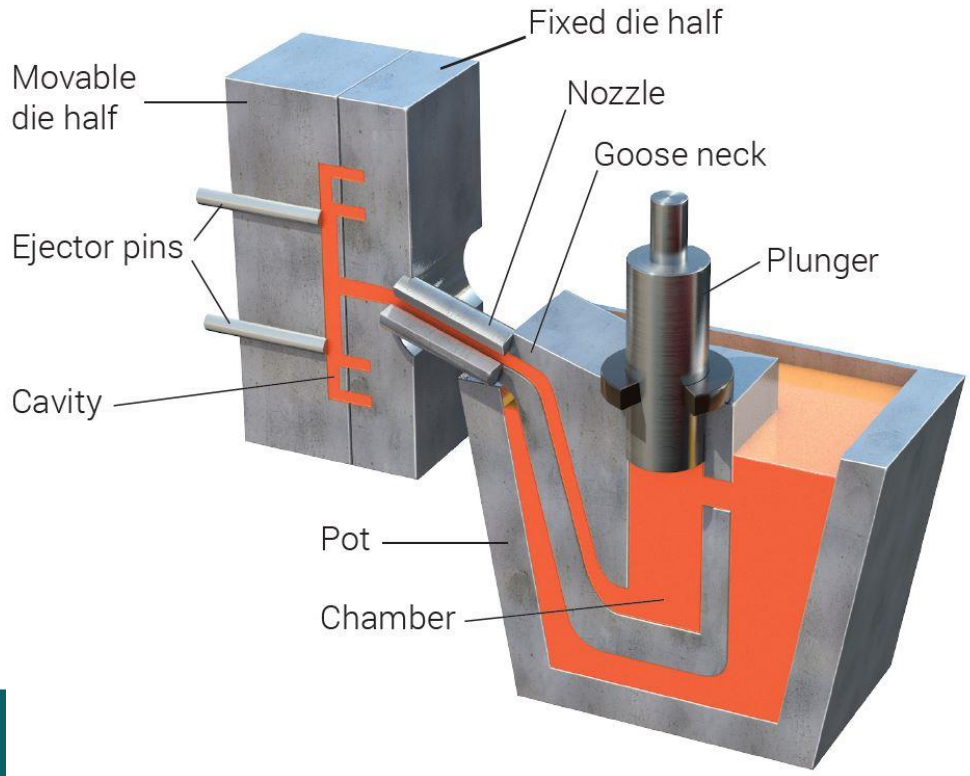
Continuous casting

At the conclusion of extraction processes, many molten metals are solidified by casting into large ingot molds. These **casting and rolling steps may be combined by a *continuous casting*** (sometimes termed *strand casting*) process. Using this technique, the refined and molten metal is cast directly into a continuous strand that may have either a rectangular or circular cross section; solidification occurs in a water-cooled die having the desired cross-sectional geometry.



Pressure die casting

In **die casting**, the liquid **metal is forced into a mold under pressure** and at a relatively high velocity and allowed to solidify with the pressure maintained. A two-piece permanent steel mold or die is employed; when clamped together, the two pieces form the desired shape. When the metal has solidified completely, the die pieces are opened and the cast piece is ejected. Rapid casting rates are possible.



Pressure die casting

https://www.youtube.com/watch?v=iSyBsdJkQu8

Powder metallurgy

Another fabrication technique involves the **compaction of powdered metal followed by a heat treatment to produce a denser piece**. The process is appropriately called **powder metallurgy**, frequently designated as P/M. Powder metallurgy makes it possible to produce a virtually nonporous piece having properties almost equivalent to those of the fully dense parent material. Diffusional processes during the heat treatment are central to the development of these properties. This method is especially suitable for metals having low ductilities, because only small plastic deformation of the powder particles need occur. **Metals with high melting temperatures are difficult to melt and cast**.

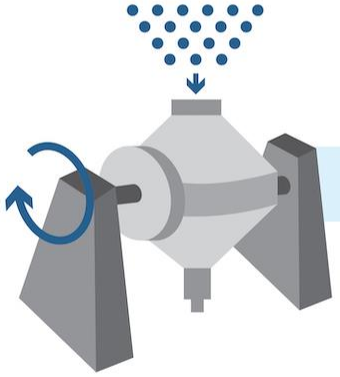
Powder metallurgy

Powder Blending

Compaction

Sintering

Secondary Operations



METAL POWDER

Iron & Steel • Stainless Steel • Aluminum
Copper & Bronze • Soft Magnetic Composites

+

LUBRICANT

+

OTHER ALLOYS & ADDITIVES