Tishk International University
Mechatronics Engineering Department
Manufacturing Technology Week 2025

Metal Forming

Instructor: Sara Serwer Youns
Email:sara.sarwer@tiu.edu.iq

CLASSIFICATION OF METAL FORMING PROCESSES ACCORDING TO TYPE OF STRESS

- Metal forming is a manufacturing process where metals are subjected to plastic deformation using force to reshape them into desired shapes and sizes without adding or removing material. The process changes the size, shape, or physical and chemical properties of the metal.
- Metal forming processes can be classified based on the type of stress employed during deformation: mainly compression, mainly tension, or a combination of compression and tension. This classification helps to understand how material flows during forming and to select suitable methods for shaping different metal products.

Mainly Compression Processes

These processes deform the metal by applying compressive forces. Examples include:

- Forging: Metal is shaped by repeated impacts or pressure.
- Rolling: Material passes between rollers, reducing thickness by compression.
- Extrusion: A billet is forced through a die to create objects with fixed cross-sectional profiles.

Mainly Tension Processes

Here, the metal is pulled to stretch it, causing deformation primarily by tensile stress.

- Drawing: Metal wire or bar is pulled through a die, which reduces its diameter and increases length through tension.

Combined Compression and Tension Processes

- Some processes use both compressive and tensile stresses in tandem:

1. Deep Drawing: Produces hollow shapes (such as cups) from sheet metal by applying compressive force with a punch and pulling/stretching the material into a die cavity, generating both stresses
2. Embossing: Imprints patterns or shapes onto sheet metal using both tension and compression.

Drawing Metal Forming

- Metal forming drawing is a process that shapes metal by pulling or pushing it through a die to change its cross-section, resulting in a reduction in its diameter and an increase in length. There are two main types: bar/wire drawing, which pulls stock through a die to create wires, rods, and tubes; and deep drawing, a sheet metal process where a punch forces a flat metal blank into a die cavity to form objects like oil pans and cups. Both processes deform the metal to achieve the desired shape and properties.

https://www.youtube.com/watch?v=MtkgKwD-lGQ

What is Metal Forming

- Metal forming is a set of primary shaping processes where a mass of metal or alloy is subjected to mechanical forces, causing the metal piece to change shape and size through plastic deformation. This process is economical in terms of material and time and requires the metal to be sufficiently malleable and ductile. Metal forming can be done at room temperature (cold forming) or at elevated temperatures (hot forming), depending on the material's ductility at those temperatures.

Classification of Metal Forming Processes

- Metal forming processes are primarily classified based on the type of stress employed:
- Bulk Metal Forming: Involves severe deformation with massive shape changes. Examples include forging, rolling, extrusion, and wire drawing. These processes work mainly under compressive stress and manipulate pieces with relatively low surface area-to-volume ratios.
- Sheet Metalworking: Performed on metal sheets, strips, and coils, typically involving bending, stretching, deep drawing, and other processes using dies and punches. These are primarily cold working processes.
- Combined Stress Processes: Include operations with both compression and tension, such as deep drawing and embossing

Advantages of Metal Forming

- Improves mechanical properties like strength, hardness, and wear resistance due to strain hardening.
- Produces grain flow along the shape contour, enhancing strength and resistance to fracture.
- Enables economical shaping of parts with minimal material wastage compared to machining.

Metal Forming Processes

- Forging: Shape metal by compressive forces between dies.
- Rolling: Reduce thickness by passing metal between rotating rolls.
- Extrusion: Push metal through a die to obtain a specific cross-section.
- Drawing: Pull metal through a die to reduce cross-section or form wire

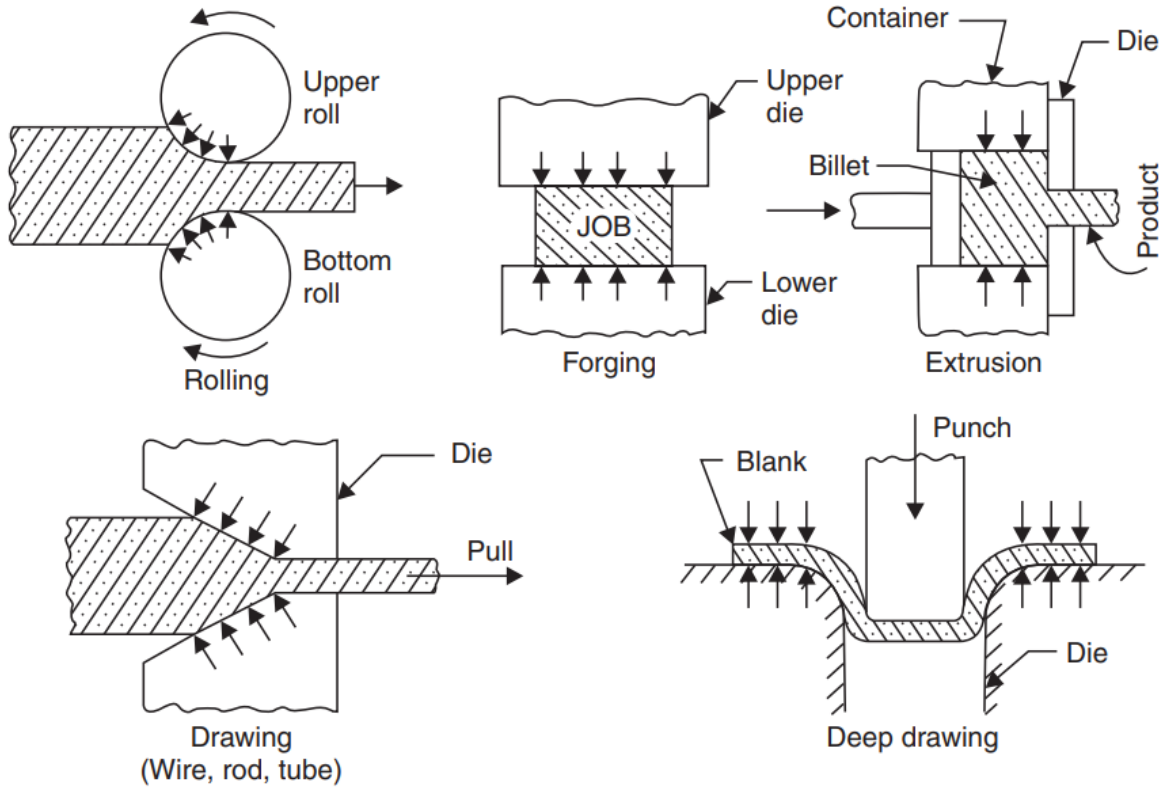


Fig. 1.2 Typical metal working processes

CLASSIFICATION OF METAL FORMING PROCESSES ACCORDING TO TYPE OF STRESS

- Metal forming is a manufacturing process where metals are subjected to plastic deformation using force to reshape them into desired shapes and sizes without adding or removing material. The process changes the size, shape, or physical and chemical properties of the metal.
- Metal forming processes can be classified based on the type of stress employed during deformation: mainly compression, mainly tension, or a combination of compression and tension. This classification helps to understand how material flows during forming and to select suitable methods for shaping different metal products.

Recrystallization temperature

- Recrystallization temperature is the specific temperature at which a metal that has been deformed and hardened by processes like bending or rolling begins to form new, fresh grains. When a metal is deformed, its internal structure becomes distorted and harder. Heating it to the recrystallization temperature allows the metal to "reset" its internal structure by growing new grains, which removes the hardness and restores softness and ductility.

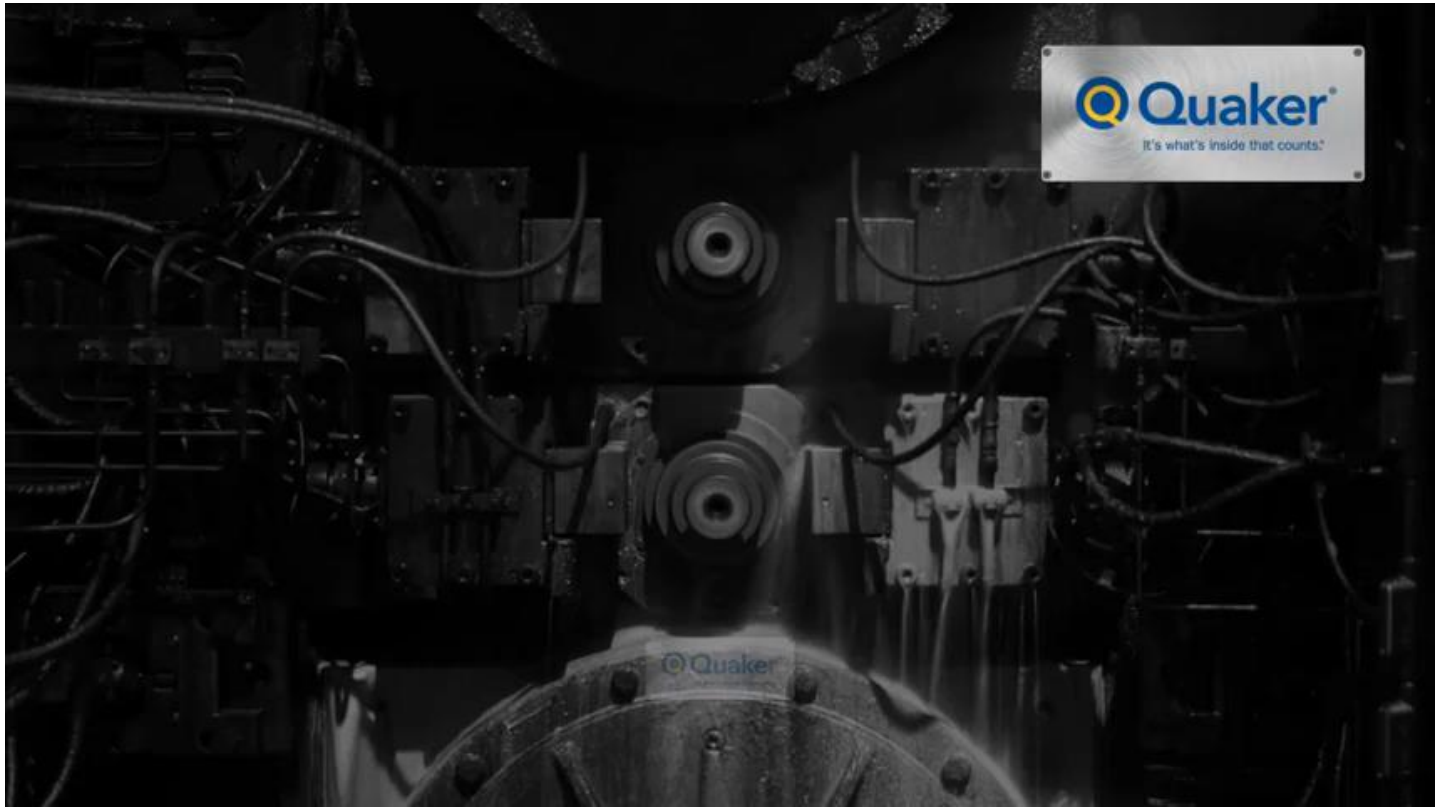
Why Recrystallization temperature is Important

- This temperature is important because if metal forming is done above this temperature (hot forming), the material remains soft and easier to shape without cracking. If forming is done below this temperature (cold forming), the metal becomes harder and stronger but less ductile, as the deformed structure is retained.

Video on metal forming process

Forging Process
https://www.youtube.com/watch?v=o4vQJnPwgiA&t=24s

Rolling Process



https://www.youtube.com/watch?v=ohkJg8JxFPY

Extrusion Process

- Extrusion is a manufacturing process where a material is pushed through a die with a specific cross-sectional shape to create a long, uniform product

https://www.youtube.com/watch?v=Y75IQksBb0M

Drawing Metal Forming

- Metal forming drawing is a process that shapes metal by pulling or pushing it through a die to change its cross-section, resulting in a reduction in its diameter and an increase in length. There are two main types: bar/wire drawing, which pulls stock through a die to create wires, rods, and tubes; and deep drawing, a sheet metal process where a punch forces a flat metal blank into a die cavity to form objects like oil pans and cups. Both processes deform the metal to achieve the desired shape and properties.

https://www.youtube.com/watch?v=MtkgKwD-lGQ

Deep Drawing

- Deep Drawing is a sheet metal forming process that uses a punch to radially draw a flat metal blank into a die cavity, transforming it into a hollow, three-dimensional shape. This process is considered "deep" when the part's depth exceeds its diameter, and it requires a blank holder to control the metal flow and prevent wrinkles. Deep drawing is used to create seamless parts like cans, sinks, and automotive body panels.

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

Hot vs. Cold Working

- Hot Working: Performed above the recrystallization temperature of the metal, allowing continuous recrystallization during deformation. This results in a fine-grained structure free of internal stresses and better ductility but may cause oxidation, scale formation, and dimensional inaccuracies.
- Cold Working: Performed below the recrystallization temperature, leading to strain hardening, increased strength, and better surface finish but also induces internal stresses and requires higher deformation forces.

Questions

- Explain the meaning of the expression ‘metal forming’. Mention the names of five metal
- forming processes.
- 2. What is the difference between hot forming and cold forming ?
- 3. What is the significance of “recrystallisation’’ temperature in metal forming ?
- 4. What do you understand by “grain flow’’ ? How is it connected with the strength of machine
- parts ?