مقدمه ای بر شکل دهی مواد فلزی

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Metal Forming

Overview

Plastic Deformation of metal

Die – Tool used to produce desired shape

Two types – Bulk Deformation & Sheet Metalworking

Stresses typically compressive

- can also apply tensile, bending and shear stresses

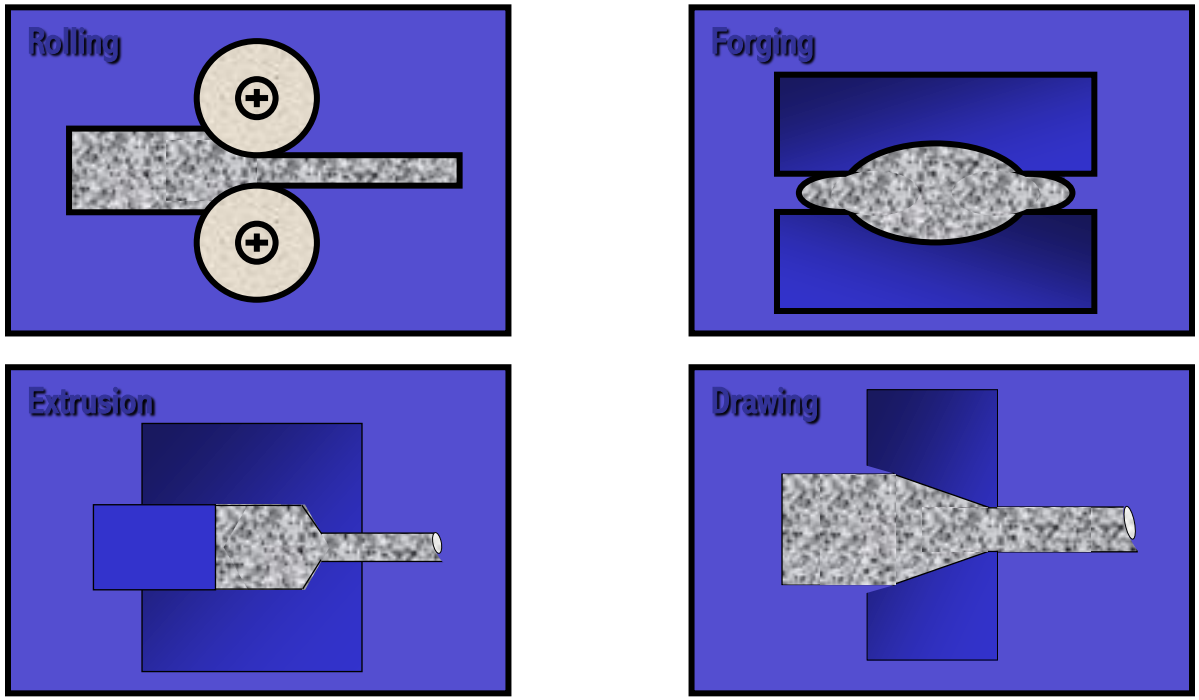
Want materials with:

- Low Yield Stress
- High Ductility

Metal Forming

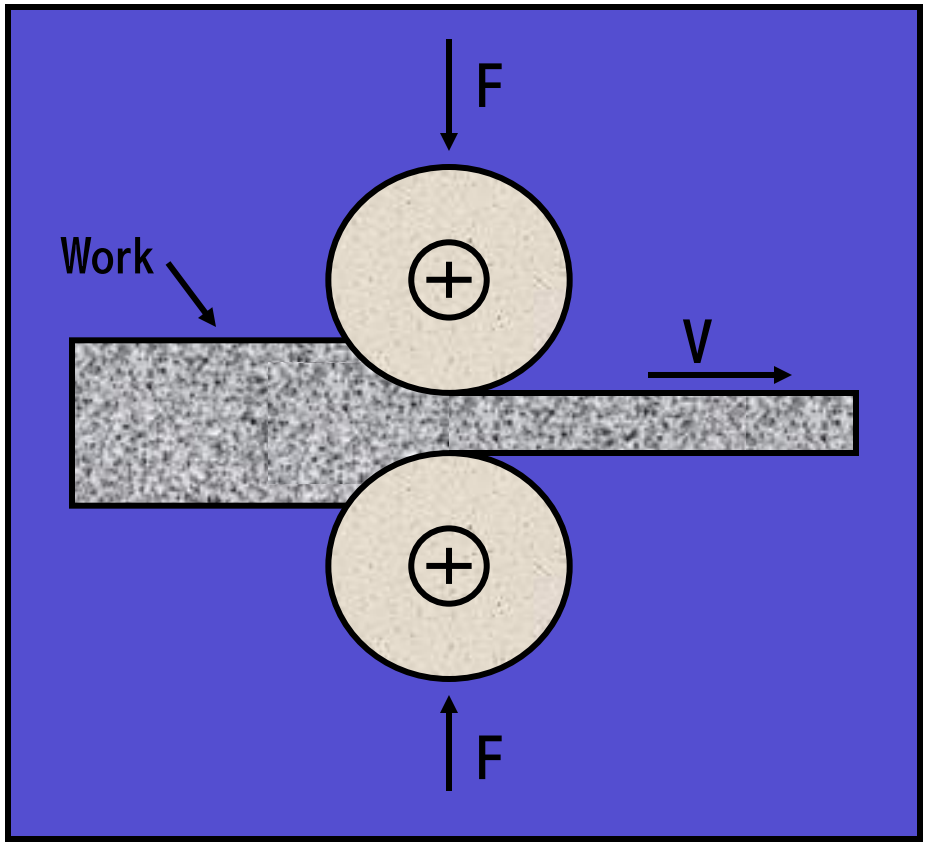
Basic Bulk Deformation Processes

- Significant Deformations - primarily shape changes
- Low surface area to volume ratio
- Starting materials – billets & bars



Bulk Deformation Processes

Rolling



- Long Sections
- Elevated temperatures
- Constant cross-sections

Bulk Deformation Processes

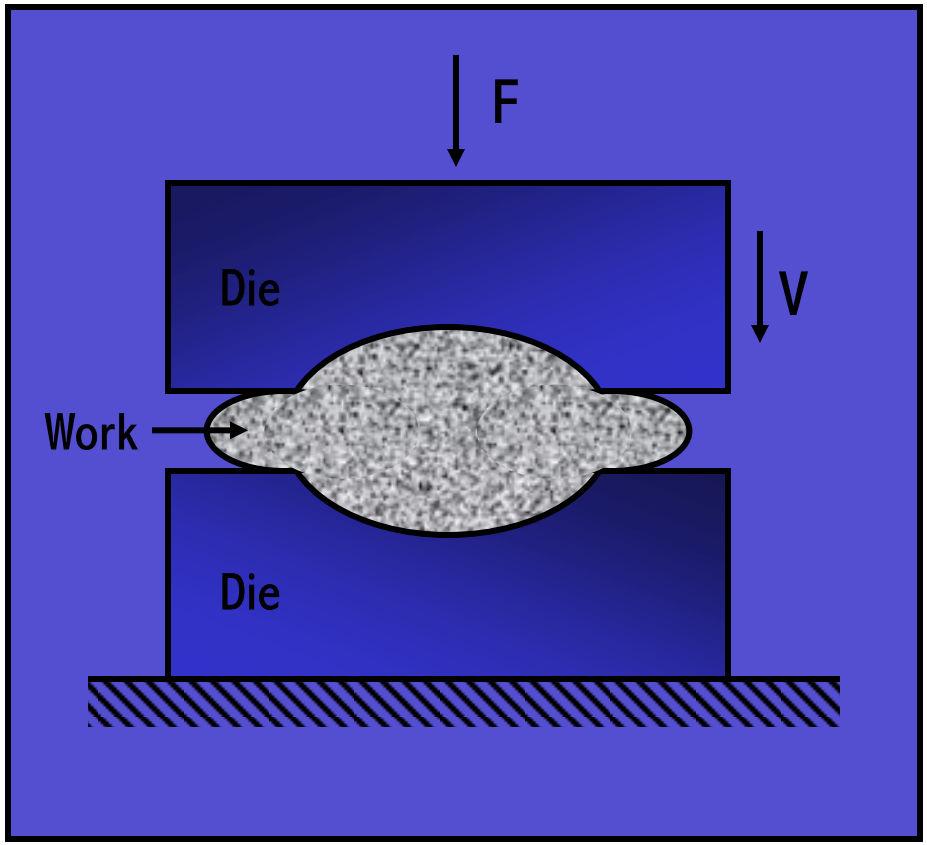
Rolling

http://www.bethsteel.com image bank

- Long Sections
- Elevated temperatures
- Constant cross-sections
- Examples
  - Beam Sections
  - Plate
  - RR Tracks

Bulk Deformation Processes

Forging



- Squeezing & pounding to near net shape
- High or low temperature
- More complex shapes
- Metallurgical properties influenced

Bulk Deformation Processes

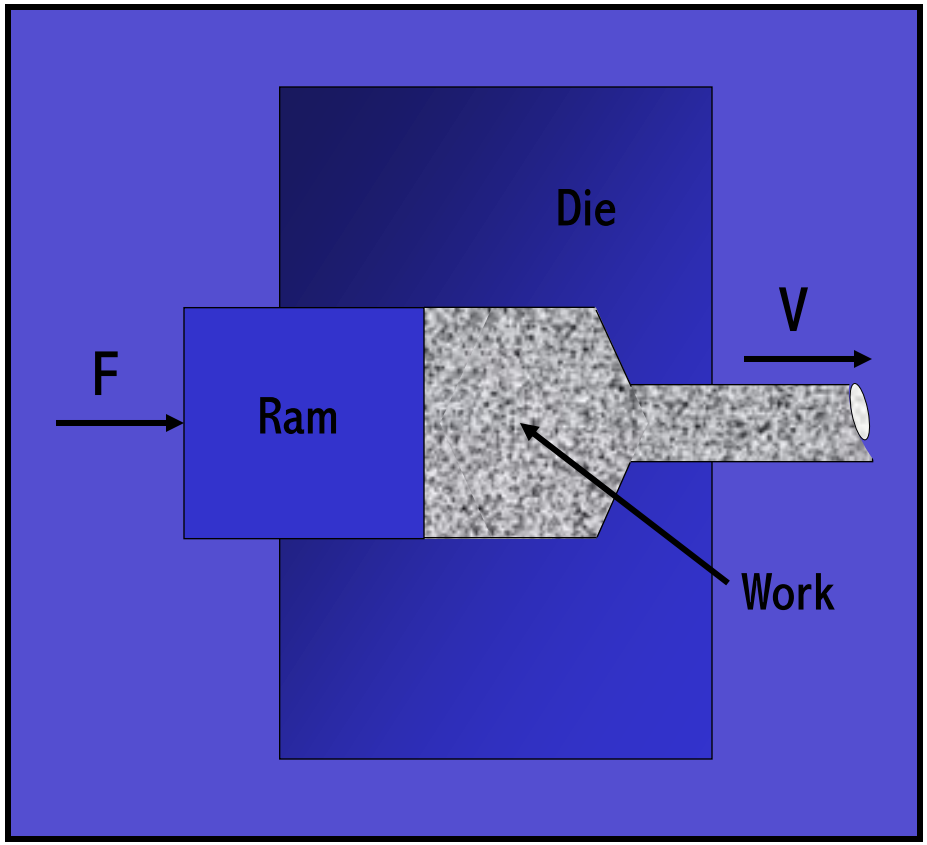
Forging

http://www.coulter-forge.com/forge.htm

- Squeezing & pounding to near net shape
- High or low temperature
- More complex shapes
- Metallurgical properties influenced
- Examples
  - Crankshafts
  - Aircraft Landing Gear
  - Bolts, nails…

Bulk Deformation Processes

Extrusion



- Metal forced through die opening under pressure
- Ambient or elevated temperature
- Cross-section determined by die opening

Bulk Deformation Processes

Extrusion

http://www.usprofiles.com/

- Metal forced through die opening under pressure
- Ambient or elevated temperature
- Cross-section determined by die opening
- Examples
  - Window frames
  - Finned tubing
  - Chalk trays

Bulk Deformation Processes

Extrusion

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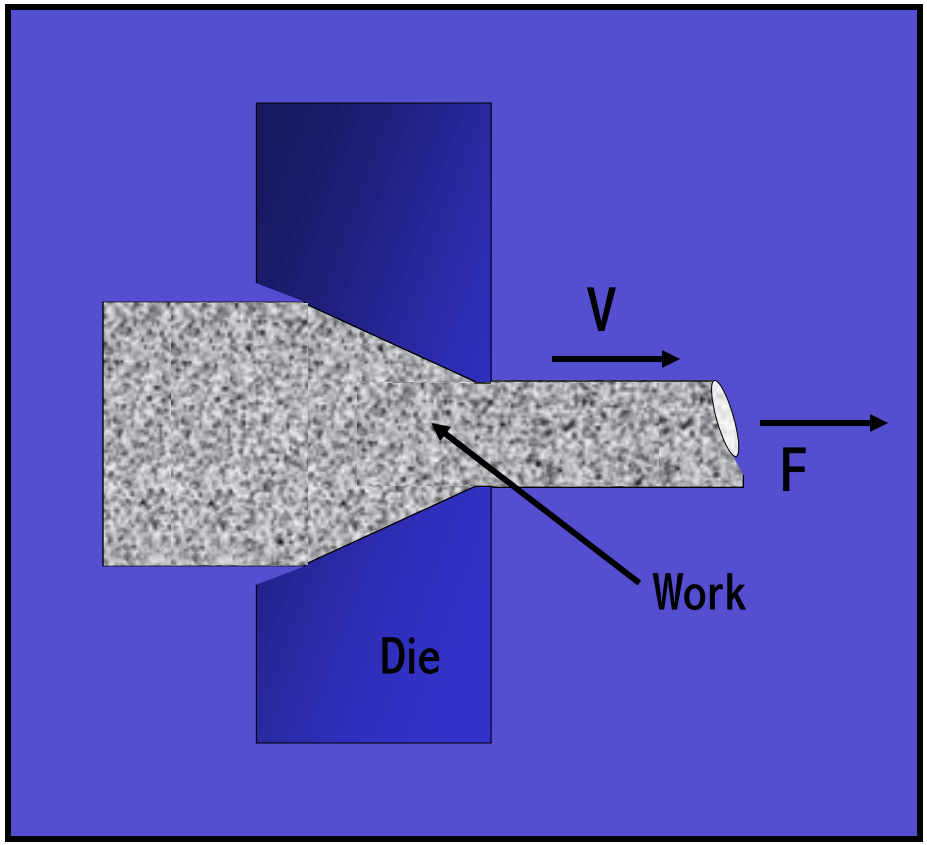
Bulk Deformation Processes

Drawing



- Metal pulled through die opening
- Typically at ambient temp.
- Similar to extrusion
- Bar or wire drawing

Bulk Deformation Processes

Drawing

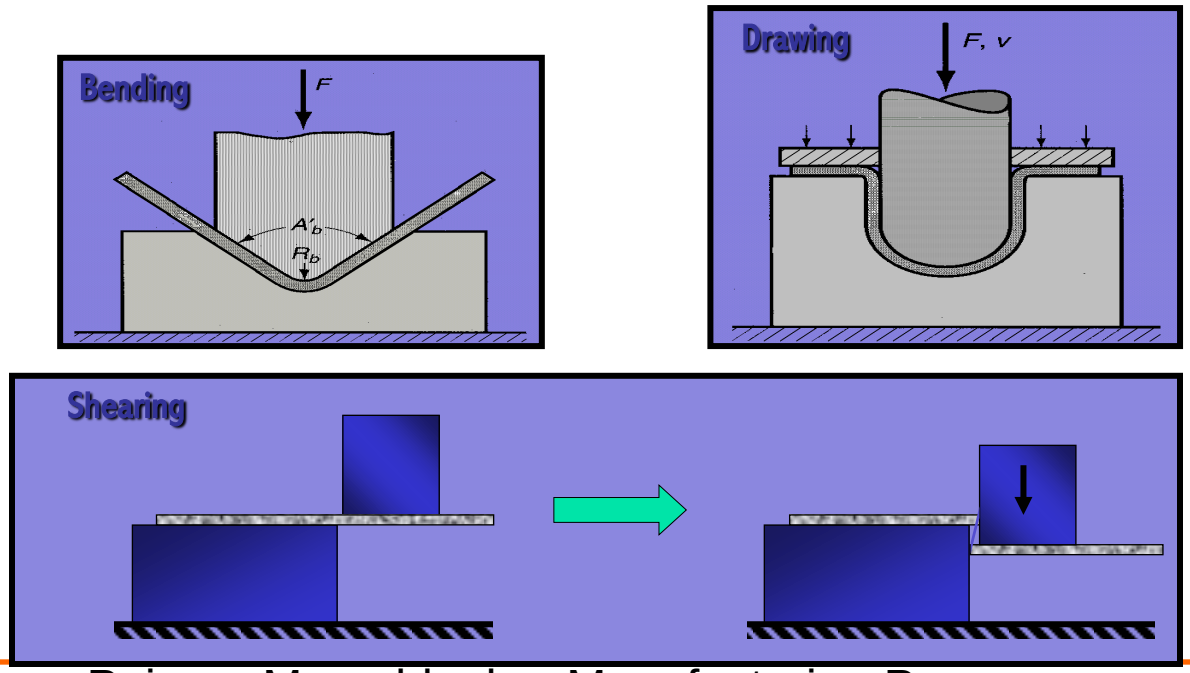
http://www.usprofiles.com/

- Metal pulled through die opening
- Typically at ambient temp.
- Similar to extrusion
- Bar or wire drawing
- Examples
  - Electrical wire
  - Wire stock for fencing, nails, springs, etc.

Metal Forming

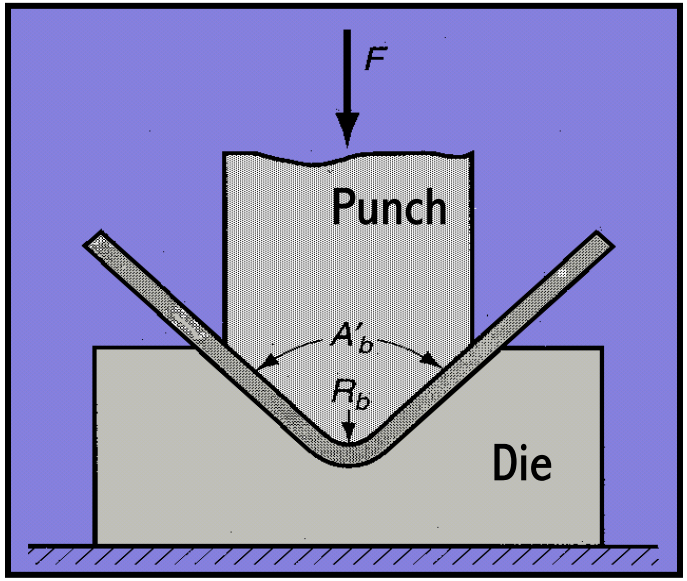
Sheet Metalworking Processes

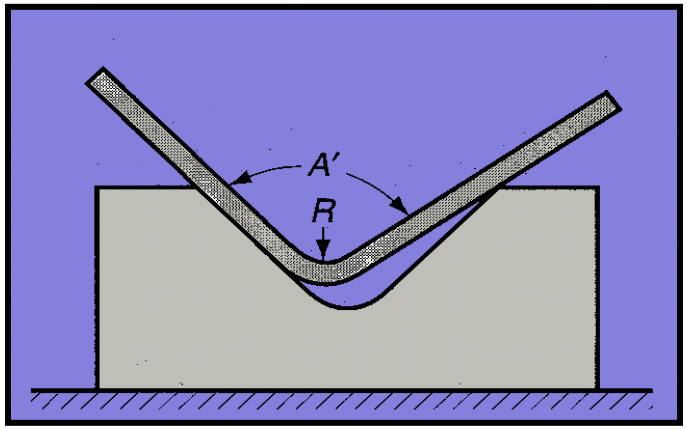
- Cold Work process using punch & die
- High surface area to volume ratio
- Starting materials – sheet, strip



Sheet Metalworking Processes

Bending

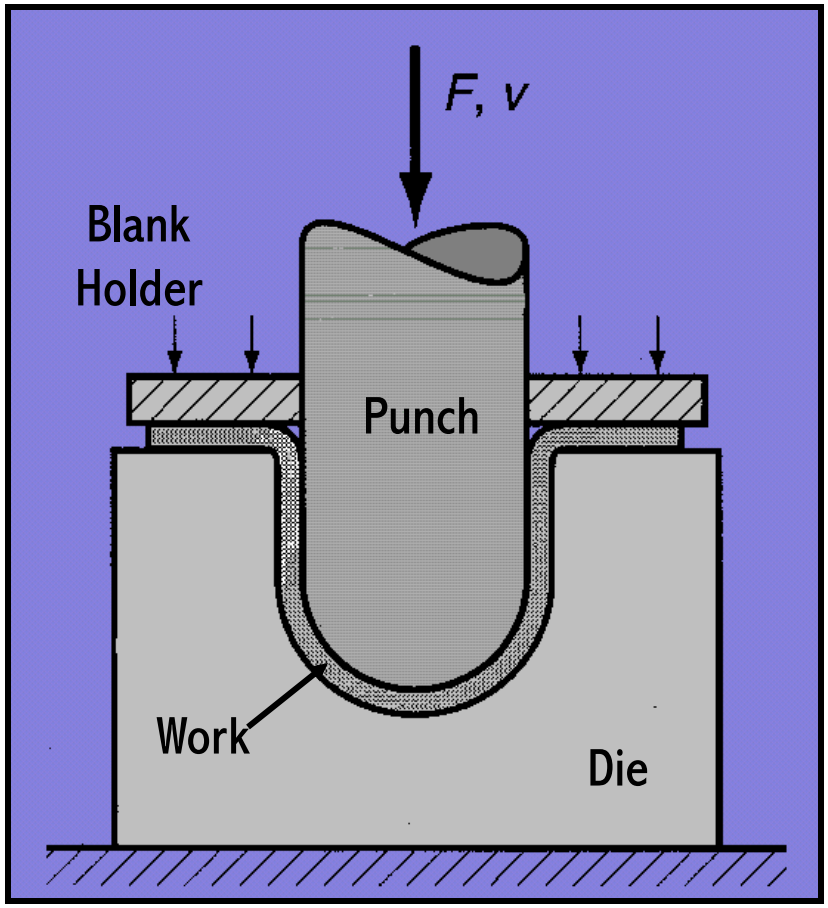




- Straining of flat metal sheet
  to form an angle
- Ambient temperatures
- Need to account for "spring-back" in part/die design
- Spring-back ≈1 - 2^0 for steel
- V-bending or edge bending

Sheet Metalworking Processes

Drawing



- Punching of flat metal sheet into die
- Bending & stretching of sheet metal stock
- Hollow or cup-shaped parts
- Dies expensive

Sheet Metalworking Processes

Drawing

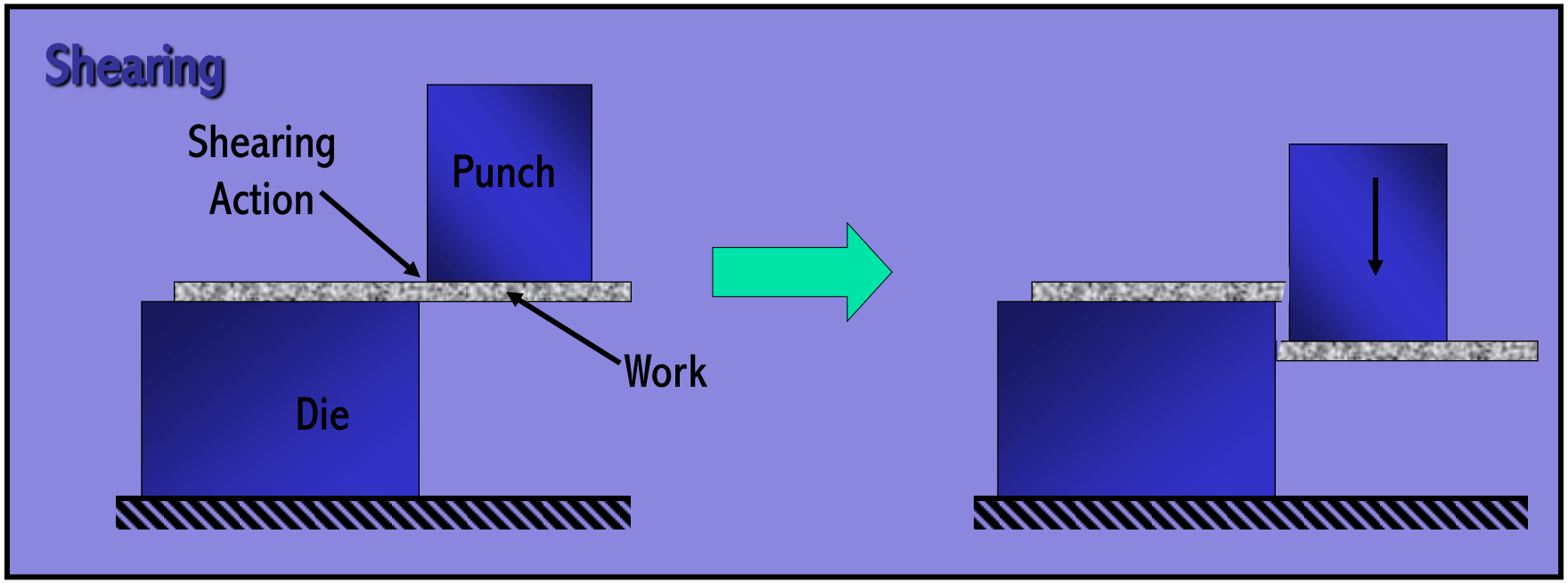
http://www.masoncan.com/

- Punching of flat metal sheet into die
- Hollow or cup-shaped parts
- Dies expensive
- Examples
  - Beverage cans
  - Auto body panels

Sheet Metalworking Processes

Shearing

- Cutting of metal by shearing action using punch & die
- Shearing, blanking & punching



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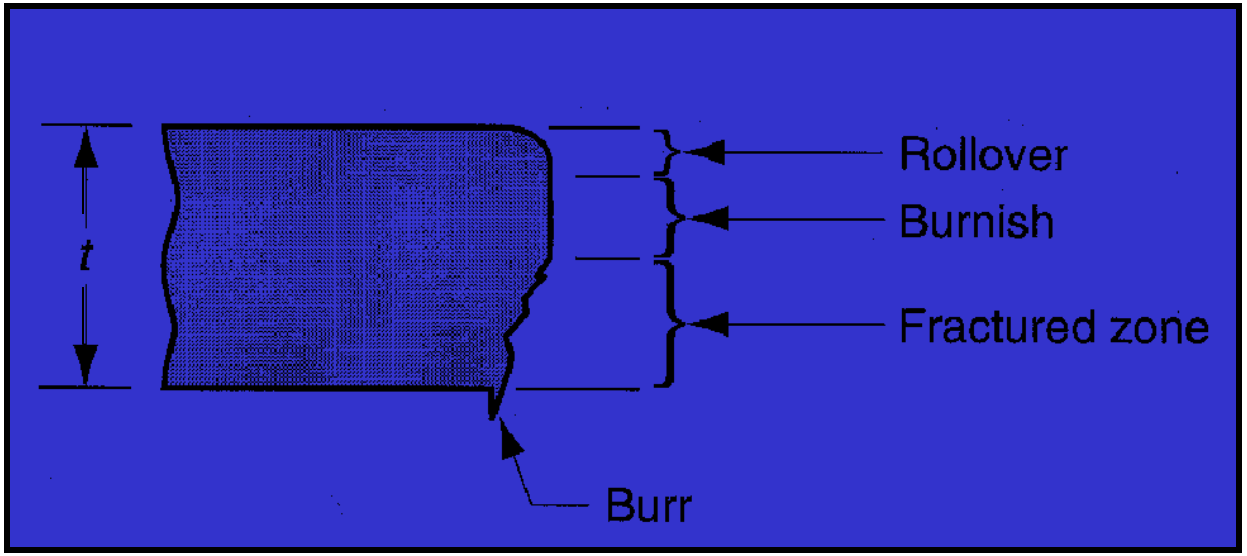


- Characteristic edge obtained

Sheet Metalworking Processes

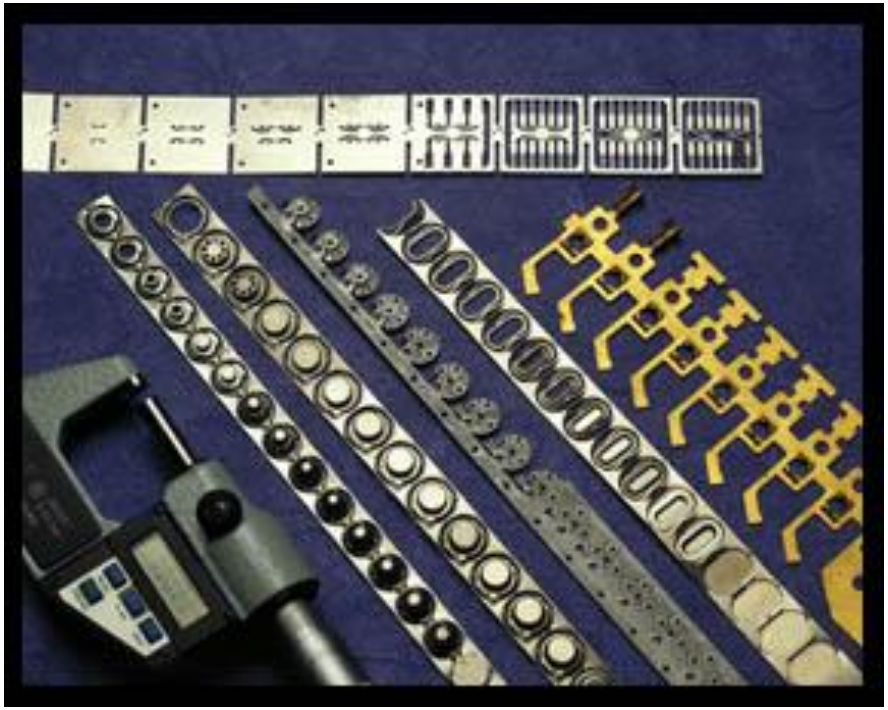
Shearing

http://www.excelsiormetals.com/

- Cutting of metal by shearing action using punch & die
- Characteristic edge obtained
- Shearing, blanking & punching
- Examples
  - Integrated circuit leads
  - Perforated sheet

Sheet Metalworking Processes

Shearing



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- Examples
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Work Temperature

Cold Working

- Ambient Temp ($T < 0.3T_m$)
- Better accuracy & surface finish
- Strain hardening & grain deformation occurs

Warm Working

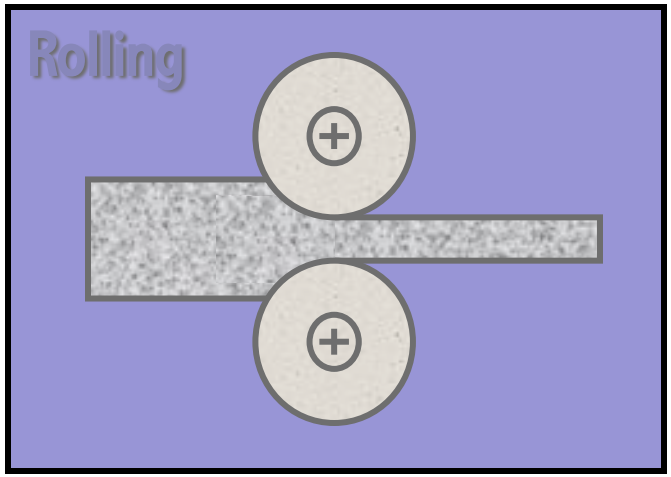
- $0.3T_m < T < 0.5T_m$
- Lower forces, more intricate geometries

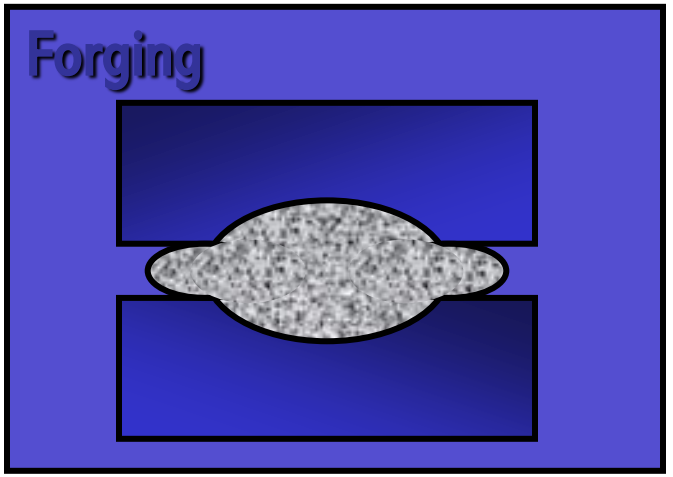
Hot Working

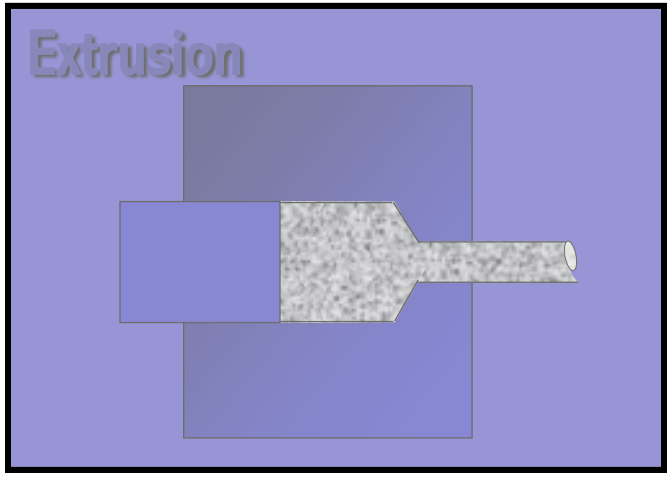
- Slightly above $0.5T_m$ (above recryst. temp.)
- Lower forces, increased ductility
- Isotropic properties, no work hardening
- Lower accuracy & surface finish

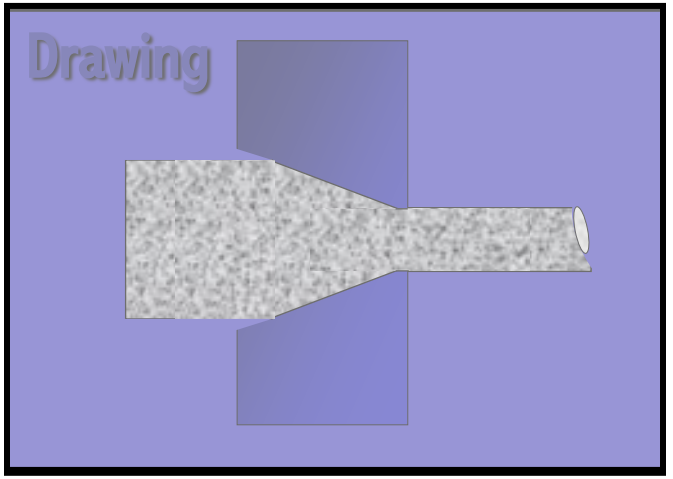
Metal Forming

Basic Bulk Deformation Processes









Questions?