



Post-Extrusion Processing

The Aluminum Transportation Group

Presenter

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Agenda

- Extrusion process (review)
- What is post-extrusion processing?
- Machining
- Joining
- Bending
- Coating
- Summary

Extrusion Process



- The extrusion process produces long profiles with a constant cross section (2D lineal)
- Common and proprietary alloys and tempers allow a wide variety of properties to be selected
- Profiles have been inspected and tested to meet customer requirements
- Now what?

Why Put More Work Into Extrusions?

- Most parts are 3D
 - What uses a constant cross sections at 50' – 60' lengths?
- Bare aluminum may not be cosmetically acceptable
- Parts need to be attached to other parts



Machining

- Machining generally means removing material
 - Drilling
 - Thread tapping
 - Punching
 - Turning
 - Sawing
 - Milling
 - De-burring
 - Shearing
- Makes a 2D profile a 3D part
- Allows tighter tolerances & precise feature location



Machinability

- Different alloys machine differently
 - Surface finish, chip formation, tool requirements
- Generally, softer alloy tempers are more difficult to machine
 - But not impossible!
- Rating is a guideline only

A-Rated

- Very small chips
- Excellent surface finish
- Alloys: 2011, 6020

B-Rated

- Curled or easily broken chips
- Good to excellent finish
- Alloys: 2024, 6262, 6042, 7075

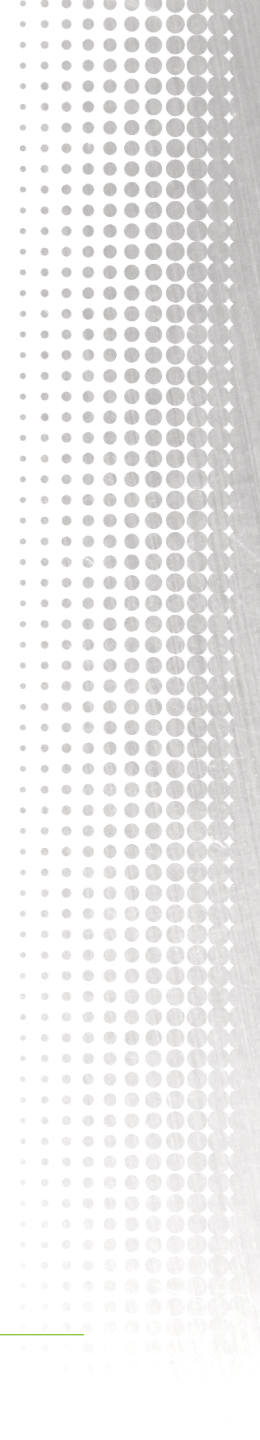
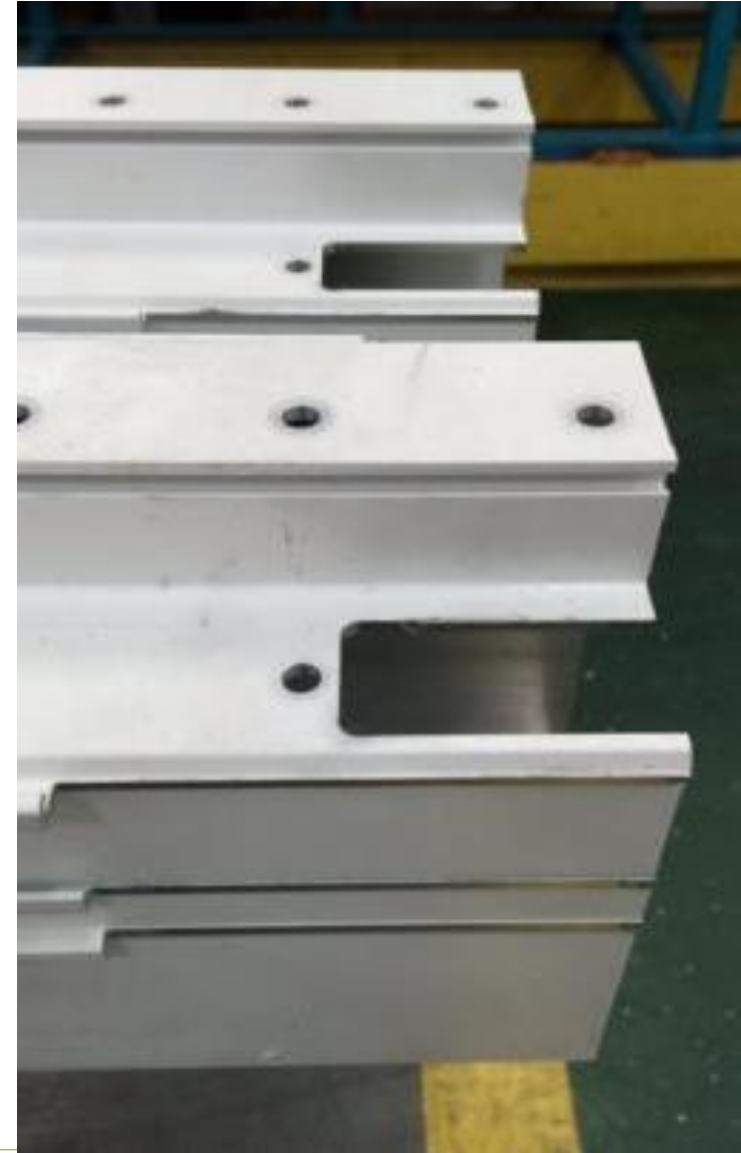
C-Rated

- Continuous chips
- Good surface finish
- Alloys: 6061, 6082, 6005, 6105, 6005A

D-Rated

- Continuous chips
- Satisfactory surface finish
- Alloys: 6063, 6101

Machining and Cutting



Cost Effective Machining

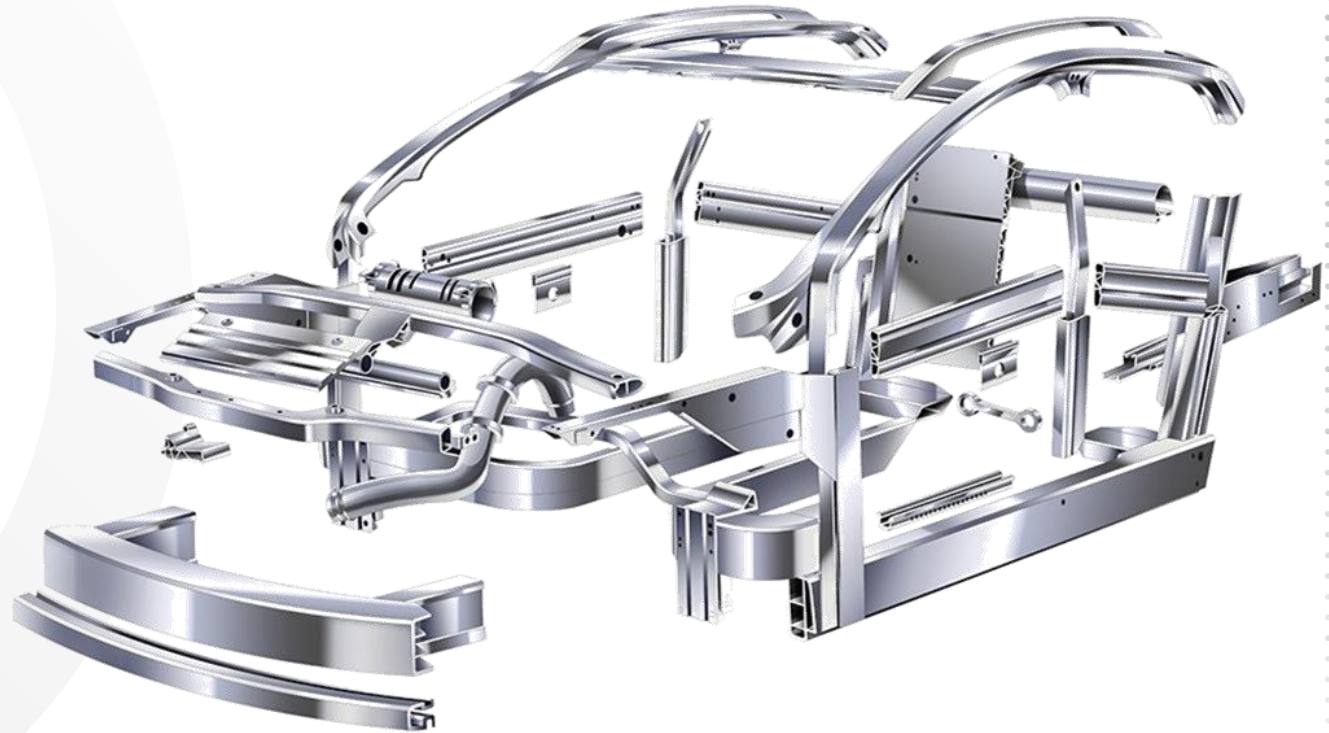
- 2 parts vs. 200,000 parts will require significantly different investment levels
- Utilize extrusion strengths
- Identify critical dimensional requirements and any datums





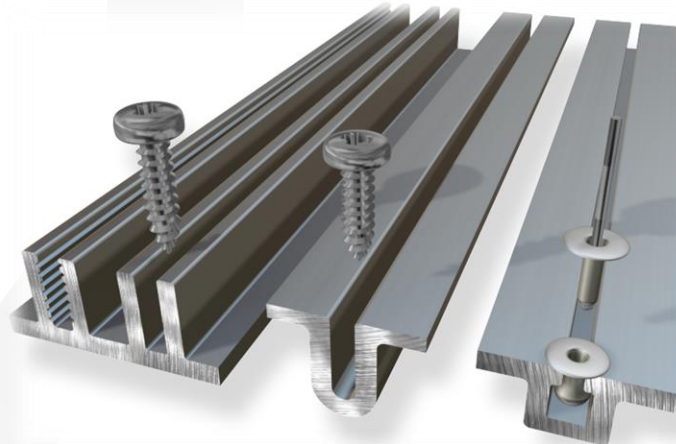
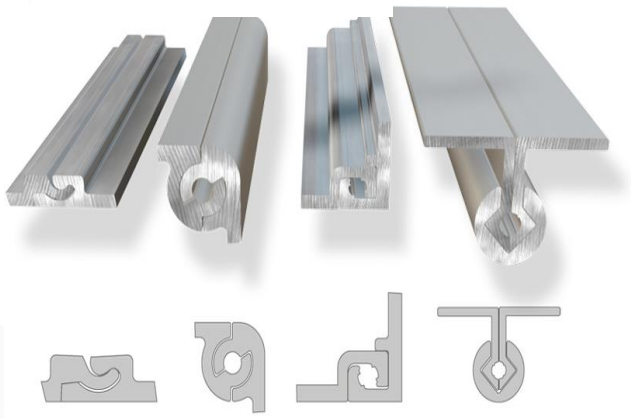
Types of Joining Methods

- Mechanical joints
- Welding



Mechanical Joints

- Mating features can be designed into extrusions
- Screw ports and snap fit assemblies can also be extruded



Mechanical Joints – Rivet Nuts

- “RivNut”, “Blind Nut”, and “Nutsert”
- Often used on hollow profiles and with thin wall profiles
- Installation can be fully automated



Mechanical Joints – Self-Piercing Rivet (SPR)

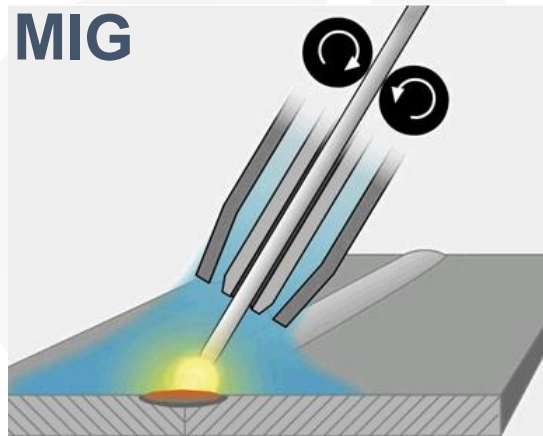
- No pre-drilling required
- Access to both sides required
- Can be fully automated and combined with other methods like adhesives
- Mixed materials can be joined with proper practices



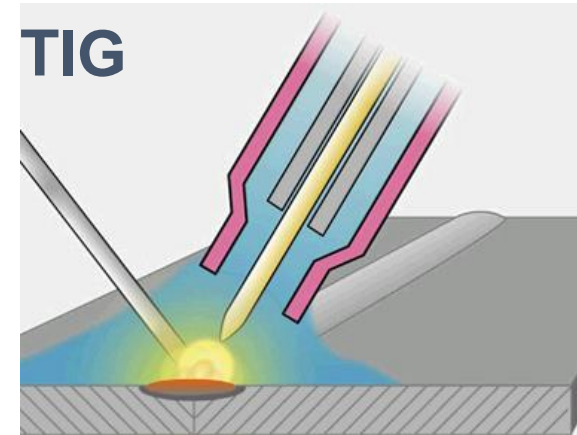
Source: Böllhoff Group

Welding

- All “automotive” aluminum alloys are weldable
- Surface preparation and shielding gas very important
- High energy input is required (due to aluminum thermal conductivity)



- Wire fed through the welding torch
- All weld positions and a variety of joint types
- Higher welding speeds yield higher productivity
- Robotic or manual welding



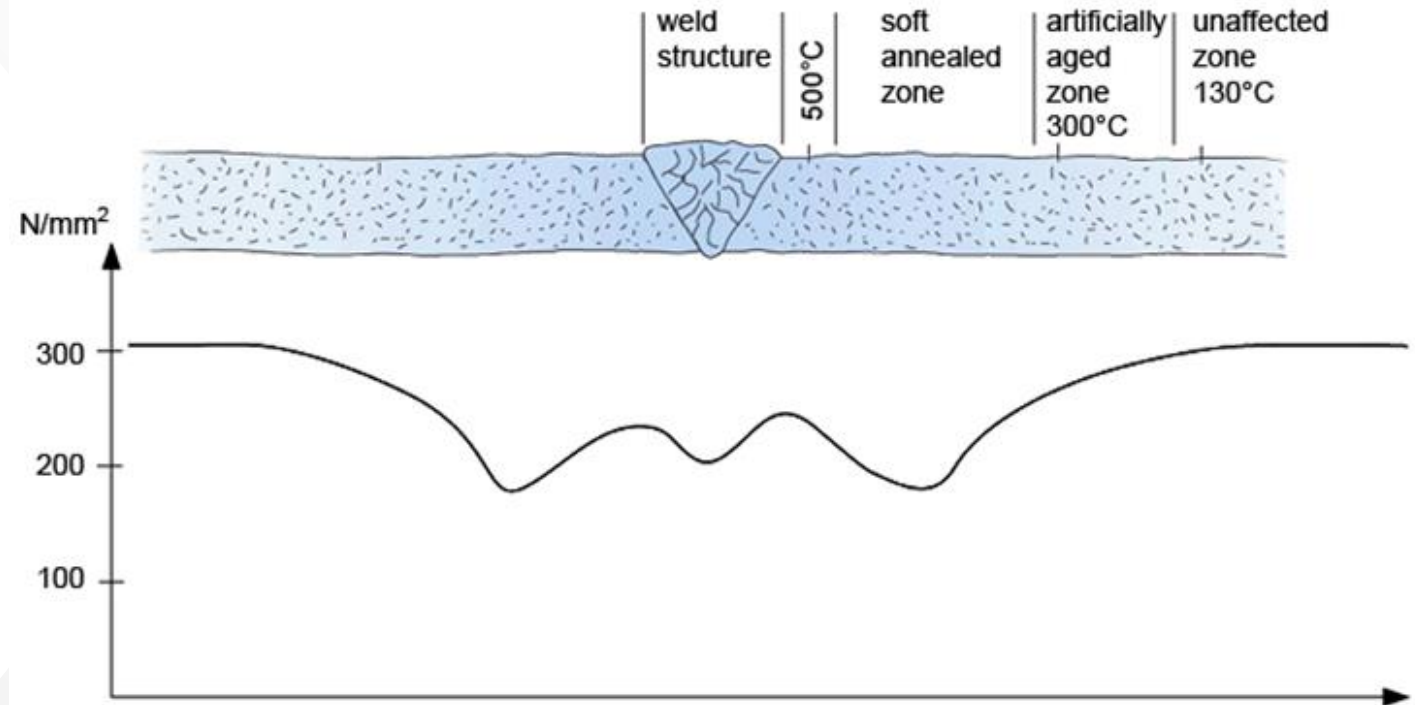
- Filler metal introduced from a side of the weld torch
- All weld positions and a variety of joint types
- Often used when appearance and performance are critical at the cost of lower productivity.

Welding – Filler Materials

- Filler selection is critical for high quality welds
- 5356 (~5% Mg)
 - Not suitable for service temp. >~150 F or post weld HT
- 4043 (~5% Si)
 - Color mis-match if anodized after welding
- Many other 4xxx and 5xxx options, based on alloys being joined

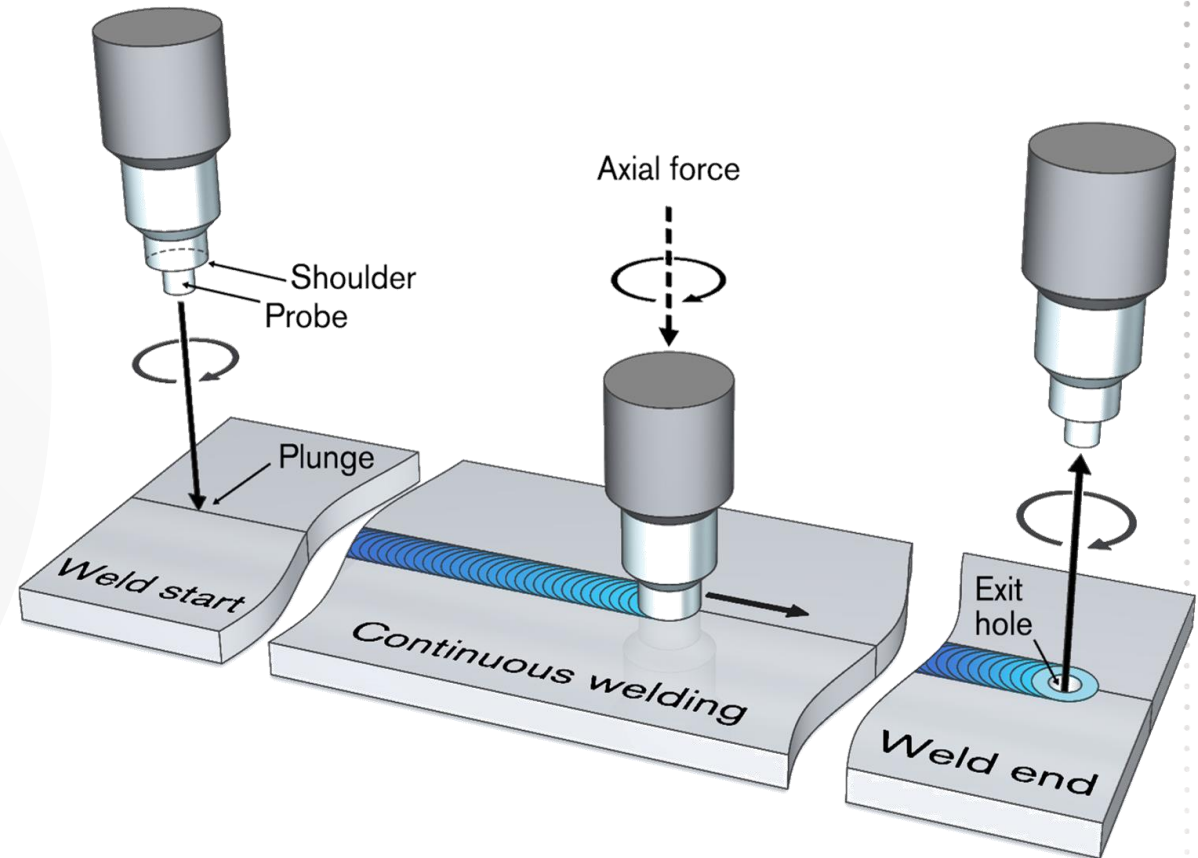
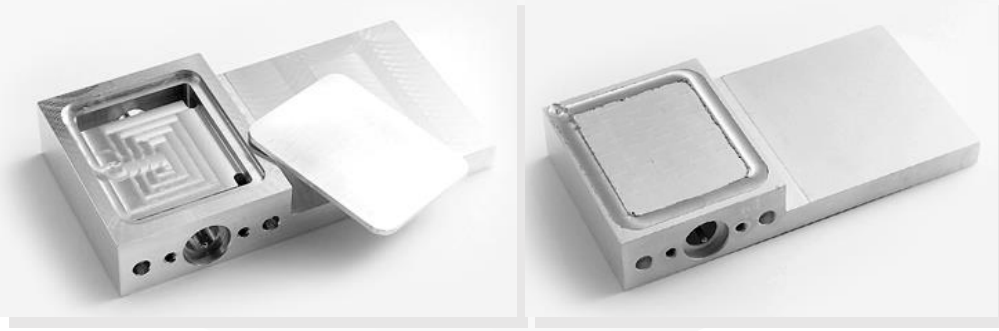
Welding Zone

- The local microstructure is modified by melting, re-solidification and heat input
 - Fusion zone (weld nugget)
 - Transition zone (mushy zone)
 - Heat affected zone (HAZ)
- Properties vary within the weld zone and between the weld zone and bulk structure
- Post weld heat treatment can reduce the variation



Solid State Joining – Friction Stir Welding

- Solid state process – no melting
- Significantly smaller HAZ
- Often used for long lengths and cold plate applications



Bending

- Bending gives design flexibility and allows complex geometries
- Often a substitute for joining corners
- Cosmetic

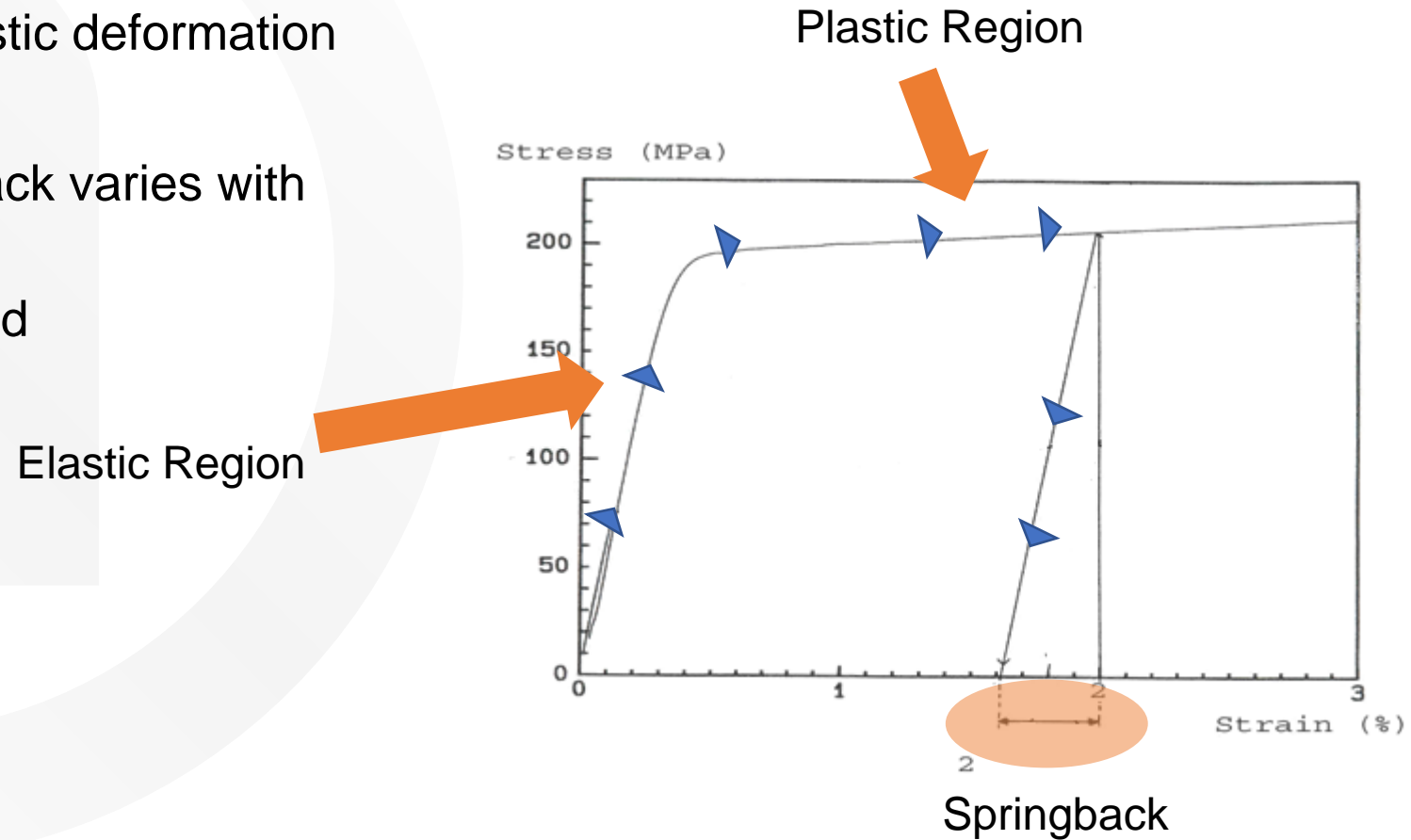


Springback



Springback

- Springback is the return toward the original shape after plastic deformation
- The amount of springback varies with yield strength
 - Unaged vs stabilized



Bending Considerations

- Alloy-temper
 - Softer alloy-tempers are able to have more severe bends
 - Fully aged (T6, T7) material are recommended for bending without special processing
- Bend unaged/stabilized, then age to T6
 - Best combination of properties, more expensive

Bending Types

- Roll bending
- Press bending
- Rotary draw bending
- Stretch bending
- Hydroforming
- Hot gas forming

Complexity

Cost



besam 
ASSA ABLOY

Roll Bending



Stretch Bending



Bending Examples



Radiator Beam



Class 8 Truck
Cross Member



Charge Air Intake



Coatings

- Bare aluminum is suitable for many but not all applications
 - Lot to lot variation
 - Silver may not be the desired color
 - Corrosion
 - Safety



Coatings

- There is a variety of coating types and application methods
- Coatings
 - Liquid (paint, PE, lacquers)
 - Powder (paint, epoxy, vinyl)
 - E-coat (electrodeposition process)
- Electrochemical
 - Anodize (not electrically conductive)
 - Conversion coatings (anti-corrosion, adhesion)
 - Alodine (electrically conductive)

Coating Pretreatment

- Pretreatment is required for best coating results (longevity, adhesion, etc)

CHROME-FREE

1. Caustic cleaner
2. Water rinse
3. Conditioner
4. Water rinse
5. Chrome-free conversion coating

CHROME

1. Caustic cleaner
2. Water rinse
3. Chrome conversion coating
4. Water rinse
5. Water rinse

Coatings

- Understand the requirements & limitations of coatings
 - Longevity
 - Any further processing/assembly
 - Environment concerns
 - Profile compatibility with application method



Battery Cables

- Combines multiple processes into an assembly
- Multiple alloys and tempers allow tailoring for packaging and electrical requirements
- Several suppliers offer polymer coatings for protection and identification



Battery cables in aluminium



Battery tray in place in EV production line. (photo: Shutterstock)

Putting It Together



Fabrication Summary

- Nearly all extrusions have multiple operations after extrusion
 - Understanding the advantages and limitations extrusions offer will help select the most cost-effective solution
 - This can include bending, machining, punching, welding, assembly and many others
 - Fabrication of extrusions is generally limited by vendors' capabilities, not the extrusion itself
- Many extruders offer fabrication services or have close relationships with preferred outside vendors – let the extruder know what will be fabricated
 - They can help ensure success by recommending alloys tempers, packaging, etc based on their experience
 - Utilize the existing supply chain whenever possible

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Questions?