• What is Anodizing
• The purpose of Anodizing
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• Characteristic of Anodizing
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• Anodizing Method
• Type of Anodizing
• Anodizing Process
• Application
What is Anodizing?

- Anodizing is the successful development and control of a natural oxidation process that occurs when aluminum is exposed to the atmosphere.

Try to corrode the aluminum but in control way.
Reaction in Anodizing Process

• Anode Reaction
  – Reaction at Metal/Oxide
    \[ 2\text{Al} + 3\text{O}_2^- \rightarrow \text{Al}_2\text{O}_3 + 6\text{e}^- \]
  – Reaction at Oxide/Electrolyte
    \[ 2\text{Al} \text{ (metal)} + 3\text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 \text{ (oxide coating)} + 6\text{H}^+ + 6\text{e}^- \]
  – Total reaction in anode
    \[ 2\text{Al} \rightarrow 2\text{Al}^{3+} + 6\text{e}^- \]

• Cathode Reaction
  \[ 6\text{H}^+ + 6\text{e}^- \rightarrow 3\text{H}_2 \text{ (gas)} \]
Reaction (cont’d)

- Total Reaction in anodizing process

$$2\text{Al}_{(metal)} + 3\text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 + 3\text{H}_2$$
The purpose of Anodizing

- The purpose of anodizing is to form a layer of aluminum oxide that will protect the aluminum beneath it.
Characteristic of Anodizing

- Hard, comparable to sapphire
- Transparent, similar to glass
- Insulative and static resistant
- Wide variety of colors and finishes
- Integral with aluminum surfaces, non-flaking
Anodizing Benefit

- Durability
- Color stability
- Ease to maintenance
- Aesthetics
- Cost
- Health and Safety
Anodizing can improve the properties of aluminum:

- **Corrosion resistance**
  A low porosity of oxide film will have good resistance against pitting, galvanic and general corrosion

- **Wear Resistance**

- **Surface Hardness**
  Bright/Architectural Anodizing increases the surface hardness from 60-130 HV to value between 200-350 HV

- **Electrical Resistance**

- **Fire Protection**
  Anodic oxide layers give a minor increase in the fire protection of aluminum constructions. The melting point of the oxide surface increases from approximately 650°C to approximately 2000°C.
# Anodizing Method

<table>
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<th>Sheet Anodizing</th>
<th>Batch or Piece Anodizing</th>
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<td><strong>Uses</strong></td>
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<td><strong>Advantages</strong></td>
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<td><strong>Advantages</strong></td>
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<tr>
<td>Wide range of metal and film thicknesses</td>
<td>Small runs</td>
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<td>Less material handling</td>
<td>Thicker films</td>
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<td>Precise color control and uniformity</td>
<td>Anodized edges</td>
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<td>Cost effective</td>
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<td><strong>Disadvantage</strong></td>
<td><strong>Disadvantages</strong></td>
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<tr>
<td>Bare edges on stamped parts</td>
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<td>Crazing when severely formed</td>
<td>High costs</td>
<td>Excessive handling</td>
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<tr>
<td>Limited to sheet and foil</td>
<td>Film thickness variance</td>
<td>High costs</td>
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<tr>
<td></td>
<td>Crazing when severely formed</td>
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</tr>
<tr>
<td><em>Coil anodizing involves continuous unwinding of coils through a series of anodizing tanks and then rewinding.</em></td>
<td><em>Sheet anodizing involves racking or framing of sheets and immersing them in large tanks.</em></td>
<td><em>Piece anodizing involves racking parts and immersing them in a series of treatment tanks.</em></td>
</tr>
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</table>
Anodizing method (cont’d)

Continuous Coil Anodizing

Sheet Anodizing

Batch or Piece Anodizing
Type of Anodizing

- Bright Anodizing
- Hard Anodizing
BRIGHT ANODIZING

• Bright anodizing is a special type of anodizing (in combination with polishing) when glossy or shiny surfaces are required

• To achieve both good abrasion resistance and good reflectivity an oxide coating thickness of approximately 10 µm is suitable

• Application: Finishing trim components, automotive applications like window trims and bumpers
HARD ANODIZING

• Hard anodizing is a term used to describe the production of anodic coatings with film hardness or abrasion resistance as their primary characteristic

• The hardness can achieved greater than 350 HV. Hardness values up to 1400 HV are reported to be obtained from a mixed electrolyte
Hard Anodizing (cont’d)

- Hard anodized aluminum shows a good heat resistance, and a hard anodic oxide coating of 75 µm withstands short exposures to temperatures of the order of 2000°C
- The coatings give also very good electrical insulation.
- Application: In industry for components which require a very wear resistant surface such as pistons, cylinders, and hydraulic gear. Another application is in the coating for the production of flame and chemically resistant surfaces.
Hard anodizing - black finish

Hard black anodizing on casting
Anodizing Process

- **Cleaning**
  The Purposes:
  - Removal of unwanted surface contamination.
  - Prepare the surface for further processing.
• Pretreatment
  ▪ Rinsing:
    ▪ Effectively terminate the previous reaction progress
    ▪ To remove all by-products and contaminants of the preceding stage
    ▪ Prevent cross contamination from one process with another

▪ Etching
  Etching is design to dissolve the surface aluminum so that we can achieve the following:
    ▪ Diminish extrusion die lines and mild scratch
    ▪ Develop a smooth, uniform finish
    ▪ Obtain a matte (diffuse) finish
Pretreatment (*cont’d*)

– **Deoxidizing & Desmutting**

Prepares the surface for subsequent finishing:

- Remove surface oxide
- Remove “smut” - which is combination of intermetallics, metal and metal oxide on the surface after cleaning/etching
- Activate surface
• Anodizing Aluminum

- Anodizing is the electrochemical oxidation of an aluminum surface to produce a stable film oxide.
- In this process a porous, insulative layer composed of aluminum and oxygen is produced by passing electricity through the aluminum in a conductive medium.
• Coloring

- This process is to enhance the appearance of the material and widen the application for anodized aluminum.
- Current power used to deposit metal (Cu, Ni, Co etc) at the bottom of the pore.
• **Sealing Anodic Coatings**
  
  ❖ The purpose of sealing an anodic coating is to close the pore structure of the anodic film and render the film inert
  
  ❖ The sealing process renders the film:
    ✓ Non-staining
    ✓ Non-absorbing
    ✓ Non-reacting
    ✓ Non-corroding
Anodized Aluminum Applications

- Structures and architectural categories of all types
- Commercial and residential building products
- Food preparation equipment
- Furniture
- Sporting goods and boats
- Motor vehicle components
- Building exteriors, such as storefronts, curtain walls, and roofing systems,
Thank You.....!