Description

Process schematic

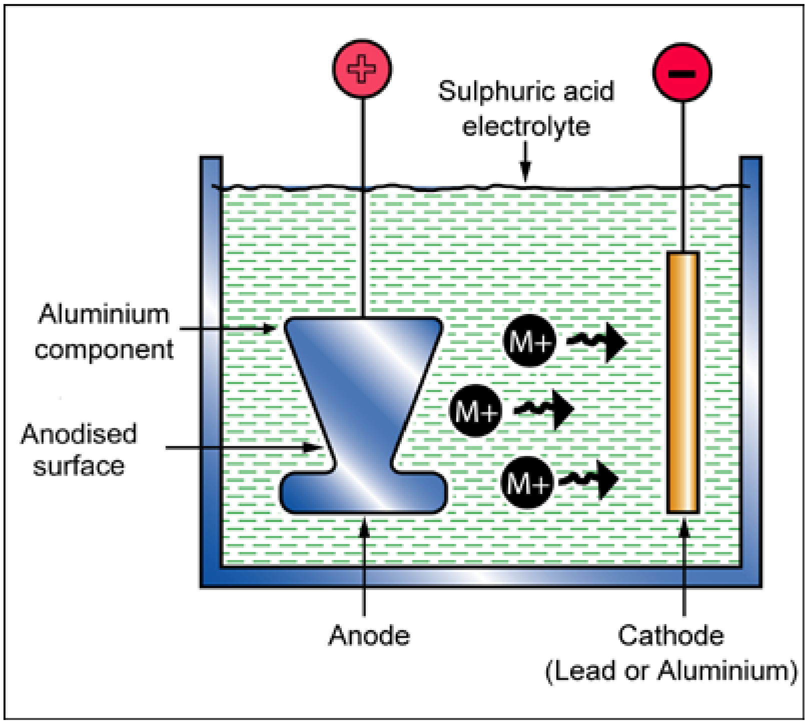

Figure caption

Anodizing

The process

Aluminum is a reactive metal, yet in everyday objects it does not corrode or discolor. That is because of a thin oxide film - Al2O3 - that forms spontaneously on its surface, and this film, though invisible, is highly protective. The film can be thickened and its structure controlled by the process of ANODISING. The process is electrolytic; the electrolyte, typically, is dilute (15%) sulfuric acid. The object to be anodized is made the anode (+) of the bath, with a potential difference of a few volts between it and the inert cathode. This sets up an enormous potential gradient across the oxide film, causing it to grow in thickness. The thicker film gives greater protection, and can be colored or patterned.

Material compatibility

Metals - non-ferrous	✓

Function of treatment

Corrosion protection (aqueous)	✓
Corrosion protection (gases)	✓
Corrosion protection (organics)	✓
Hardness	✓
Wear resistance	✓
Electrical insulation	✓
Decoration	✓
Color	✓
Reflectivity	✓

Economic compatibility

Relative tooling cost	low
Relative equipment cost	medium
Labor intensity	low

Physical and quality attributes

Surface roughness (A=v. smooth)	A			
Curved surface coverage	Good			
Coating thickness	0.1	-	0.591	mil
Surface hardness	50	-	100	Vickers
Processing temperature	31.7	-	107	°F

Process characteristics

Discrete	✓

Supporting information

Design guidelines

Anodizing is most generally applied to aluminum, but magnesium, titanium, zirconium and zinc can all be treated in this way. The oxide formed by anodizing is hard, abrasion resistant and resists corrosion well. The oxide is micro-porous, allowing it to absorb dyes, giving metallic reflectivity with an attractive metallic, colored sheen; and it can be patterned.

Technical notes

There are three main types of electrolytes: 'Weak dissolving' baths are based on boric acid; they form a thin (0.1 to 1micron), non-porous oxide layer. 'Medium dissolving' baths are based on a solution of chromic acid 3 -10%, sulfuric acid 20%; oxalic acid 5%. They give a two-layer oxide: a thin, non-porous initial barrier layer with a porous layer on top of it. 'Strong dissolving' baths contain phosphoric acid based electrolytes, are used as pre-treatment before electroplating, for example, copper and nickel on aluminum. Modified electrolytes in this group are used for electro-polishing. The ability of the film to accept dyes depends on alloy composition: pure aluminum and Al-5 Mg alloys are well-suited for anodizing for protection from corrosion and altered aesthetics. A higher current density shortens the process time for the same thickness of the oxide layer, but at the risk of "burning": damage caused by local heating. Pulse anodizing allows higher current density without burning. Anodizing at temperatures close to 0 °C creates a harder, denser non-porous oxide film.

Typical uses

Anodizing is routinely used to protect and color aluminum; barrier layer anodic films on aluminum, titanium or tantalum are the basis of thin-film resistor and capacitor components for the electronic industry; the anodic film is exploited in the printing industry for photo-lithographic printing plates.

The economics

Equipment costs are moderately high, but tooling costs are low. Alternative treatments are chromating and phosphating: the ranked costs are: anodizing > chromating > phosphating.

The environment

The chemicals involved here are aggressive but in manageable. Disposal of spent anodizing fluids requires a recycling loop.

Links

MaterialUniverse

Reference