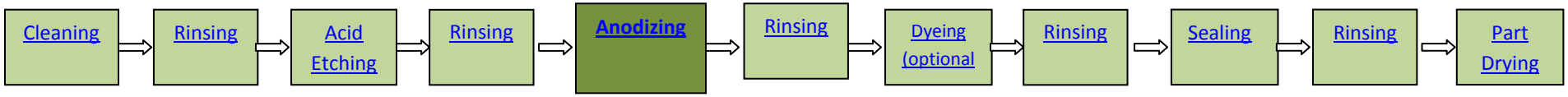
Plating or Conversion Coatings
with Anodizing as a Special Case



Overview of Anodizing

The term anodizing is typically used to describe the conversion coating applied to aluminum. It can also be used to describe conversion coating applied to titanium, magnesium, niobium, or tantalum parts. The difference between anodizing and a typical conversion coating is that anodizing is generated by a combination of both chemical conversion and electric current at the metal surface. The electrical current forces the anodizing layer to form both faster and thicker than it would by chemical reaction alone. Another aspect of anodizing is that the anodizing process leaves micropores in the coating which can be filled with dyes to produce a wide range of part colors.

Typical steps associated with anodizing:

1. Cleaning (may be a modified alkaline cleaning to avoid pitting)
2. Rinsing
3. Acid etching, acid cleaning (may contain fluorides to remove aluminum oxides)
4. Rinsing
5. Anodizing
6. Rinsing
7. Dyeing (optional)
8. Rinsing
9. Sealing
10. Rinsing
11. Part Drying

Porosity in an unsealed anodized surface

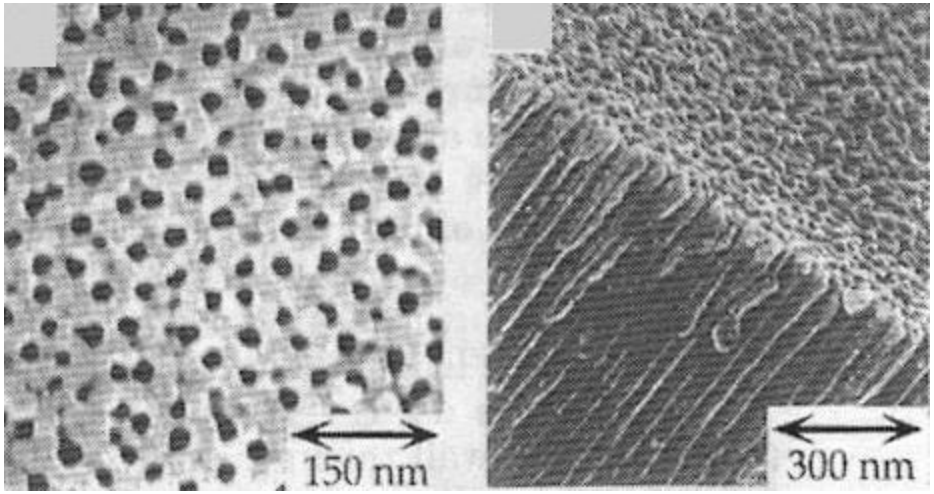


Fig. 6. Surface and cross section near outer surface of porous oxide (From T. Kyotani, L. Tsai, and A. Tomita, Chemistry of Materials, Vol. 8, p 2109, 1996).

Example of color capability in anodizing

Dyeing

The dyeing operation in anodizing is rather unique compared to other chemical process steps in metal finishing. Typically the dyes used are organic and can be sensitive to acid from the anodizing process or contaminants in the rinse water. Therefore, post-anodizing rinsing is critical before parts go into the dye tanks to avoid contamination of the dye tanks. The pre-dye rinse needs to be a high purity water rinse such as deionized water and room temperature or cooler water. The use of a heated pre-dye rinse would begin to seal the pores in the anodized surface and could reduce the dye pickup into the pores.

Depending on the dye, air agitation is either required or forbidden. The dye manufacturer should be able to provide the best practices for their dyes.

The dyeing tanks are typically heated per the dye manufacturer's instructions. The warm dye is drawn into the pores of the anodized layer due to capillary action.

Sealing

The sealing operation is the final stage of the anodizing process. Immersion of an anodized part into hot (boiling point) water causes the pores to seal over due to the slight solubility of the aluminum oxide of the anodized surface. This provides stain and corrosion protection for a clear anodized surface and prevents dye migration or degradation in a dyed surface. The hot water used in sealing also needs to be high purity such as deionized water. Sealing additives are also sometimes used such as nickel acetate with boric acid. The use of additives requires additional wastewater treatment.

Solution recovery

Anodizing solution is typically sulfuric acid. A small amount of dissolved aluminum is helpful to the anodizing process. However, concentration limits are suggested by the manufacturers of specialty chemical mixes for anodizing. In "Aluminum How To, The Chromating-Anodizing-Hardcoating Handbook" by H. R. Probert, the author recommends concentrations no higher than 12 grams per liter of dissolved aluminum.

Methods of dissolved aluminum concentration control:

1. Decant and replace
   A known amount of solution is removed from the anodizing tank such that an addition of the same volume of fresh acid will reduce the total dissolved aluminum to between 5 and 8 grams per liter. The acid-aluminum solution that is removed can either be purified off-line, disposed of as hazardous waste, or be used for other purposes in the plating area.
2. Diffusion dialysis
   This process is able to control the aluminum concentration in the anodizing tank with the use of a selective membrane that allows sulfuric acid through the membrane while holding back the dissolved aluminum. Mech-Chem Associates, Inc. is one company that provides this type of equipment for acid recovery.
3. Acid sorption
   The process of acid sorption is a resin column method of holding back the acid while allowing the dissolve metal to pass through. A back-flush of the resin with pure water allows the acid to be recovered from the resin and put back into the anodizing tank. The waste from this process will be high in dissolved aluminum and small amounts of acid. One company that manufactures acid sorption equipment is Eco-Tec, Inc.