

HIGH PURITY ALUMIPLATE® ELECTROPLATED ALUMINUM: IDEAL ANTI-CORROSION, DIELECTRIC AND ANODIZE FOR CRITICAL SEMICONDUCTOR PROCESSING EQUIPMENT COMPONENTS

Electroplated High Purity AlumiPlate® Aluminum provides excellent corrosion protection for semiconductor equipment components. High purity aluminum unlocks the full performance of standard and next-generation anodization processes. It transforms any structural substrate with the application of a pure aluminum surface. The coating is free of voids and alloying elements, with extremely low levels of contaminants. Anodized electroplated aluminum offers plasma protection at unprecedented levels with very high corrosion resistance and di-electric strength. The ultra-high purity plating is dense; it limits migration of substrate elements which can lead to process environment contamination. The coating can also be used without anodization for non-critical applications due to its inherently high compatibility with aggressive gases and acids.

HIGH PURITY ALUMINUM IS THE IDEAL PROTECTIVE COATING FOR CRITICAL COMPONENTS USED IN SEMICONDUCTOR MANUFACTURING PROCESSES.

Benefits of Electroplated Aluminum

- Ultra-high Purity: 99.99% pure, corrosion resistant, superior dielectric properties.
- Anodization: Can be anodized to Type I, Type II or Type III thickness with standard and special anodize acids.
- Special Semiconductor Anodize Processes: Further enhanced when performed on AlumiPlate aluminum.
- Particulate-free surface: ready for immediate use in clean room and medium vacuum operating processes.
- AlumiPlate Bond Layer™: Coating is bonded directly to the substrate aluminum alloy; the anodizing process may penetrate through the coating to the substrate with no loss of adhesion or undercutting.
- Anodized Electroplated Aluminum: Breakdown voltages in excess of 2,000 volts per 0.001" of oxide layer thickness; withstands 100+ hours of HCl bubble testing.
- Anodize Any Material: Not limited to Al alloys. Enables use of Fe-based super alloys, SST, Copper, Graphite, anything!

Ideal Anodization Surface

High purity Al is dense, and free of voids and defects. It can be uniformly deposited to any thickness serving as an ideal surface for anodization. The proprietary AlumiPlate Bond Layer™ allows for full conversion of the plating on virtually all component geometries. The full performance of next generation oxalic and multi-acid anodize processes is unlocked, resulting in better protection and longer service life.

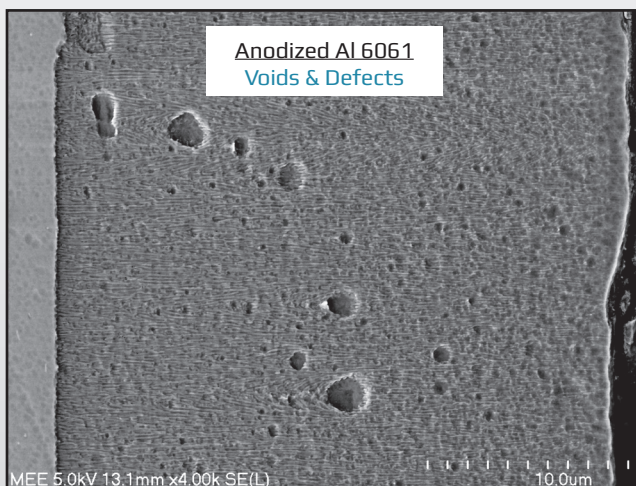


Figure 1: Anodized Al 6061. Note the converted voids and defects, a result of inclusions and impurities in the substrate. The anodized structure is not optimum.

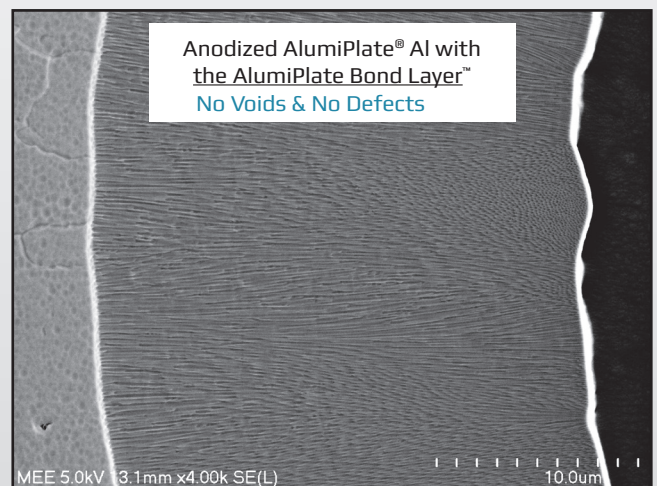


Figure 2: Anodized high purity AlumiPlate aluminum. Note the ideal anodize structure, without voids or defects, resulting from the conversion of pure electroplated Al.

Purity, Corrosion Resistance & Di-Electric Strength

Critical components require highly protective oxide layers to withstand corrosive gases and plasmas used during the etching and deposition of semiconductor materials. When plated with AlumiPlate Al, the surface of these components reacts uniformly and predictively in end-use environments. Electroplated aluminum is 99.99% pure Al. There are no inclusions, contaminants nor voids. There are no alloy-rich phases nor grain boundaries inclusions that provide initiation sites for corrosion and attack. Semiconductor and renewable energy processing equipment is increasingly sensitive to contamination, originating from these alloying elements and inclusions. Pure electroplated Al provides an ideal, dense diffusion barrier to process contamination from the substrate. When anodized, the resultant oxide is extremely pure and dense providing the best possible corrosion and di-electric properties.

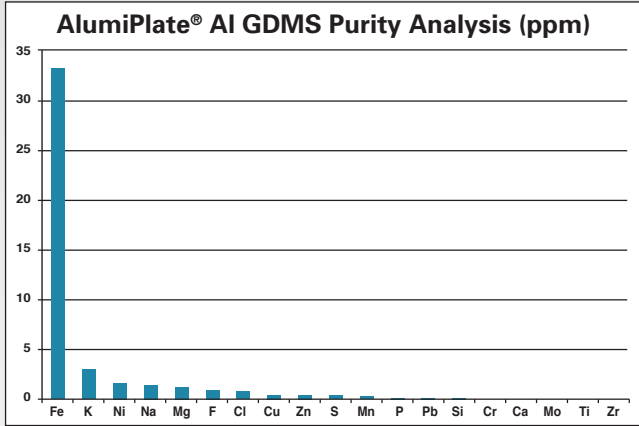


Figure 3: GDMS analysis of high purity AlumiPlate Al. The coating is 99.99% pure.

Anodize Properties	AlumiPlate® Al	Al 6061
Corrosion Resistance HCl bubble test (hrs)	>100	5
Breakdown Voltage (V/mil)	2,000	1,000
Zinc Content (ppm)	<0.5	180
Structure	Optimum	Voids and Defects
Microhardness (VHN)	325-575	300-500
Anodize Thickness	25 µm	25-75 µm

Figure 4: Anodized high purity AlumiPlate Al vs Al 6061. AlumiPlate Al yields a superior anodize with better performance than the current baseline of anodized Al 6061.

ELECTROPLATED ALUMINUM IS AVAILABLE, ECONOMICAL AND REQUIRES NO ADDITIONAL CLEANING IN VACUUM AND CLEAN-ROOM ENVIRONMENTS.

Particulate-free surface

The aluminum electroplating process is performed in a proprietary fully enclosed, solvent-based environment. Components to be plated are cleaned before and after the plating process. Because the activation, rinsing, and plating chemistries are solvent-based, the as-plated surface is free of any contamination. As-plated parts are clean-room ready after plating and packaging at AlumiPlate's facility. No additional cleaning is required for components operating under medium vacuum (1×10^{-5} Torr). The coating has been tested extensively to limit particulate contamination of machined parts. A major manufacturer of hard drive mechanisms has experienced dramatic reductions in particulate contamination when plating with pure aluminum.

Enables Use of Preferred Materials

Electroplated aluminum facilitates the use of non-traditional materials that have attractive properties for a specific application. Until now, the limited compatibility of these materials with the end-use environment precluded their use in semiconductor environments. However by electroplating the component with aluminum, material and design engineers can take advantage of the bulk material properties (strength, thermal conductivity, CTE, stiffness, machinability, etc.) AND enhance service life. Due to its improved corrosion resistance, custom "pure" wrought or cast grades of aluminums have been the only alternate to Al 6061. However, these materials have lower ultimate and fatigue strength, are more expensive, and are logistically difficult to integrate into the current supply chain. Therefore they can be used only on a limited window of applications. With electroplated aluminum, an Al 6061 component retains its attractive mechanical properties AND has improved corrosion resistance and service life. Its superior corrosion performance and capability enable use of non-traditional alternatives to Al and Fe-Ni alloys, resulting in lower maintenance costs and significant material savings.

Diverse Applications

High purity aluminum is an ideal coating for critical semiconductor equipment. Dry Etch, Ion Beam Implant, Gas Delivery components, Hardware and Magnets can all benefit from the coating. Small hardware (fasteners, locking parts), delicate components and rare-earth magnets can be easily electroplated with aluminum. The plating process is benign and low temperature (100 °C). Its applicability across a wide range of products makes electroplated aluminum the best choice for corrosion protection in semiconductor processing equipment.