

# Electroplated aluminum: An ideal anti-corrosion coating for fasteners in critical service applications.

Many high strength fasteners, particularly those used in critical service applications where the cost of failure is very high, are employed without adequate anticorrosion coatings because of the lack of acceptable alternatives. Commonly available anticorrosion coatings can be incompatible with the application, or can cause hydrogen embrittlement leading to catastrophic failure.

An ideal anticorrosion coating for fasteners is tough, thin, non-embrittling, highly corrosion resistant, supports repeatable torque/tension performance and is environmentally friendly. Electroplated high purity aluminum offers an excellent solution, offering all these properties and giving users a new solution that has historically been unavailable.

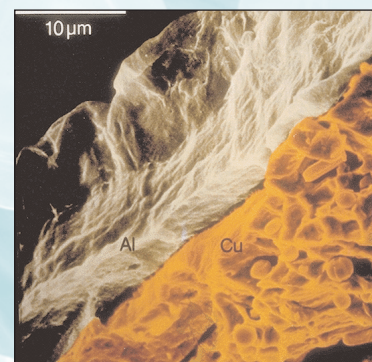
## High purity aluminum - the best alternative for high-strength fasteners

**Corrosion resistance.** Electroplated aluminum is highly corrosion resistant. The pure aluminum electroplated layer is fully dense and pore-free at thicknesses of 0.0003" inches (~8 micrometers) to provide a naturally corrosion-resistant barrier. The tenacious, non-degenerating oxide surface acts as a barrier layer, and the metallic high-purity aluminum layer serves as a sacrificial anode to nearly any metal substrate — when minor abrasions or scratches occur in the layer. Long lasting corrosion resistance is achievable without chromium-based conversion coatings. In ASTM B-117 salt-spray tests, high-purity aluminum outperforms all the other commonly used anti-corrosion coatings as indicated in the test results summary on the back of this sheet.



**Non-embrittling process.** Hydrogen embrittlement, caused by exposure to and diffusion of free hydrogen in the substrate, has long been associated with water-based plating processes and other traditional anti-corrosion electroplating coatings such as cadmium. This has prevented the use of electroplated metal anti-corrosion coatings in applications where this risk could not be tolerated. The patented aluminum electroplating process is non-aqueous and instead uses an aprotic (proton-free) electrolyte. This limits the potential for hydrogen embrittlement, and the process has been certified non-embrittling based on tensile, fatigue, and field-customer test data. Aluminum electroplated high-strength components do not require a post-plating heat treatment for hydrogen relief, and the coating minimizes environmentally assisted cracking (EAC) in end-use environments.

*This photomicrograph illustrates electroplated aluminum's density and demonstrates the integrity of the coating/substrate interface. Note the lack of voids and pores in the coating.*



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**Compatibility with your applications.** Electroplated aluminum is compatible in a wide variety of difficult environments and applications.

Where dimensional tolerances need to be maintained, the thin aluminum layer can be applied within tight specifications. A plating thickness on the order of .0003" inches is typical and provides long lasting protection. This thin coating is compatible with thread tolerances and eliminates the "thread fill" phenomenon associated with organic coatings.

Aluminum has a relatively high melting point and the electroplated aluminum performs well at temperatures up to 1000 deg F. In applications where electroplated aluminum is being used as a replacement for cadmium, torque tension specifications can be controlled with friction modifiers.

## Diverse applications

Electroplated aluminum is valuable in a broad spectrum of applications with a wide range of requirements, including corrosion resistance, temperature, galvanic or chemical compatibility and cost. Comprehensive testing of the AlumiPlate layer has proven its efficacy in several target applications:

**Heavy Equipment:** Corrosion and environmentally assisted cracking can cause high-strength bolts, springs, and connectors to fail prematurely, in some cases catastrophically. The non-embrittling AlumiPlate aluminum coating has been tested and approved for use by major equipment builders, offering an excellent solution where superior corrosion resistance is needed.

**Marine:** Marine manufacturers are facing growing environmental pressure to reduce their usage of cadmium, which is still the standard plating material for components where corrosion resistance is critical. An excellent option is to plate such components with a thin, dense aluminum layer that is ductile and will withstand high temperatures. AlumiPlate's electroplated aluminum has been tested in chloride and sulfur dioxide-rich atmospheres, and has proven its outstanding corrosion resistance.

	AlumiPlate * Al	Cadmium	Organic Coatings	Zn Alloy Coatings	IVD Al
Nominal Recommended Thickness	0.3 mils	0.3 mils	1-2 mils	0.3 mils	0.3 mils
Salt Spray (B-117) Performance	1000+ hrs	1000 hrs	500 hrs	400-1000 hrs	500 hrs
Non-Embrittling	Yes	No	Yes	No	Yes
Fully Dense and Pore Free	Yes	Yes	Yes	Yes	No
Sacrificial Protection	Yes	Yes	Partial	Yes	Yes
No galvanic reaction with Al parts	Yes	Yes	Partial	No	Yes
Complex Geometries and ID's	Yes	No	No	Yes	No
Tightly Adhering	Yes	Yes	No	Yes	No
Environmentally Friendly	Yes	No	Yes	No	Yes
High Temp. Applicability	Up to 1000° F	Up to 500° F	Up to 500° F	Up to 500° F	Up to 1000° F
Drop-In Cad Replacement	Yes	—	No	No	No
No peening required	Yes	Yes	Yes	Yes	No
Ductile, Formable and Stampable	Yes	Partial	No	No	No
Low Process Temperature	Yes	Yes	Yes	Yes	No
Anodizeable	Yes	No	No	No	No

**Aerospace:** Both the military and the commercial aviation industry struggle to eliminate cadmium plating as required under Executive Order 12856. This order requires suppliers to find alternatives to cadmium for fasteners, electrical connectors and avionics components — all areas where electroplated aluminum offers attractive solutions. AlumiPlate addresses environmental and toxicity concerns and also reduces the risk of galvanic corrosion. In addition, critical high-strength components can benefit from AlumiPlate aluminum's reduced tendency toward hydrogen embrittlement and is excellent for use in electrical connectors where low electrical resistance is required. High-purity electroplated aluminum has also proven superior to ion vapor deposited (IVD) aluminum, with better uniformity and surface density without shot peening.

**Electroplated aluminum is available, effective, and economical**

The technology for electroplating aluminum is well established and commercially available in both the U.S. and Europe, and its availability is growing rapidly as plating costs continue to drop and capacity continues to expand. Since electroplating is now included in most industry and defense specifications calling for aluminum coatings — including Mil-DTL-83488D — electroplated high-purity aluminum offers an immediate drop-in replacement for cadmium.

*Superior performance, significant cost savings, and applicability across a wide range of products and components, make electroplated high-purity aluminum a high performance coating alternative.*