

# Electroplated High Purity Aluminum:

Provides an ideal conductive anti-corrosion coating for military and commercial aircraft electrical connectors as an alternative to cadmium.



Photo courtesy of Amphenol Corp.

Historically, finding replacement coatings for cadmium plating on electrical connectors has been difficult. Material performance requirements have been demanding and varied. Additionally, replacement candidates have been expected to be "drop-in", offering the same or better performance as cadmium with no increase in cost, no base product redesign, and no compromise in meeting the various end-use application specifications. Environmental mandates continue to drive the search for and evaluation of candidate replacement coatings.

Scores of products have been developed and tested for this difficult application, yet no single product has offered a true "drop-in" replacement for cadmium. Electroplated aluminum, however, has proven to be an attractive alternative in the most demanding commercial and military electrical connector applications. This proven environmentally friendly coating technology offers improved resistance on both metal and composite substrate connectors and meets or exceeds all relevant military specifications for aerospace environments.

To properly qualify a functional coating for electrical connectors, each of the following performance requirements must be thoroughly considered:

**Corrosion resistance**

**Conductivity**

**Durability**

**Weight**

**Conformance to military specifications**

**High temperature capability**

**Galvanic compatibility with mating materials**

**Compatibility with end use environments**

Salt

Sulfur Dioxide (SO<sub>2</sub>)

De-Icing fluid

Lightning strikes

**Electroplated aluminum meets or exceeds each of these requirements in the military and commercial aerospace industries, as indicated by the following specifications and/or test results:**

**Corrosion resistance** AlumiPlate<sup>®</sup>'s pure aluminum MIL-DTL-83488 electroplated coating exhibits superior corrosion protection when compared to cadmium and other surface finish technologies. A MIL-DTL-83488 Class 2, Type II (0.0005" min with conversion coating) coating, provides protection in excess of all MIL-DTL-38999 salt fog corrosion requirements. This plating thickness represents the typical surface finishing parameters for connector company drop-in cadmium replacement. Actual plating thickness using AlumiPlate technology for specific connector products can be fine tuned according to product dimensional requirements and specific end-use performance requirements.

# AlumiPlate

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**Conductivity** Throughout all test protocols mandated by military electrical connectors performance specifications (ASTM B117 salt fog, ASTM G85, Appendix 4 sulfur dioxide, and MIL-DTL-38999 durability), electroplated aluminum from AlumiPlate easily passes all conductivity requirements. The superior conductivity of the pure dense coating provides an excellent choice for applications that require highly conductive bonding and grounding performance. Repeated tests by connector manufacturers and independent test labs have confirmed the coating meets the most stringent requirements.

**Durability** With the application of dry film lubricant, electroplated aluminum meets or exceeds all the wear and conductivity requirements called out in MIL-DTL-38999. This specification requires demanding combination of salt fog corrosion testing and mate-and-unmate durability testing.

Parts must maintain full functionality as well as electrical conductivity within tight specifications.

**Conformance to military specifications** AlumiPlate's electroplated aluminum meets the requirements for:

- MIL-DTL-38999
- MIL-DTL-5015
- MIL-C-85049 (now AS 85049)
- MIL-DTL-83488

**High temperature tolerance** Electroplated aluminum meets the MIL-DTL-38999 temperature requirements of 175C for electrical connector applications. In other applications, electroplated aluminum performs in high temperature environments up to 500C (932F) for short exposure times. In sustained high temperature applications, the coating provides excellent long-term performance up to 330C (626F).

**Galvanic compatibility with mating materials** Many mating and mounting components in aerospace structures are comprised of aluminum. Electrical connectors that are electroplated with high purity aluminum can eliminate the possibility of galvanic corrosion at the interface of dissimilar metals in these environments. The coating is especially effective in humid, salt air environments where salt water provides an electrolyte, thereby accelerating corrosion among dissimilar metals.

**Compatibility with end use environments** Aluminum is highly electrically conductive and, as such, performs well in lightning strike tests. This excellent lightning strike performance has been achieved on electrical connectors using both metal and composite base materials.

The recent introduction of advanced pre-flight de-icing agents, based on the chemical active ingredient potassium formate, has proven to be destructive to cadmium as well as other wheel well component materials. High purity electroplated aluminum offers reliable and long lasting protection against such de-icing chemicals, extending the life of electrical connectors and lowering maintenance, replacement costs and unanticipated part failure.

Electroplated aluminum has also exceeded ASTM G85 Appendix 4 testing for sulfur dioxide exposure (well over 336 hrs). This is a qualifying test requirement for suitability of electrical connector performance for many military aircraft.

**AlumiPlate's MIL-DTL-83488 pure aluminum electroplated coating has been tested by Lockheed Martin Aeronautics Company and is being considered as the leading choice for electrical connectors for the F-35 Joint Strike Fighter program.**

	AlumiPlate® Aluminum	Cadmium	Electroless Nickel	MIL-C-5541 Class 3 Chromate	Zn/Ni/Fe Alloy Coatings	IVD Aluminum
Nominal Recommended Thickness	0.0005"	0.0005"	0.0005"	Very thin	0.0005"	0.0005"
Meets MIL-DTL-38999 Requirement - Dynamic Salt Spray with Conductivity*	1000+ hrs	Yes	Yes	98 hrs	Yes	Fails
Meets Military/Aerospace Requirement - SO <sub>2</sub> (ASTM G-85) with Conductivity**	336+ hrs	Fails	Fails	Fails	Fails	Fails
Ability to coat metal and composite connectors	Yes	Yes	Yes	No	Yes	Yes
Fully Dense and Pore Free	Yes	Yes	Yes	No	Yes	No
Sacrificial Protection	Yes	Yes	No	No	Partial	Yes
No galvanic reaction with Al parts	Yes	Yes	No	Yes	Partial	Yes
Good Coverage for Complex Electrical Connector Geometries	Yes	Yes	Yes	Yes	Yes	No
Environmentally Friendly	Yes	No	No	No	No	Yes
High Temp. Applicability	Up to 1000F	Up to 500F	Up to 500F	Up to 150F	Up to 500F	Up to 1000F
Drop-In Cad Replacement	Yes	-	No	No	No	No
Compatible with Aerospace Fluids/Oils/Chemicals/De-icing Agents	Yes	No	No	No	No	No
Ductile, Formable and Stampable	Yes	Yes	No	No	Partial	No
Low Process Temperature	Yes	Yes	Yes	Yes	Yes	No
Anodizeable	Yes	No	No	No	No	No

\*Requirements for corrosion resistance, conductivity and durability after 500 hours of testing.

\*\*Requirements for corrosion resistance, conductivity and durability after 336 hours of testing.