Armor*Galv*® Zinc/Iron Alloy Thermal Diffusion Coating

A Dream Come True for Fastener Coaters and Users?

Traditionally, fasteners were coated to provide them with corrosion resistance and proper torque tension (coefficient of friction) characteristics, while trying to avoid inducing them with the catastrophic affects of hydrogen embrittlement. Today, there is the added requirement, and challenge, that the process of coating the fasteners be environmentally friendly, and that the resulting coating itself be **non-toxic and chrome free.**

THE PROBLEM

COATING CONUNDRUMS:

- How do you coat the entire fastener while not undercoating the recesses or filling them with excessive material?
- How do you easily coat the internal threads of nuts uniformly?
- How do you coat long fasteners uniformly?
- How do you coat to whatever thickness is needed – 10 microns or 100 microns?
- How do you eliminate Hydrogen Embrittlement?

IS THE ENTIRE FASTENER *REALLY* IMPORTANT?

There are a few different methods for testing the corrosion resistance of fastener coatings depending upon their function and end use. These various methods account for different corrosive environments and conditions to which the coated fastener will be subjected, so they are, by definition, quite different from each other viz., Salt Spray, Kesternich, etc. There are, however, two important elements that all of these methods have in common.

The first, of course, is that failure occurs when base metal corrosion appears.

The second is that only "***significant***" surfaces are subject to evaluation. Surfaces that are considered not to be "significant" include:

Sharp edges

Roots of thread

Head recesses

These surfaces do not coat well by electro-plating, mechanical plating, and dip/spin methods, so there is no sense evaluating them when they cannot really be protected in the first place. But, ultimately, these surfaces ARE part of the fastener, and are, in fact, quite **significant** to the long-term survival and functioning of the fastener.

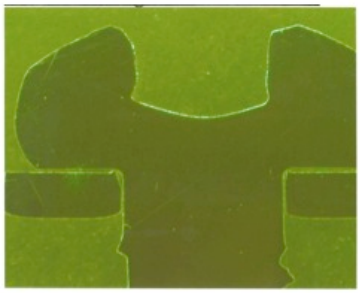
THE SOLUTION

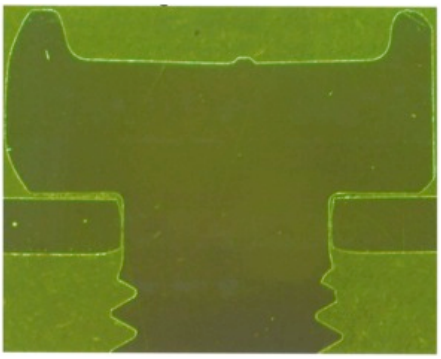
Armor*Galv*® THERMAL DIFFUSION (HUH?)

An English metallurgist named Sherard Cowper-Coles invented **Thermal Diffusion** in 1904. He discovered that by heating a special blend of dry zinc dust with steel parts in a closed cylinder to a temperature of at least 650 degrees F resulted in a uniform corrosion resistant **zinc/iron alloy** coating.

This process has been used in England ever since then under the name of **Sherardizing**, which has been applied by Bodycote, Int'l. Recently, advances have been made in this technology to improve its efficiency and reproducibility, and it is now available in the United States under the trade name of Armor*Galv*®.

Below is a picture of fasteners with a captive washer that were coated with Armor*Galv*® by Chem-Plate Industries, in Elk Grove Village, IL.





Notice that the Armor*Galv*® coating is extremely uniform, obviating the need to designate portions of a fastener as "insignificant". The WHOLE fastener is significant – and coated! Salt spray results of greater than 1,000 hours are common.

CAN Armor*Galv*® REPLACE CADMIUM?

Ever since 1971 when the Japanese court found the Mitsui Mining and Smelting Company guilty of causing a severe outbreak of "Itai Itai" disease, better known as cadmium poisoning, cadmium has been virtually banned the world over.

The main benefits of cadmium were its anti-galling properties, and its ability to not "seize" in the presence of its own corrosion products due to its inherent lubricity properties.

A stainless steel screw, when cadmium plated, could easily be driven without galling.

A cadmium-plated bolt could usually be unscrewed after years of service, whereas zinc plated bolts totally seize up and have to be cut or torched for removal.

Stainless steel fasteners coated with Armor***Galv***® exhibit the same ability to drive as do cadmium plated ones, and Armor***Galv***® nut/bolt assemblies are easily unscrewed even after being subjected to 1,000 hours of salt spray.

WILL Armor*Galv*® INDUCE HYDROGEN EMBRITTLEMENT TO HEAT TREATED FASTENERS?

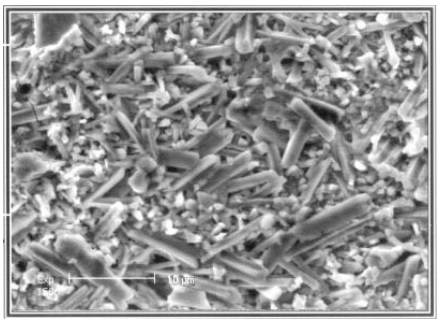
Absolutely not! Fasteners are coated using temperatures of, at least, 650 degrees F for over 90 minutes in a completely *dry* environment. At this time and temperature matrix, there is no chance of inducing hydrogen embrittlement, and would even relieve any residual stresses that might already be present in the fastener due to other factors. This is verified in **ASTM 1059 A/M.**

WILL THE Armor*Galv*® COATING STICK TO FASTENERS?

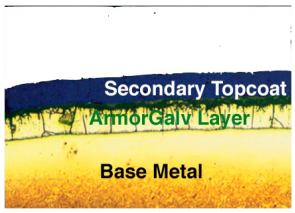
The Armor***Galv***® coating actually becomes *part of the surface* of the fastener! It not only coats, it penetrates (diffuses) into the surface. The result is a hard (38-42 Rc) super *abrasion resistant* coating that cannot easily be removed by mechanical means.

WILL TOPCOATS ADHERE TO Armor*Galv*®?

Let me start by saying that Armor***Galv***® is NOT pure zinc. It is, in fact, layers (phases) of zinc/iron alloy. The automotive industry has been using a form of this type of "galvanizing" for body sheet metal that will be painted because of its proven superior adhesion to paints characteristic. It is known as "Galvanneal", which results in better paint adhesion ***and*** corrosion resistance. Armor***Galv***®'s surface is not smooth like that of bright electroplated zinc, but is rather "geographic". This is demonstrated in the following photo:



This surface results in superior adhesion of paint, silicates or Xylan to the surface. This is why **Bodycote, Int'l** of England uses Armor***Galv***® as a base for Xylan that is used in offshore oil well applications for **BP**, and other topcoats under the tradename of "**Sheraplex**". When Armor***Galv***® is followed by a paint, it is designated as Armor***PLEX***™.



Armor***PLEX***™

YEAH, BUT CAN Armor***Galv***® **REALLY *TAKE* THE HEAT?**

The Armor***Galv***® coating has great heat resistance. Unlike any other zinc based coating, this coating can withstand continuous service of 650 degrees C.

HOW ENVIRONMENTALLY FRIENDLY IS Armor***Galv***®**?**

The Armor***Galv***® **Thermal Diffusion** process generates practically **zero** landfill material, uses **hardly any water** and results in a **chrome free non-toxic** coating. This could make Armor***Galv***® an attractive addition to a fastener manufacturing operation.

In 2006 the US EPA awarded the Armor***Galv***® process its prestigious MVP[2] Award – The most valuable new technology award.[1]

IS THERE A SPECIFICATION COVERING Armor***Galv***® **COATING?**

The Armor***Galv***® coating is covered by the just issued **ASTM 1059 A / M Standard.**

HEY, HOW MANY PEOPLE ACTUALLY APPLY Armor***Galv***®**?**

There are currently about forty Armor***Galv***® installations around the world. They range from construction fastener manufacturers to coaters of 40-foot long oil well sucker tubes.

OK – BUT IS THE Armor***Galv***® **COATING COST COMPETITIVE?**

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[1] See David Ferguson of US EPA: Clean Tech Environ Policy (2006) "Approaching Zero Discharge" DOI 10.1007/s10098-006-0045-8

The Armor***Galv***® process requires a very small investment in pollution control equipment and costs. The Armor***Galv***® process is also extremely efficient in its use of zinc and requires practically no water. These factors combine to make Armor***Galv***® very cost competitive with other high corrosion resistant zinc alloy processes.

Any more questions? If so, then, please contact us and we will reply right away.

Please look at the Comparison Chart on the next page.

COMPARISON COATING CHART

Coating	Thickness Range	Corrosion Resistance	Uniform	H_2 Embrittlement	Recess Fill	Paint & Rubber Bonding	Weldable	Galling	Heat Resistant	Abrasion Resistant	Coat S/S	Hard
Hot Dip	0.001-0.002	Moderate	Poor	Yes	Yes	Very Poor	No	Yes	No	Poor	No	No
Mechanical Plating	0.0001-0.003	Moderate	Poor	No	Yes Glass Beads	Poor	No	Yes	No	Poor	No	No
Dip/Spin	0.00075-0.001	Moderate	Poor	No	Yes	Good	No	Yes	No	Very Poor	No	No
Electro-Plating	0.0001-0.0005	Moderate to Good for Alloys	Very Poor	Yes	No	Moderate	No	Yes	No	Poor	No	No
Armor*Galv* Thermal Diffusion	**0.0005-0.006**	**Excellent**	**Excellent**	**No**	**No**	**Excellent**	**Yes**	**No**	**Yes To 1,000F**	**Excellent**	**Yes**	**Yes 38/42 Rc**