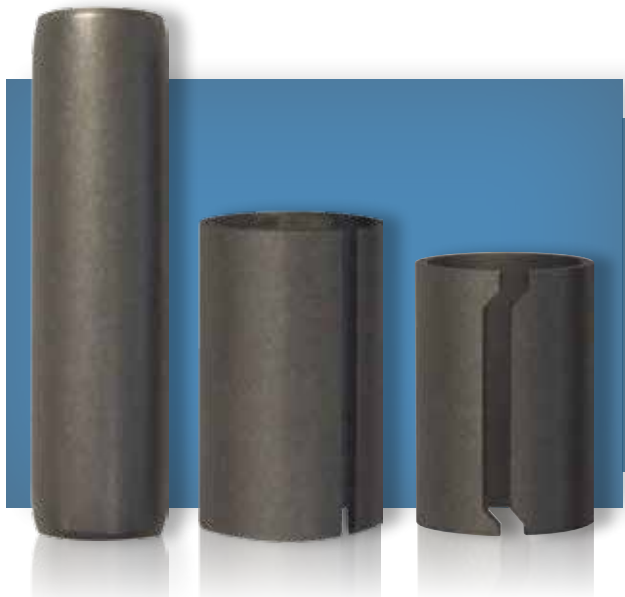


SPIROL®

WHITE PAPER

Features and Benefits of ArmorGalv® Thermal Zinc Diffusion

by Michael J. Pasko, Applications Engineer
SPIROL International Corporation



ArmorGalv® Thermal Diffusion

1,000+ HOURS

corrosion resistance

Thermal Diffused Zinc, a finishing process historically known as Sherardizing, has been used for corrosion protection of metal parts for over a century. Over the years, improvements have been made to the Sherardizing zinc/iron diffusion process. The modern, greatly improved process, known as **ArmorGalv®** is now being introduced to the fastener industry by **SPIROL**, and is poised to revolutionize the market. ArmorGalv® is anodic to steel and as such, provides long term sacrificial galvanic protection. Unlike traditional electroplating there is no risk of hydrogen embrittlement, adhesion is superior, coating thickness uniform, and all surfaces are covered. **There are no insignificant surfaces.** The affordability, durability, and low environmental impact of ArmorGalv® makes it ideal for today's market.

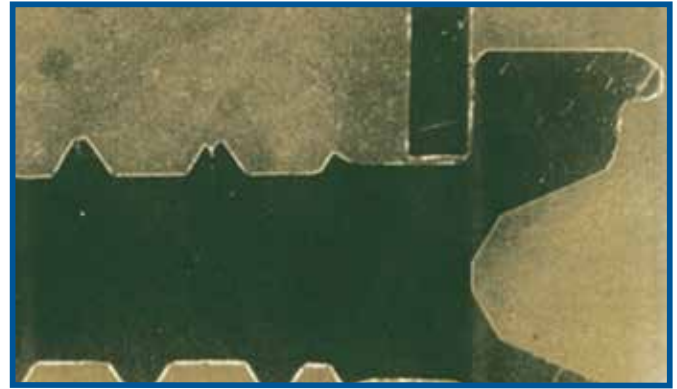
ArmorGalv® is a zinc alloy thermal diffusion coating, and is covered by ASTM A1059M-08(2013). This process requires a closed container, heated to a minimum 343°C (650°F), with a powdered zinc mixture. At this temperature sublimation of the zinc mixture occurs and it is dispersed into the container as a vapor. Being soluble in iron, the zinc vapor subsequently diffuses into the surface of ferrous parts. Volume of the zinc mixture is calculated based upon total surface area of the parts resulting in excellent control of resultant thickness with near total consumption of the zinc powder. After the diffusion, specially designed topcoats and sealers are applied to complete the finish. The United States Environmental Protection Agency has stated this finish approaches zero emissions and it has received recognition and awards for its contribution to pollution prevention. There is no hazardous chemistry and water consumption is extremely low. In addition to these benefits, ArmorGalv® exceeds the performance benchmarks of many competing solutions.

SPIROL recommends ArmorGalv® coating as an alternative to traditional platings and coatings for many reasons; chief among them product quality, maximum corrosion protection/performance, cost effectiveness, and environmental stewardship. Primary benefits of ArmorGalv® are:

	1,000 hours or greater corrosion resistance of time to red rust (base metal attack)
	ZERO risk of hydrogen embrittlement
	Will not reduce fatigue strength of material (applicable to all alloys including stainless)
	Uniform deposition of coating on all surfaces (No insignificant surfaces). All internal features or ØID's receive full coating and protection
	Cost effective
	Anti-galling characteristics similar to cadmium (may be applied to stainless steel)
	No flaking, peeling, or blistering – approximately 1/3 of finish thickness is diffused into the coated surface effectively becoming part of the component
	Hard and highly abrasion resistant @ 37-42 HRC
	Slightly porous surface will retain paint and other coatings in the event complete pinned assembly requires subsequent painting, powder coating, etc.

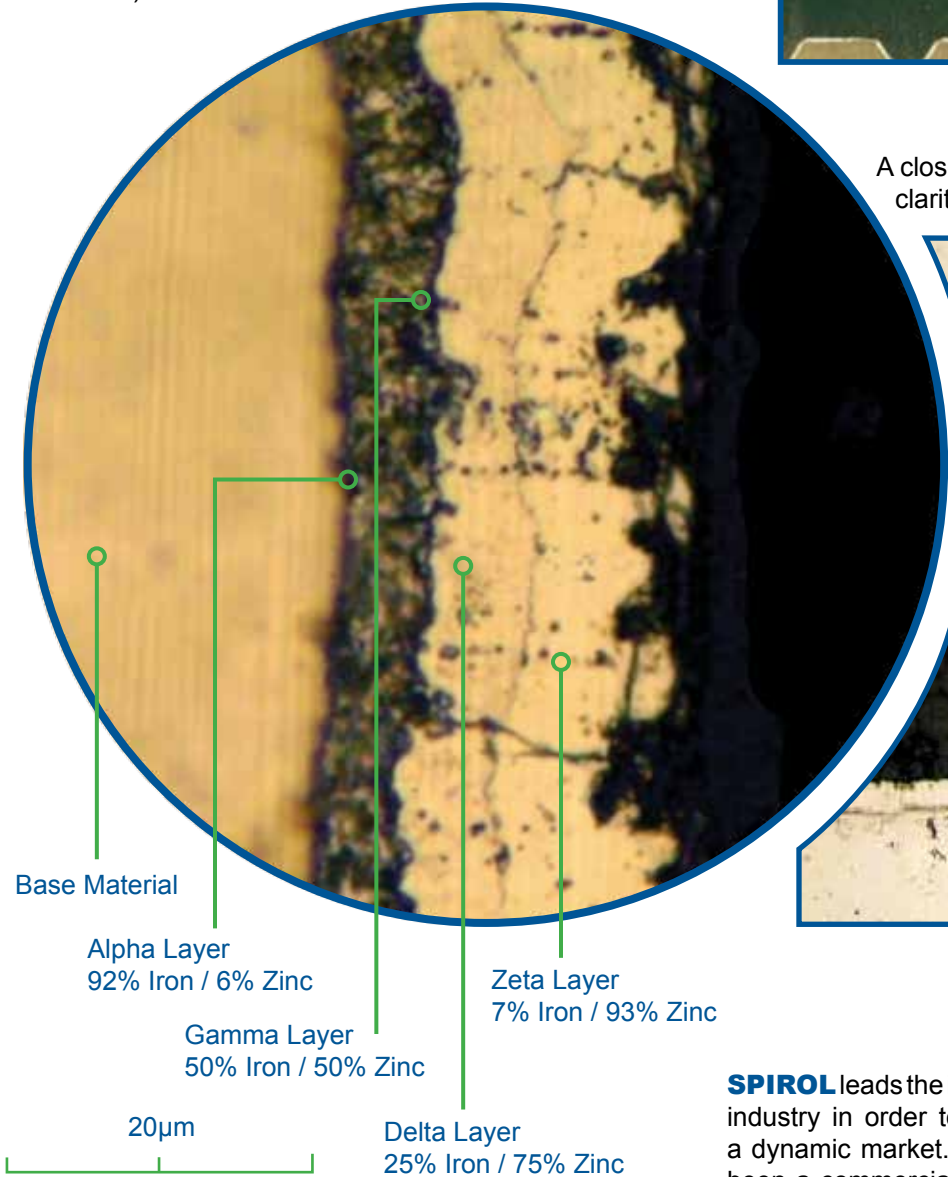
ArmorGalv® offers a low risk, cost effective, high performance alternative to many of today's platings and coatings. With ever-increasing performance and life cycle requirements, this coating is an ideal solution for fasteners used in some of the most aggressive environments such as marine, automotive, mining, and industrial manufacturing. The following photographs provide visual representation of this coatings effectiveness.

Uniformity of deposition is visible in the following photographs. Note coverage of all surfaces including peaks, valleys, corners, and gaps:



Fastener and washer with ArmorGalv® coating.

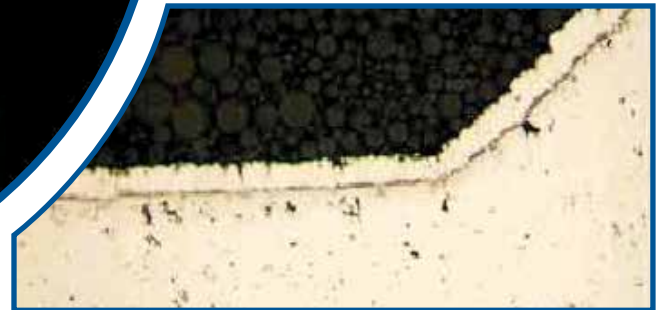
The image below demonstrates the layered structure of ArmorGalv®. Maximum percentages of zinc occur at the surface with the percent iron increasing with depth (20 microns average coating thickness is applied to SPIROL fasteners):



A closer cross-section with thicker deposition for clarity in the two images below:



Powder Metal Parts Before ArmorGalv®



Powder Metal Parts After ArmorGalv®
(100 microns / 4mils)

SPIROL leads the innovation of new technologies in the fastener industry in order to meet the ever-changing requirements of a dynamic market. Until now, Thermal Diffused Zinc had not been a commercially viable option for small components. By leveraging its 68+ years of engineering ingenuity, developing the associated process, and investing in the necessary equipment, SPIROL is able to bring this superior coating to the fastener market at a cost effective price. As stated by SPIROL's Marketing Manager, Christie Jones, "ArmorGalv® is a game-changer in the fastener industry, and SPIROL is proud to be at the forefront of bringing this technology to the market."

Contact SPIROL today for more information about ArmorGalv®!

SPIROL® Innovative fastening solutions. Lower assembly costs.



Technical Centers

Americas

SPIROL International Corporation
30 Rock Avenue
Danielson, Connecticut 06239 U.S.A.
Tel. +1 860 774 8571
Fax. +1 860 774 2048

SPIROL Shim Division
321 Remington Road
Stow, Ohio 44224 U.S.A.
Tel. +1 330 920 3655
Fax. +1 330 920 3659

SPIROL West
1950 Compton Avenue, Suite 112
Corona, California 92881 U.S.A.
Tel. +1 951 273 5900
Fax. +1 951 273 5907

SPIROL Canada
3103 St. Etienne Boulevard
Windsor, Ontario N8W 5B1 Canada
Tel. +1 519 974 3334
Fax. +1 519 974 6550

SPIROL Mexico
Carretera a Laredo KM 16.5 Interior E
Col. Moisés Saenz
Apodaca, N.L. 66613 Mexico
Tel. +52 81 8385 4390
Fax. +52 81 8385 4391

SPIROL Brazil
Rua Mafalda Barnabé Soliane, 134
Comercial Vitória Martini, Distrito Industrial
CEP 13347-610, Indaiatuba, SP, Brazil
Tel. +55 19 3936 2701
Fax. +55 19 3936 7121

Europe

SPIROL France
Cité de l'Automobile ZAC Croix Blandin
18 Rue Léna Bernstein
51100 Reims, France
Tel. +33 3 26 36 31 42
Fax. +33 3 26 09 19 76

SPIROL United Kingdom
17 Princewood Road
Corby, Northants
NN17 4ET United Kingdom
Tel. +44 1536 444800
Fax. +44 1536 203415

SPIROL Germany
Ottostr. 4
80333 Munich, Germany
Tel. +49 89 4 111 905 71
Fax. +49 89 4 111 905 72

SPIROL Spain
08940 Cornellà de Llobregat
Barcelona, Spain
Tel. +34 93 193 05 32
Fax. +34 93 193 25 43

SPIROL Czech Republic
Sokola Tůmy 743/16
Ostrava-Mariánské Hory 70900
Czech Republic
Tel/Fax. +420 417 537 979

SPIROL Poland
ul. M. Skłodowskiej-Curie 7E / 2
56-400, Oleśnica, Poland
Tel. +48 71 399 44 55

Asia Pacific

SPIROL Asia Headquarters
1st Floor, Building 22, Plot D9, District D
No. 122 HeDan Road
Wai Gao Qiao Free Trade Zone
Shanghai, China 200131
Tel. +86 21 5046 1451
Fax. +86 21 5046 1540

SPIROL Korea
160-5 Seokchon-Dong
Songpa-gu, Seoul, 138-844, Korea
Tel. +86 (0) 21 5046-1451
Fax. +86 (0) 21 5046-1540

e-mail: info@spirol.com

Please refer to www.SPIROL.com for current specifications and standard product offerings.

SPIROL Application Engineers will review your application needs and work with you to recommend the optimum solution. One way to start the process is to visit our **Optimal Application Engineering** portal at **SPIROL.com**.