



## QUALITY IS MORE THAN SKIN DEEP

Thermal Diffusion Zinc (**TDZ**), as covered by the ASTM 1059 A/M SPEC, is fast becoming a popular and sought after coating. The reason is that **TDZ** offers exceptional corrosion resistance, freedom from Hydrogen Embrittlement, high strength to resist coating damage, and much, much more.

However, people are not yet familiar with what **TDZ** is really all about or why it protects against corrosion and resists being damaged as well as it does. In brief, it is a zinc/iron coating applied in a dry state to form three distinct phase layers of a zinc/iron alloy on any steel/iron parts. **The quality and integrity of these layers are primarily responsible for its high corrosion resistant and strength qualities.**

As with **all metal coatings**, there are two tests to determine the quality of the coating. The first, is looking at its appearance – is it uniform, adherent, free of blisters and surface imperfections, etc.?

The second is testing the coating's thickness with readily available thickness testing devices.

Although this holds true for the **TDZ** coating as well, it does **NOT** paint the full picture: there are those **phase layers** discussed earlier that also need to be considered and evaluated. In order to produce a consistently high quality **TDZ** coatings in bulk, the technology must be robust and "foolproof"! Thickness and appearance of the coating are important, but.....**Quality is More Than Skin Deep**. To verify the quality of a **TDZ** coating, we must look below the surface and observe the phase layers obtained. These phase layers should be uniform, consistent, continuous and strong enough to withstand the cross sectioning procedure.

After ten years and thousands of tons of **TDZ** coated parts produced, **CPI** has been consistently producing high quality **TDZ** coatings using the **ArmorGalv®** process licensed from Distek NA.

Currently, there are a few choices of obtaining a product coated with TDZ.

The question is: **Are they equivalent?**

Any

**TDZ** coating can be verified by testing in a salt spray chamber. After all, that's what it's all about, isn't it? Unfortunately, waiting for the 3,000 and 5,000 hours of the salt spray claimed takes three and seven months respectively; a long time to wait. However, **CPI** and the other licensed coaters of **ArmorGalv®** have been in business for long enough to have reliable salt spray data based on continuous process verification testing, removing the need to wait months for test results.



How can one predict whether a **TDZ** coated part is likely to provide these long salt results without having to wait that for that long? - **CROSS SECTION**

By performing a cross section on a production coated part, the quality of these important phase layers can be readily observed and evaluated.

At **CPI**, and other licensees, cross sectioning of parts coated with **ArmorGalv®** is regularly performed to verify that the production parameters are correct and that the equipment is, indeed, operating at peak performance.

Now that we've covered what to look for to evaluate the quality **TDZ** coatings, we can circle back to the original question - are **ArmorGalv®** and BRAND "X" **TDZ** equivalent?

We will let YOU be the judge of that!

**CPI** has obtained a quantity of **production** BRAND "X" coated **A325 TC** bolt sets on the open market.



The coating “looks good” uniform with full coverage, and magnetic thickness testing indicates a  $30\mu$  result. But predicting how well this coating will actually perform can only be definitively ascertained by peering into what lurks below the surface, a skill a met lab technician only shares with Superman.

**CPI** conducted a certified side by side comparison laboratory report that clearly reveals the inherent differences between **ArmorGalv®** and BRAND "X" production coated **A325 TC BOLTS**, and not of the “Laboratory Queens” so often provided by suppliers. Your own testing should reveal similare results.

In addition, **CPI** provides, at no cost, up to 250# of samples of **ArmorGalv®** on parts sent in by customers for evaluation, produced on a 1/3 full production capacity **ArmorGalv®** coating machine.



## WHAT A GOOD QUALITY TDZ COATING LOOKS LIKE

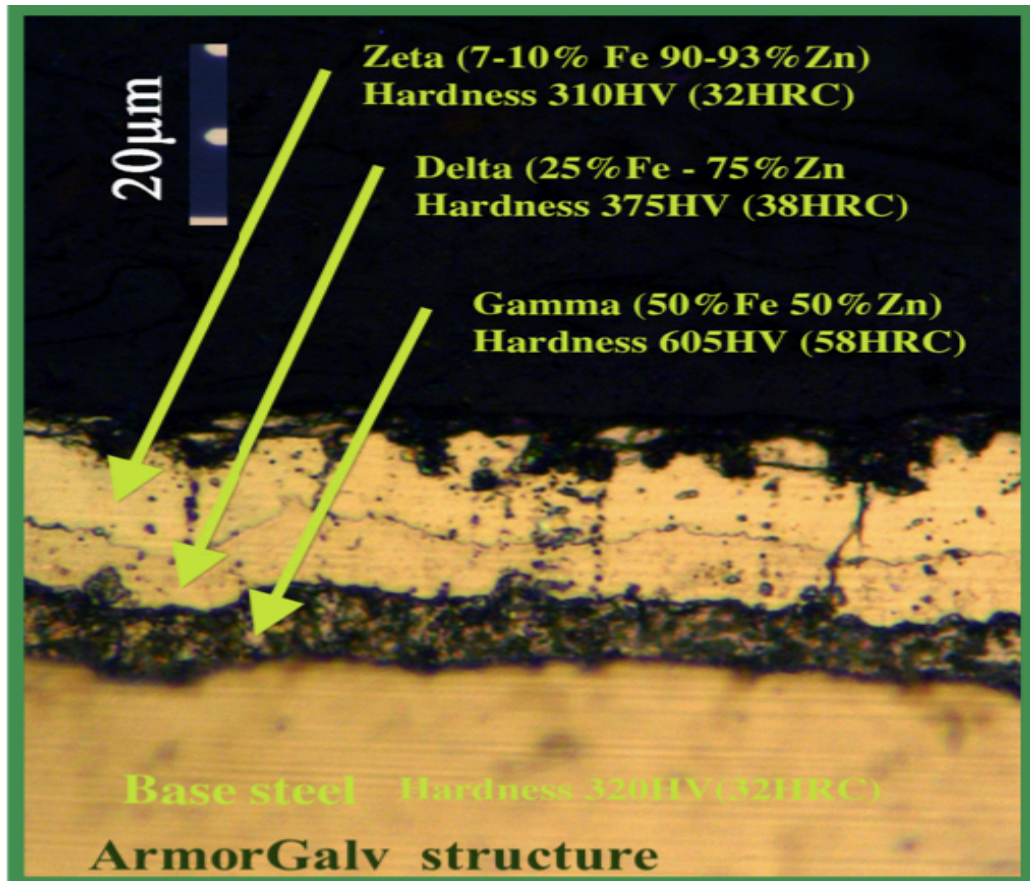
When ascertaining whether a part has been properly Thermally Diffused a quick method of determining the quality of the coating is by Cross Section Analyses.

Thermal Diffusion is deposited in three distinct zinc/iron phase layers. There should be no discontinuities (Holidays )in the coating and the overall thickness should be uniform.

The layer phases are, from the base metal outward:

- 1) Gamma - 50/50 zinc/iron very dense and hard (Rc 65)
- 2) Delta - 25/75 zinc/iron dense (Rc 40)
- 3) Zeta. - 10/90 zinc/iron; microporous layer that absorbs passivates and top-coats.

## WHAT A GOOD QUALITY COATING LOOKS LIKE:



IATF 16949 2016 APPROVED A2LA Laboratory Cert#: 940-01

1800 Touhy Avenue • Elk Grove Village, IL 60007 • Telephone: 847/640-1600 • Facsimile: 847/640-1699



Cert No. 0940.01

**LABORATORY REPORT**

Date:  Test Date:  Test Type:  W:  R:

Customer:  CPI Job#:  Specification:

PO#:  Part:  Process:

**DESCRIPTION:**

A production sample of an **A325 TC BOLT SET** that was coated with 30 $\mu$  Brand "X" TDZ was cross sectioned to evaluate the quality of the phase layers. Alongside, are the cross sections performed at the same relative locations of an **Armorgalv®** coated **A325 TC BOLT SET**.

Report By:

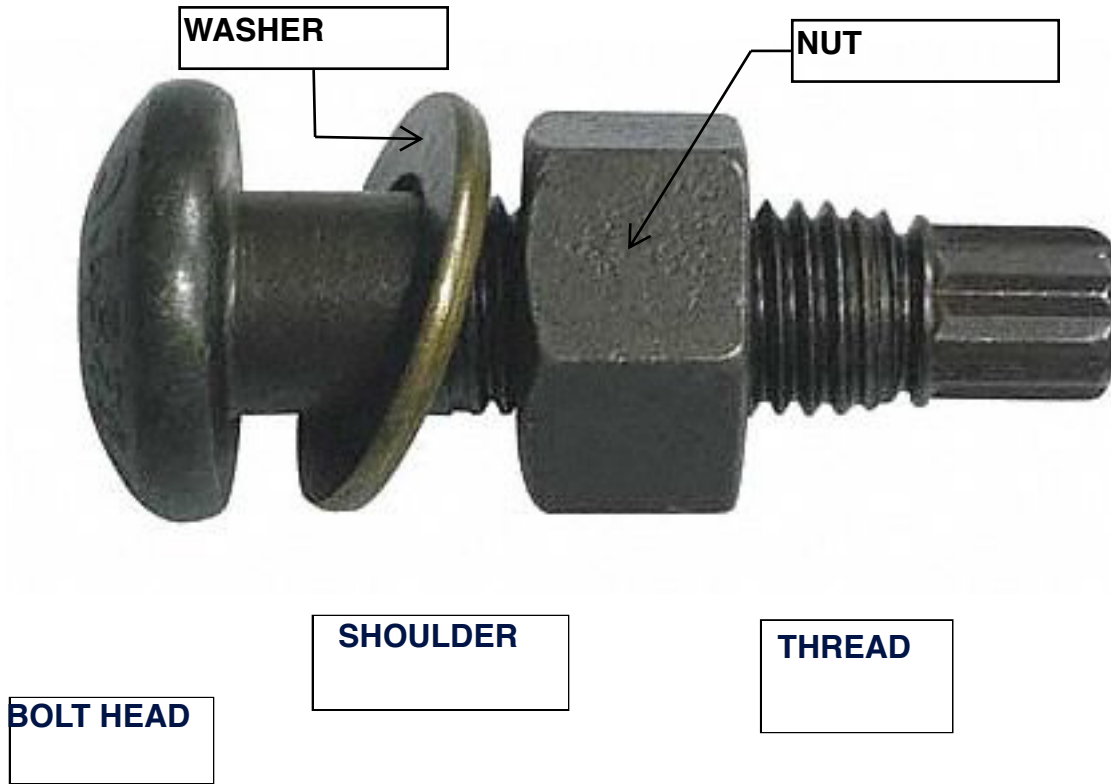


**IATF 16949 2016 APPROVED**

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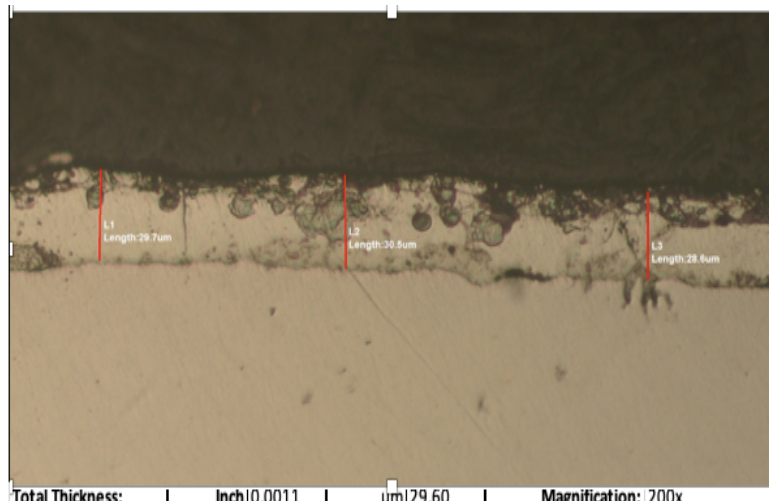
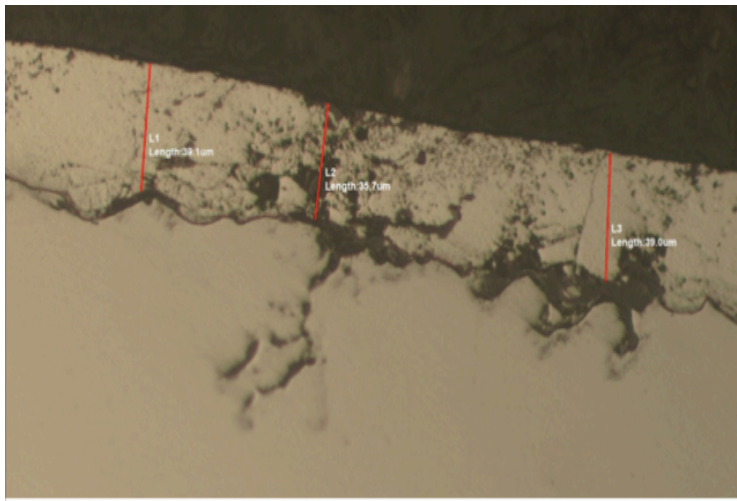
**WHERE CROSS SECTIONS WERE PERFORMED ON THE TDZ COATED BOLTS:**



**BOLT HEAD:**

**BRAND "X" TDZ**

**ArmorGalv®**

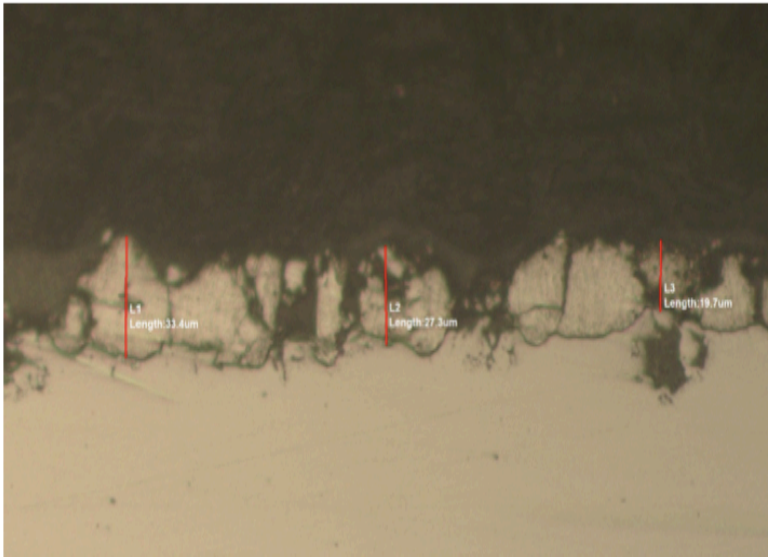


<b>Total Thickness:</b>	<b>Inch</b>   0.0011	<b>µm</b>   29.60	<b>Magnification:</b> 200x
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**TOTAL THICKNESS: 0.0015". µm: 37.90 magnification: 200X**

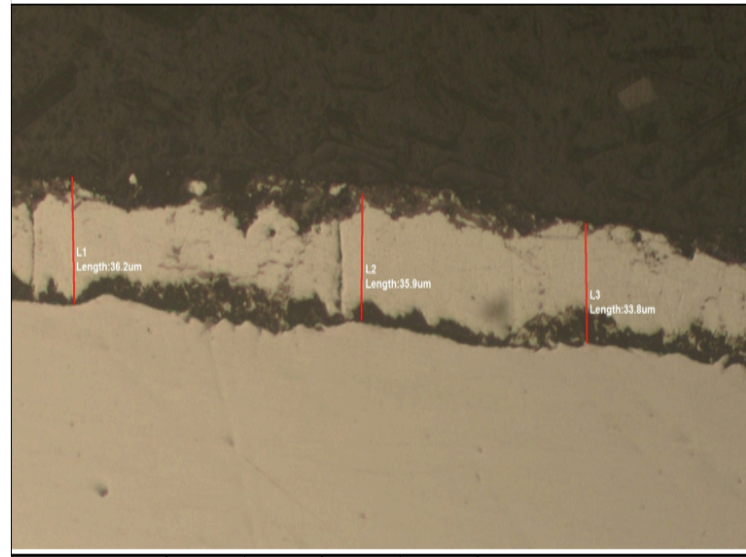
**BOLT SHOULDER:**

**BRAND "X" TDZ**



TOTAL THICKNESS: 0.0016"  $\mu\text{m}$ : 26.8 magnification: 200X

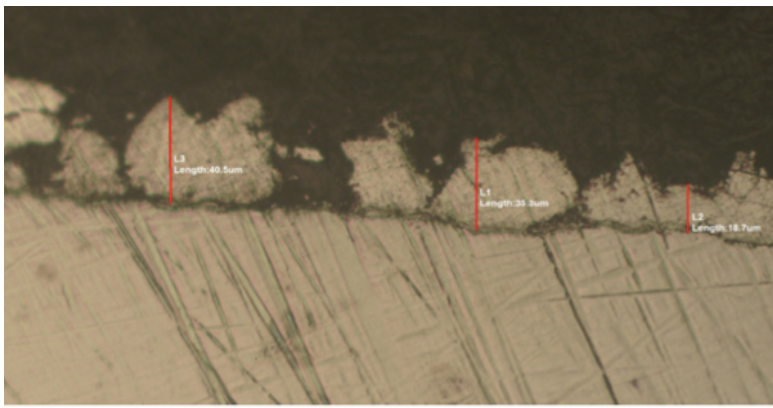
**ArmorGalv®**



Total Thickness:	Inch	0.0013	$\mu\text{m}$	35.30	Magnification:	200X
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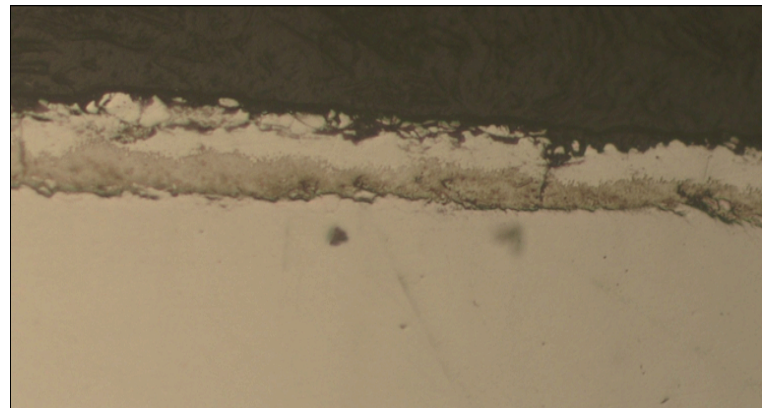
**BOLT THREAD:**

**BRAND "X" TDZ**



Total Thickness:	Inch	n/a	$\mu\text{m}$	31.50	Magnification:	200X
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**ArmorGalv®**



Total Thickness:	Inch	0.0012	$\mu\text{m}$	30.50	Magnification:	200X
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**NOTE:**

The uniformity of the thickness of the **TDZ** coating on the **BRAND "X"** coated bolt varies by  $11.1 \mu$  or 30% on the same part.

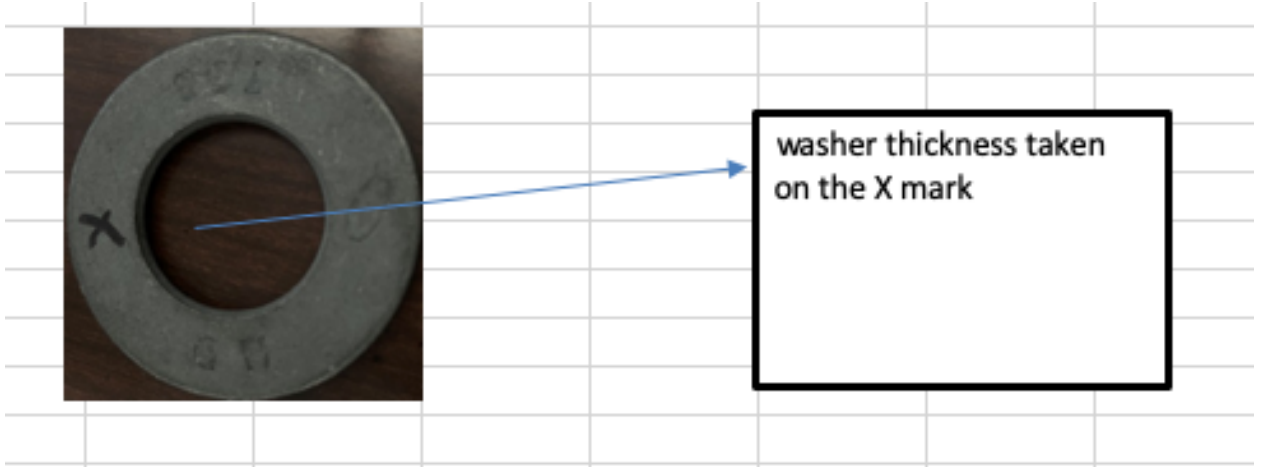
The uniformity of the **ArmorGalv® coated bolt** varies by  $5.7\mu$  or 16%.

Both the quality of the phases and the thickness uniformity of the **ArmorGalv®** coating are quite superior to that of the **BRAND "X"** coating.

The **BRAND "X"** TDZ coating is broken up, with large enough gaps to create potential corrosion issues.

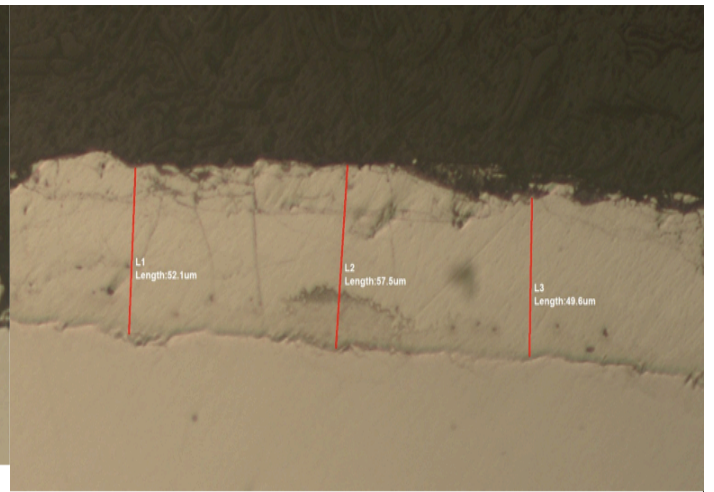
The **BRAND "X"** TDZ coating seems to lack a meaningful Gamma layer, which points to a deficiency with the actual diffusion process. We highly recommend that you perform your own comparison cross sections to verify these findings.

# F436 WASHER



WASHER: BRAND "X" TDZ

ArmorGalv®



TOTAL THICKNESS: 0.0009"  $\mu$ m: 22.6 magnification: 200X

Total Thickness:	Inch	0.002	$\mu$ m	53.00	Magnification:	200X
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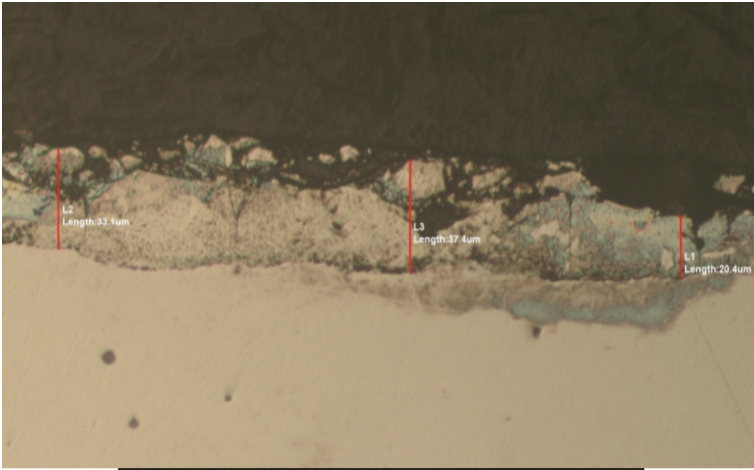


NUT READING AT "X"

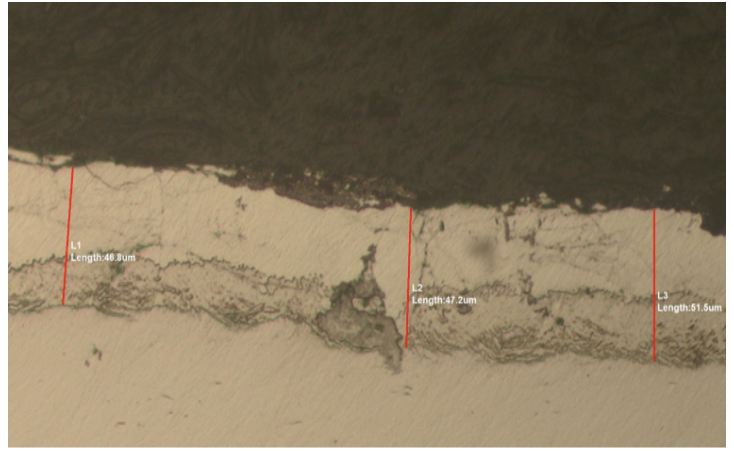
NUT:

BRAND X TDZ

ArmorGalv®



TOTAL THICKNESS: 0.0012" 30.30 magnification 200x



Total Thickness:	Inch	0.0019	µm	48.50	Magnification:	200X
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It is evident from the above comparison information that the production quality of the **ARMORGALV®** brand of TDZ coating and that of the **BRAND "X"** TDZ are not all equivalent!

**QUALITY IS MORE THAN SKIN DEEP™**





SCOPE OF ACCREDITATION TO ISO/IEC 17025 :2005

CHEM-PLATE INDUSTRIES, INC.<sup>1</sup>  
1800 Touhy Avenue  
Elk Grove Village, IL 60007  
Virginia Gibbs Phone: 847 473 4793

MECHANICAL

Valid To: October 31, 2019

Certificate Number: 0940.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory at the location listed above as well as the two satellite laboratory locations listed below to perform the following test on fasteners:

**Test**

**Test Method(s)**

Rockwell Hardness (A, BW, C, 15N, 30N)

ASTM E18, F606/F606M;  
GM 6010M (Section 3.1) (*superseded*)<sup>2</sup>;  
GM 6170M (Section 3.1) (*superseded*)<sup>2</sup>;  
GM 6171M (Section 3.1) (*superseded*)<sup>2</sup>;  
ISO 898-1 (Section 9.9);  
ISO 2702 (Section 4.1.3)

Microhardness (Knoop 500 gf, Vickers 300 gf)

ASTM E384;  
GM 6010M (Section 3.2) (*superseded*)<sup>2</sup>;  
GM 6170M (Section 3.2) (*superseded*)<sup>2</sup>;  
GM 6171M (Section 3.2) (*superseded*)<sup>2</sup>;  
SAE J419;  
ISO 898-1 (Section 9.11);  
ISO 2702 (Section 4.1.1)

Torsional Strength

GM 6010M (Section 3.5) (*superseded*)<sup>2</sup>;  
GM 6170M (Section 3.5) (*superseded*)<sup>2</sup>;  
GM 6171M (Section 3.6) (*superseded*)<sup>2</sup>;  
ISO 2702 (Section 4.1.3)

Case Depth (Traverse and Visual)

GM 6010M (Section 3.3) (*superseded*)<sup>2</sup>;  
GM 6170M (Section 3.3) (*superseded*)<sup>2</sup>;  
GM 6171M (Section 3.6) (*superseded*)<sup>2</sup>;  
SAE J423;  
ISO 2702 (Section 4.1.2)

Decarburization

ASTM F2328, F2328M;  
SAE J121 (*superseded*)<sup>2</sup>;  
SAE J121M (*superseded*)<sup>2</sup>, SAE J419;  
ISO 898-1 (Section 9.10)

(A2LA Cert. No. 0940.01) 12/13/2017

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**Test**

**Test Method(s)**

Wedge Tensile

ASTM F606/F606M;  
ISO 898-1;  
SAE J429<sup>3</sup>;  
GM 6170M (Section 3.5) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.5) (*superseded*)<sup>2</sup>

Axial Tensile

ASTM F606/F606M;  
ISO 898-1;  
SAE J429<sup>3</sup>

Ductility

GM 6010M (Section 3.7) (*superseded*)<sup>2</sup>,  
GM 6170M (Section 3.8) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.8) (*superseded*)<sup>2</sup>

<sup>1</sup> This accreditation covers testing performed at the main laboratory listed above, and the satellite laboratories listed on the following pages.

<sup>2</sup> This laboratory's scope contains withdrawn or superseded methods. As a clarifier, this indicates that the applicable method itself has been withdrawn or is now considered "historical" and not that the laboratory's accreditation for the method has been withdrawn.

<sup>3</sup> The laboratory is accredited for the test methods listed above. The accredited test methods are used in determining compliance with the material specifications listed; however, the inclusion of these material specifications on this Scope does not confer laboratory accreditation to the material specifications. Inclusion of these material specifications on this Scope also does not confer accreditation for every method embedded within the specification. Only the methods listed above on this Scope are accredited."

CHEM-PLATE INDUSTRIES, INC.  
1990 East Devon Avenue  
Elk Grove Village, IL 60007

<u>Test</u>	<u>Test Method(s)</u>
Rockwell Hardness (A, BW, C, 15N, 30N)	ASTM E18, F606/F606M; GM 6010M (Section 3.1) ( <i>superseded</i> ) <sup>2</sup> ; GM 6170M (Section 3.1) ( <i>superseded</i> ) <sup>2</sup> ; GM 6171M (Section 3.1) ( <i>superseded</i> ) <sup>2</sup> ; ISO 898-1 (Section 9.9); ISO 2702 (Section 4.1.3)
Microhardness (Knoop 500 gf)	ASTM E384; GM 6010M (Section 3.2) ( <i>superseded</i> ) <sup>2</sup> ; GM 6170M (Section 3.2) ( <i>superseded</i> ) <sup>2</sup> ; GM 6171M (Section 3.2) ( <i>superseded</i> ) <sup>2</sup> ; SAE J419; ISO 898-1 (Section 9.11); ISO 2702 (Section 4.1.1)
Neutral Salt Spray	ASTM B117; ISO 9227; SAE/USCAR-1
Measurement of Coating Thickness Eddy Current / Magnetic X-Ray	ASTM B499, B568, E376
Coating Weight	QP-DZ-01 (NOF Metal Coatings)
Adhesion	ISO 2819
Hydrogen Embrittlement (Threaded Parts)	GM 6010M (Section 4.7) ( <i>superseded</i> ) <sup>2</sup> ; GM 6170M (Section 3.9) ( <i>superseded</i> ) <sup>2</sup> ; GM 6171M (Section 3.9) ( <i>superseded</i> ) <sup>2</sup> ; USCAR-7
Torsional Strength	GM 6010M (Section 3.5) ( <i>superseded</i> ) <sup>2</sup> ; GM 6170M (Section 3.6) ( <i>superseded</i> ) <sup>2</sup> ; GM 6171M (Section 3.6) ( <i>superseded</i> ) <sup>2</sup> ; ISO 898-1 (Section 9.13); ISO 2702 (Section 4.2.2)
Case Depth (Traverse and Visual)	GM 6010M (Section 3.3) ( <i>superseded</i> ) <sup>2</sup> ; GM 6170M (Section 3.3) ( <i>superseded</i> ) <sup>2</sup> ; GM 6171M (Section 3.6) ( <i>superseded</i> ) <sup>2</sup> ; SAE J423; ISO 2702 (Section 4.1.2)

**Test****Test Method(s)**

Decarburization

ASTM F2328, F2328M;  
SAE J121 (*superseded*)<sup>2</sup>,  
SAE J121M (*superseded*)<sup>2</sup>, SAE J419;  
ISO 898-1 (Section 9.10)

Ductility

GM 6010M (Section 3.7) (*superseded*)<sup>2</sup>,  
GM 6170M (Section 3.8) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.8) (*superseded*)<sup>2</sup>CHEM-PLATE INDUSTRIES, INC.  
1250 Morse Avenue  
Elk Grove Village, IL 60007**Test****Test Method(s)**

Rockwell Hardness (A, BW, C, 15N)

ASTM E18, F606/F606M;  
GM 6010M (Section 3.1) (*superseded*)<sup>2</sup>,  
GM 6170M (Section 3.1) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.1) (*superseded*)<sup>2</sup>;  
ISO 898-1 (Section 9.11);  
ISO 2702 (Section 4.1.3)

Microhardness (Vickers 300 gf)

ASTM E384;  
GM 6010M (Section 3.2) (*superseded*)<sup>2</sup>,  
GM 6170M (Section 3.2) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.2) (*superseded*)<sup>2</sup>;  
SAE J419;  
ISO 898-1 (Section 9.11);  
ISO 2702 (Section 4.1.1)

Neutral Salt Spray

ASTM B117;  
ISO 9227;  
SAE/USCAR-1Measurement of Coating Thickness  
Eddy Current / Magnetic X-Ray

ASTM B499, B568, E376

Torsional Strength

GM 6010M (Section 3.5) (*superseded*)<sup>2</sup>,  
GM 6170M (Section 3.6) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.6) (*superseded*)<sup>2</sup>

**Test**

**Test Method(s)**

Case Depth (Traverse and Visual)

GM 6010M (Section 3.3) (*superseded*)<sup>2</sup>,  
GM 6170M (Section 3.3) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.6) (*superseded*)<sup>2</sup>;  
SAE J423;  
ISO 2702 (Section 4.1.2)

Decarburization

ASTM F2328, F2328M;  
SAE J121 (*superseded*)<sup>2</sup>,  
SAE J121M (*superseded*)<sup>1</sup>, SAE J419;  
ISO 898-1 (Section 9.10)

Ductility

GM 6010M (Section 3.7) (*superseded*)<sup>2</sup>,  
GM 6170M (Section 3.8) (*superseded*)<sup>2</sup>,  
GM 6171M (Section 3.8) (*superseded*)<sup>2</sup>

Torque-Tension

ISO 16047;  
JDM F15X;  
GMW3044

Adhesion

ISO 2819



## Accredited Laboratory

A2LA has accredited

### CHEM-PLATE INDUSTRIES INC.

*Elk Grove Village, IL*

for technical competence in the field of

### Mechanical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 13<sup>th</sup> day of December 2017.

A handwritten signature in black ink, appearing to read "L. Sen", written over a horizontal line.

President and CEO  
For the Accreditation Council  
Certificate Number 0940.01  
Valid to October 31, 2019