“Know thy enemy”

– Sun Tzo, The Art of War

CORROSION TECHNOLOGIES

Corrosion

Chemistry

Causes

Cures

CORROSION TECHNOLOGIES

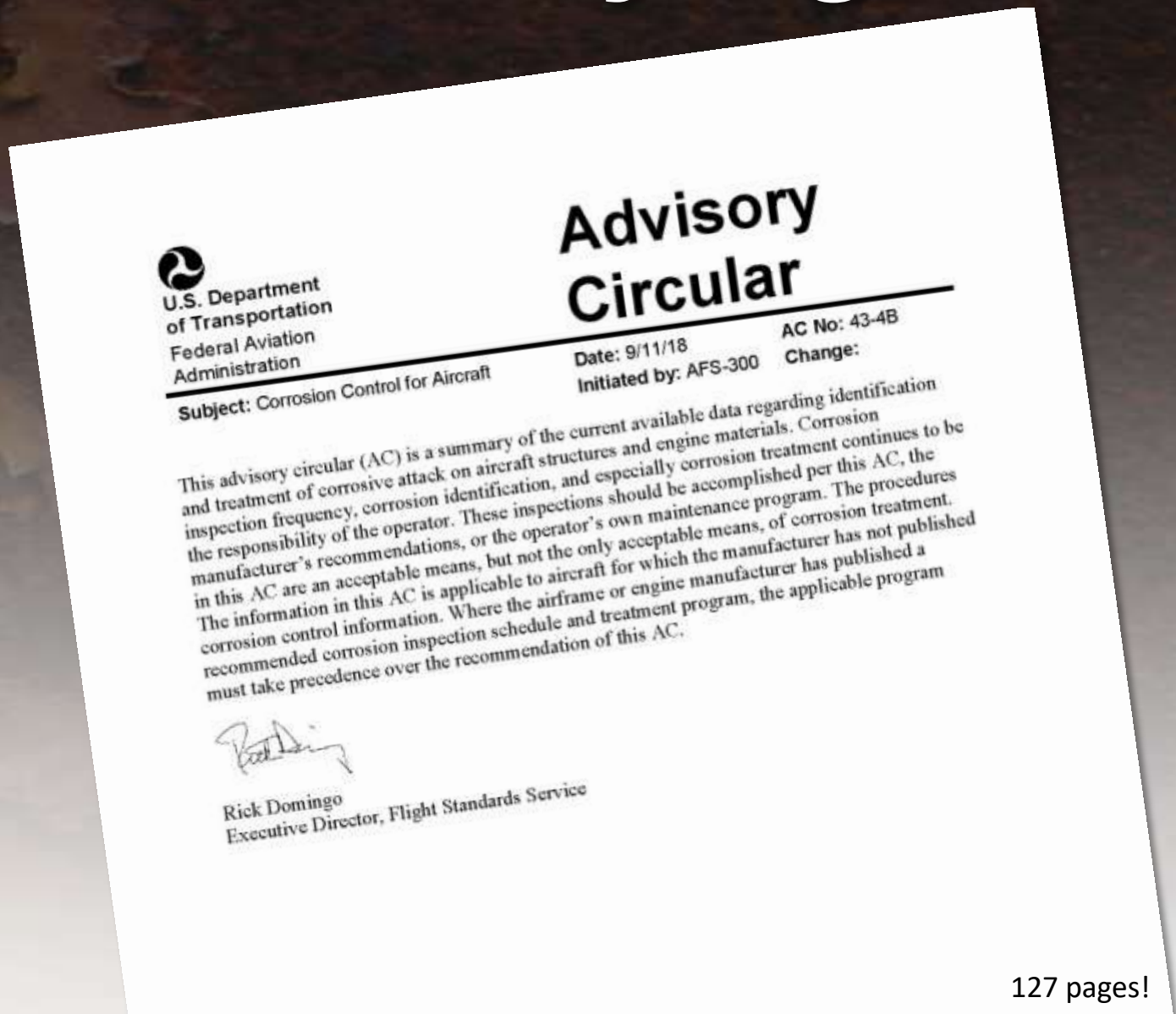
Average Age of the General Aviation Fleet:

38.1 Years … and growing older

Source: General Aviation Manufacturers Association 2019 Databook

CORROSION TECHNOLOGIES

The FAA is Paying Attention



U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Corrosion Control for Aircraft **Date:** 9/11/18 **AC No:** 43-4B
Initiated by: AFS-300 **Change:**

This advisory circular (AC) is a summary of the current available data regarding identification and treatment of corrosive attack on aircraft structures and engine materials. Corrosion inspection frequency, corrosion identification, and especially corrosion treatment continues to be the responsibility of the operator. These inspections should be accomplished per this AC, the manufacturer's recommendations, or the operator's own maintenance program. The procedures in this AC are an acceptable means, but not the only acceptable means, of corrosion treatment. The information in this AC is applicable to aircraft for which the manufacturer has not published corrosion control information. Where the airframe or engine manufacturer has published a recommended corrosion inspection schedule and treatment program, the applicable program must take precedence over the recommendation of this AC.

Rick Domingo
Executive Director, Flight Standards Service

127 pages!

CT CORROSION TECHNOLOGIES

Chemistry 101: What is corrosion?

- "The gradual destruction of materials (usually metals) by chemical reaction with their environment."

  – Wikipedia

- "An electrochemical reaction that converts metals back to their natural state – an oxide."

  – J.D.

CORROSION TECHNOLOGIES

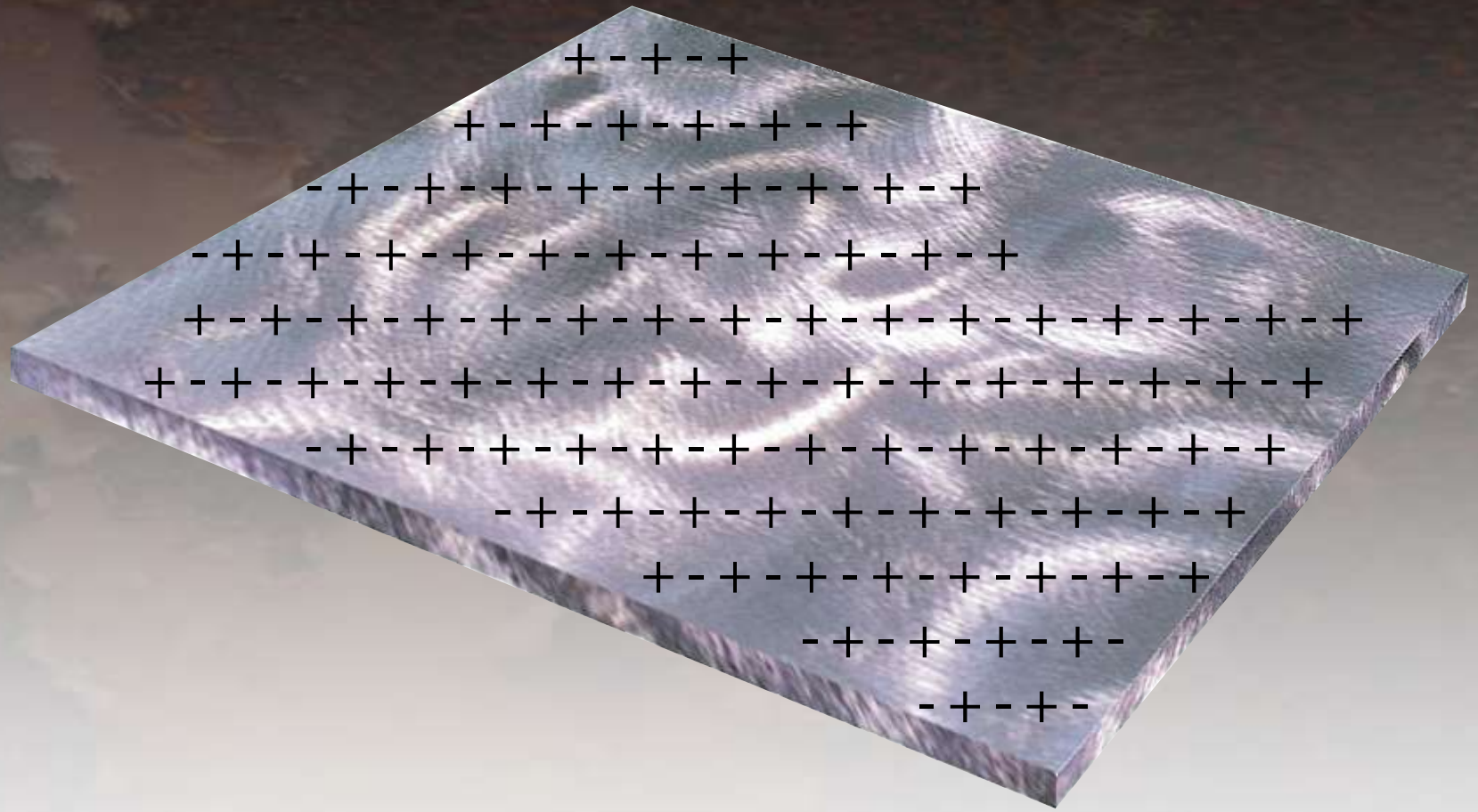
Some Causes of Corrosion

- Begins on the surface of the metal / metal alloy
- Availability of oxygen
- Presence of electrolytes (rain, saltwater, dirt, battery fluids, dissolved engine exhaust gasses which become acidic, etc.)
- Dissimilar metals and/or stray current
- Design (faying surfaces, crevices) and manufacturing processes (cutting, machining, forming, welding, heat treatment)
- Biological organisms (slimes, molds, fungi – many of which can be microscopic)

CT CORROSION TECHNOLOGIES

The Battery Analogy

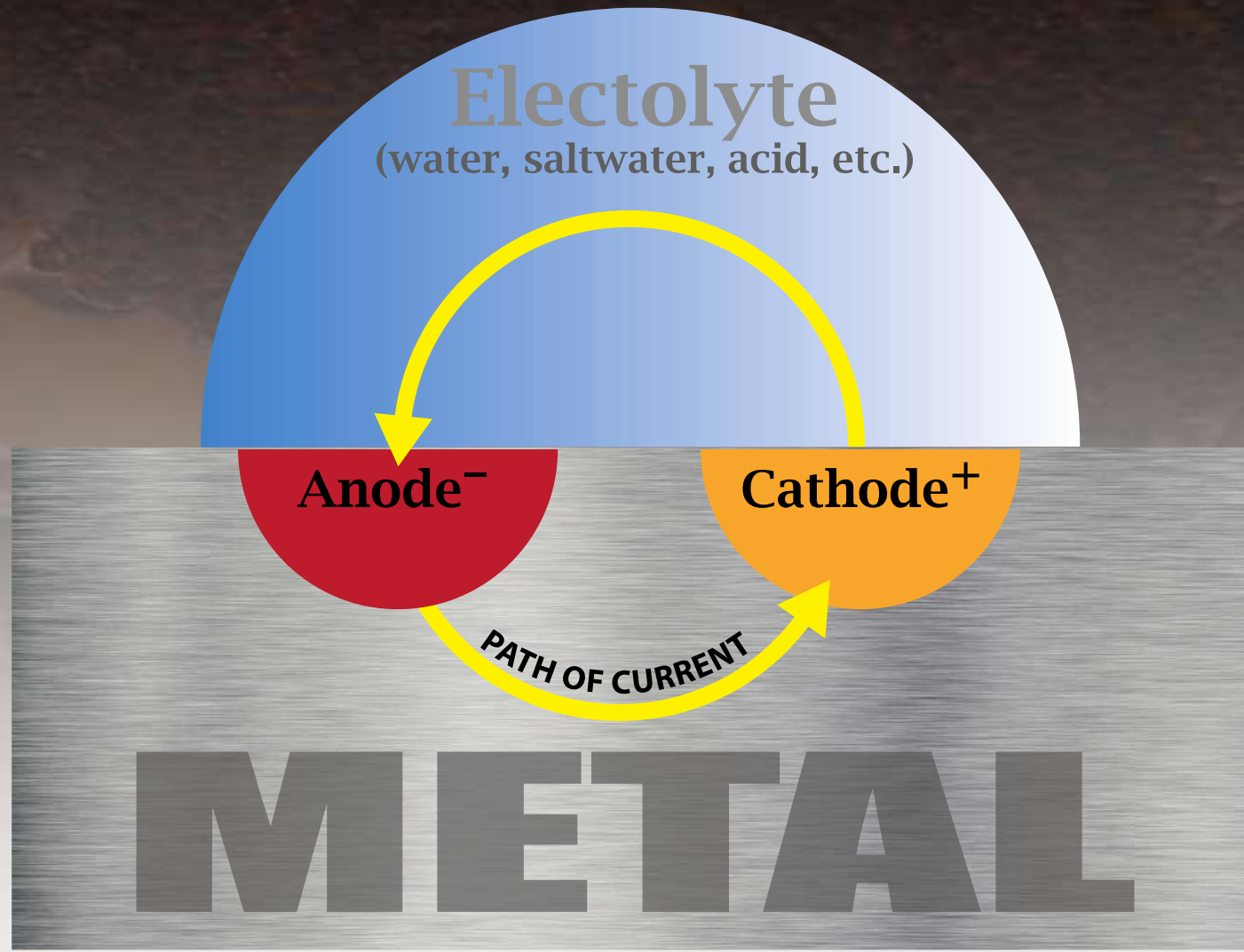
Chemically, the surface of common metals and their alloys can be visualized as a series of tiny batteries



Corrosion Components

The corrosion “cell” is like a tiny battery. It contains:

1. Anode
2. Cathode
3. Path of current
4. Electrolyte
   - Remove / interfere with any 1 component and corrosion cannot occur



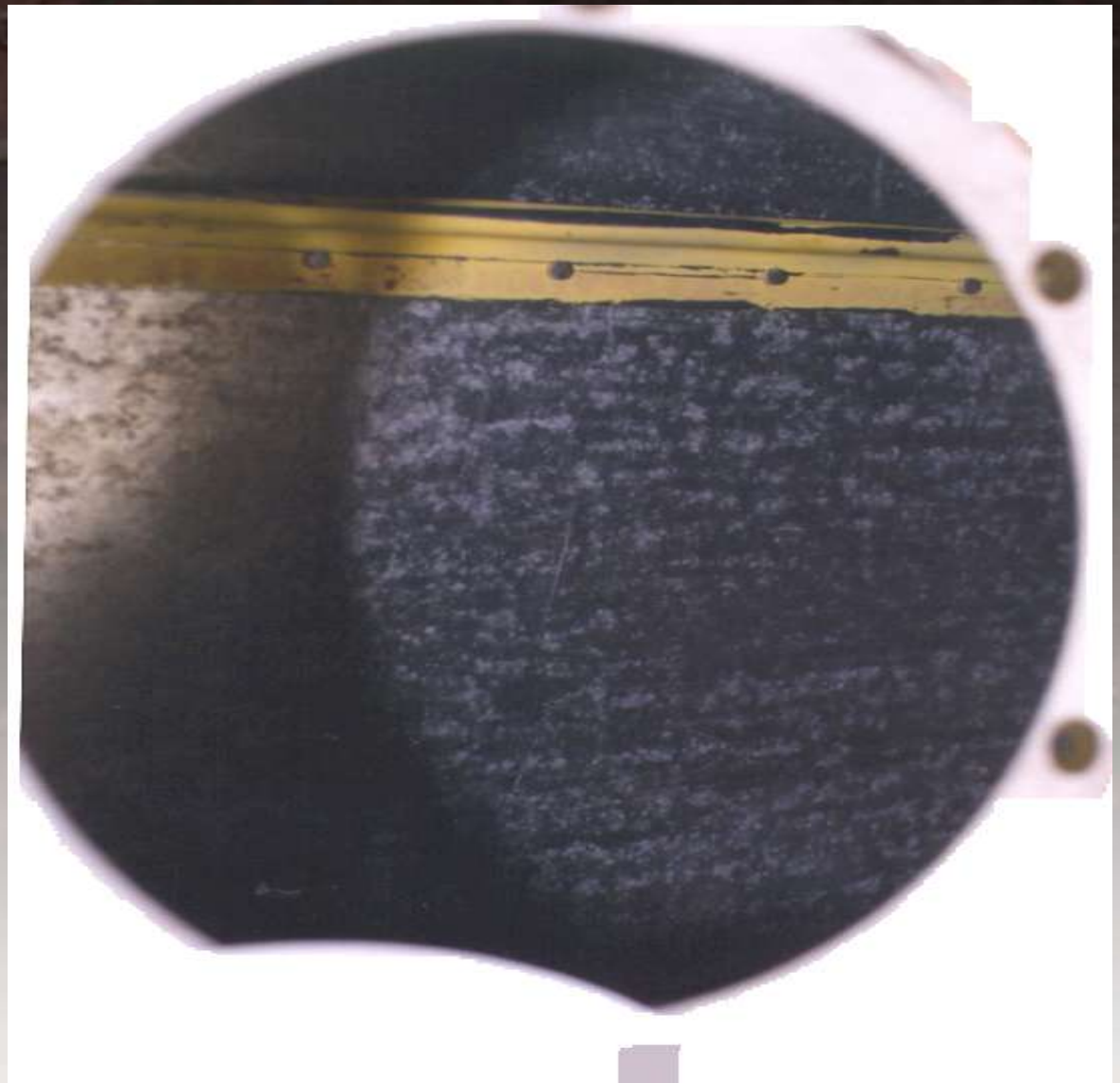
Where you'll find corrosion

Virtually anywhere there's metal or metal alloys, especially in places where moisture can sit. For example:

- "Bathtub fittings" on Bonanza and King Air
- Behind rubber door seals
- Around antennas, external fittings and hinges
- On landing gear and in wheel wells
- Around rivets, inside laps, seams and joints
- Anywhere you have dissimilar metals (stainless steel and aluminum – think stainless rivets)

CT CORROSION TECHNOLOGIES

What you're looking for: SURFACE



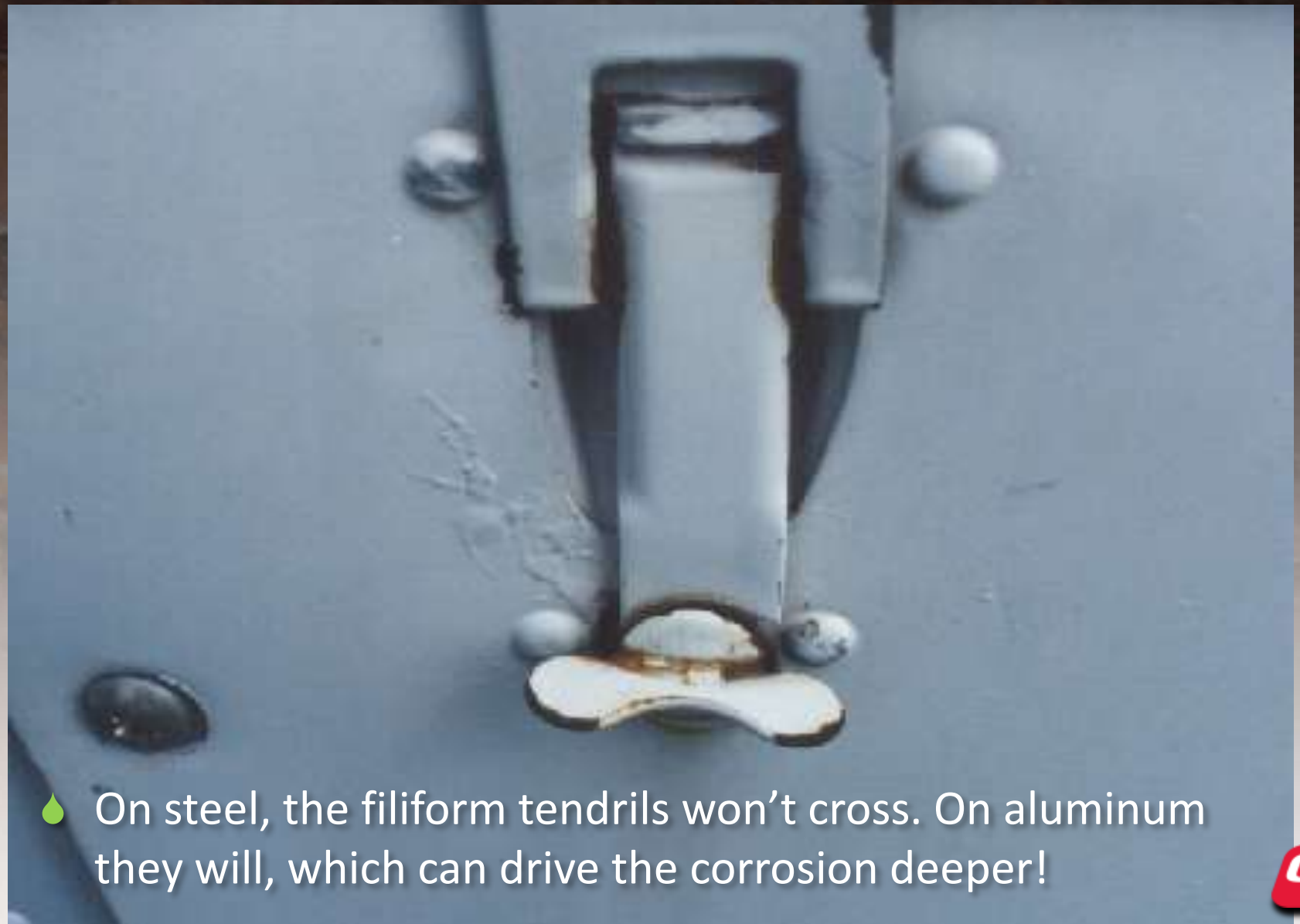
CORROSION TECHNOLOGIES

What you're looking for: GALVANIC

- Even the same grade of metal can corrode if the potential between the two is different enough!

CORROSION TECHNOLOGIES

What you're looking for: FILIFORM



- On steel, the filiform tendrils won't cross. On aluminum they will, which can drive the corrosion deeper!

CORROSION TECHNOLOGIES

What you're looking for: PITTING

- Warning! Most common on metals that form a protective oxide
- Tiny openings can penetrate deeply and create cavities that are much larger than surface openings!

CORROSION TECHNOLOGIES

What you're looking for: STRESS

- Often difficult to spot prior to failure

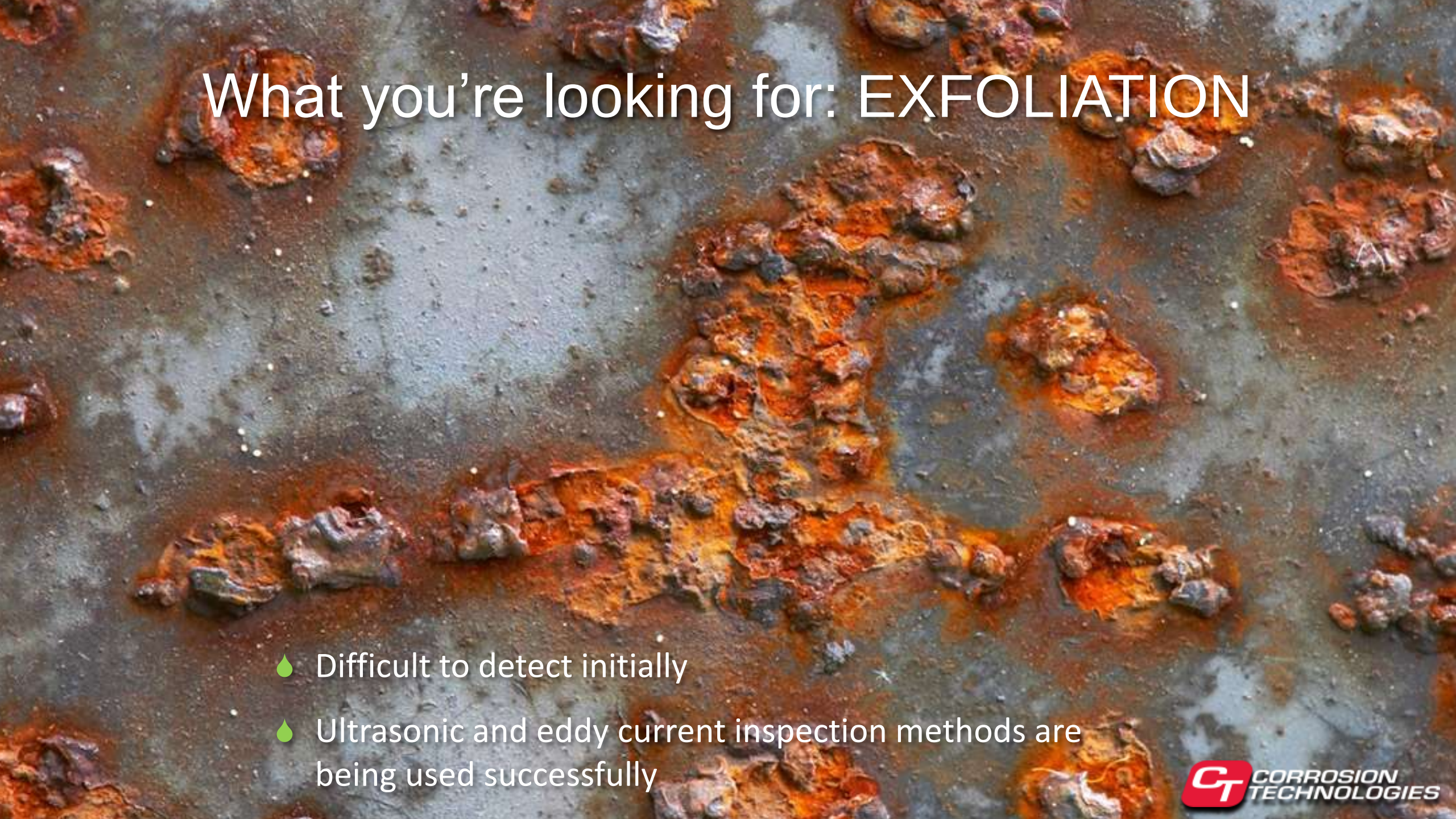
CORROSION TECHNOLOGIES

What you're looking for: INTERGRANULAR

- Caused by lack of alloy uniformity in the manufacturing process

CORROSION TECHNOLOGIES

What you're looking for: EXFOLIATION



- Difficult to detect initially
- Ultrasonic and eddy current inspection methods are being used successfully

CORROSION TECHNOLOGIES

Conventional Corrosion Prevention Methods

- Anodizing
- Plating
- Cladding
- Zinc Chromating

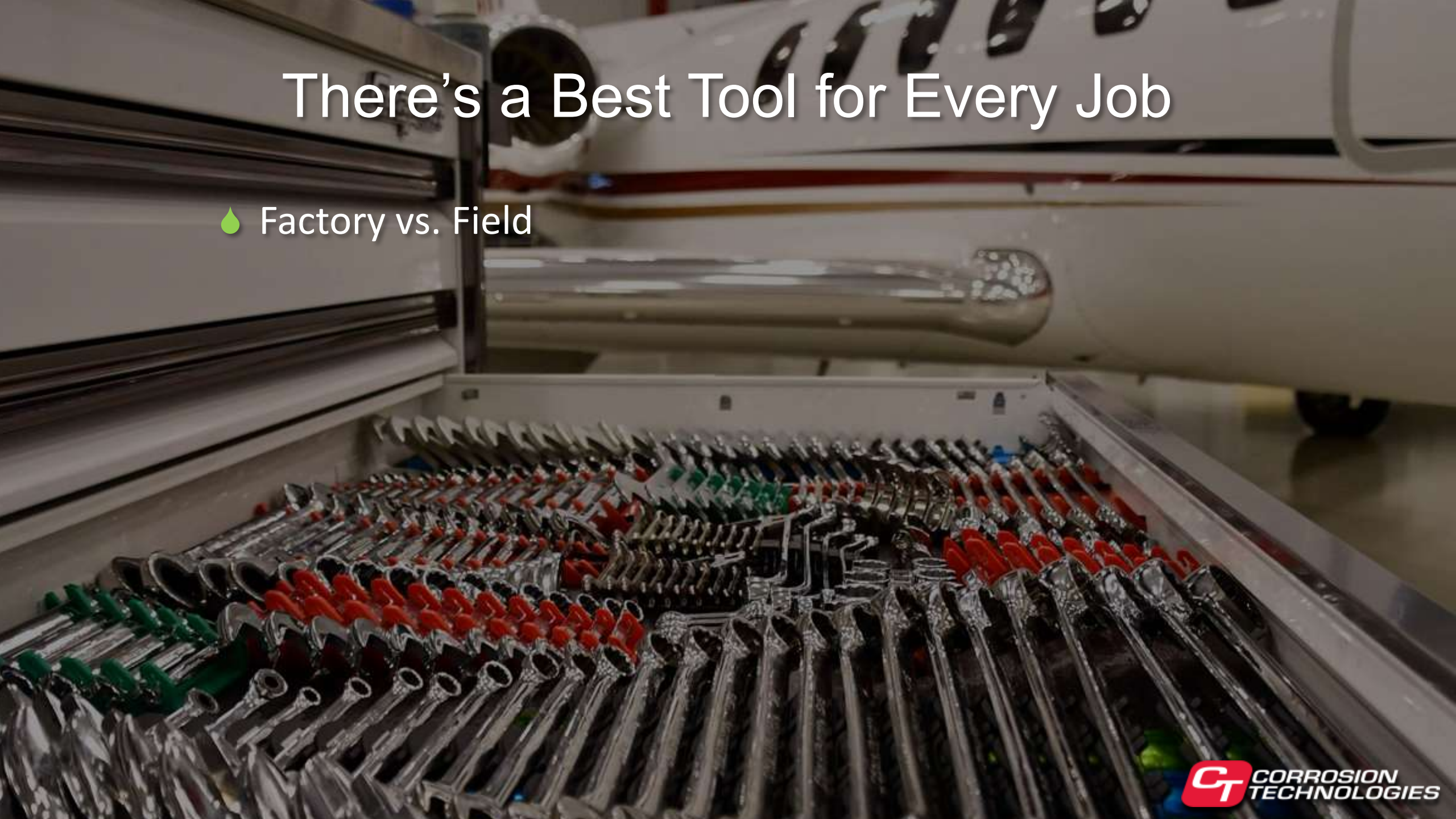
They're NOT working! Why?

- Vibration / abrasion, expansion / contraction
- Imprecise application
- Does not address existing corrosion
- Nothing lasts forever

CT CORROSION TECHNOLOGIES

There’s a Best Tool for Every Job

- Factory vs. Field



CORROSION TECHNOLOGIES

Best Practical Solutions

Treat with your choice of two types of sprayable corrosion preventive compounds

1. Barrier Coatings
2. Fluid Thin Film Coatings (FTFC)

Barrier Coatings

- Been around for years, some more effective than others
- Usually wax-based in aviation industry

Pros:

- Primary benefit is that they can be long-lasting initially

Cons:

- Require pre-removal of all corrosion
- High in VOCs
- Limited penetrating ability
- Opaque to some degree – hides trouble and makes inspection difficult
- Once exhausted, they must be removed
- Hard (expensive) to remove

CT CORROSION TECHNOLOGIES

Fluid Thin Film Coatings

- Newest proven corrosion prevention technology (1989)

Pros:

- Can be applied over existing corrosion
- Actively destroys corrosion cells
- Tremendous penetrating capability
- Doesn't interfere with inspections
- Easy to apply, and more thorough application
- Low in VOCs, minimal environmental impact

Cons:

- Biennial reapplication (depending on environment)

CT CORROSION TECHNOLOGIES

Barrier Coatings vs. CorrosionX

Barrier Coatings (passive)	CorrosionX (active)
Opaque (hides rust)	Transparent
Thick film (100ths)	Thin film (4/10,000ths)
Comparatively heavy	Practically weightless (180 lb. weight savings in 747 wings alone)
Coating compromised by abrasion, cracking, exhaustion of sacrificial ingredients	Bonded to metal surface and self-healing (Doesn't dry, crack, rub off, etc.)
Hardens, cracks, melts and voids	Flexible, , never dries, doesn't melt, fills voids
Can retain corrosion and moisture	Removes corrosion and moisture
No effect on galvanic, filiform or pitting	Dielectric value > 39,000 volts
Messy cleanup	No cleanup or removal required
Can contaminate oil and hydraulic fluid	Inner-engine and hydraulic tested
Expensive to remove and reapply	Less than $50 of product treats standard single

CT CORROSION TECHNOLOGIES

Selecting A Product

There are three ways a product is approved for use on airframes in the U.S.

- Mil Spec
  - Current revision of MIL-PRF-81309 is rev. H
  - https://qpldocs.dla.mil
- JCAA approval?
- OEM Approval (how current is the approval?)

Note: The FAA does not approve or certify chemicals.

CORROSION TECHNOLOGIES

FOGGABLE FLUID FILMS

	Penetration as measured by capillary migration	Aged Film characteristics (7 days@160˚ F)	VOC	SALT SPRAY days to failure steel	SALT SPRAY days to failure aluminum	SO2-SALT days to failure aluminum	SSSA SPRAY cycles to failure steel
New CorrosionX (CorrosionX Aviation)	9	Viscous Fluid	52g/l	<12, <12, 17, 18	35, 35	5 & 5	>12, >12, >12
Esgard PL-4 Class2 Grade 4	5	Fluid	99g/l	7, 11	15, 15		>12, >12, >12
Tectyl 511M Class 2 Grade 5	13	Fluid	335g/l	4, 4	5, 10, 10, 27		3, 4, 4
ZC-010	10	Viscous Fluid	576g/l	<1, 2	26, 27		2, 2, 3
ACF-50	9	Oily Fluid	>166.9g/l	2, 3	4, 4		1, 2, 3
CorrosionX (General Purpose)	8.5	Oily Fluid	?	2, 3	13, 19		1, 2, 3
Esgard PL-5 Class 2 Grade 5	10	Fluid	19g/l	1, 2	5, 7		1, 1, 1

Recommended by JCAA
Not recommended

Source: 2004 Joint Council on Aging Aircraft National Strategy Synopsis Briefing

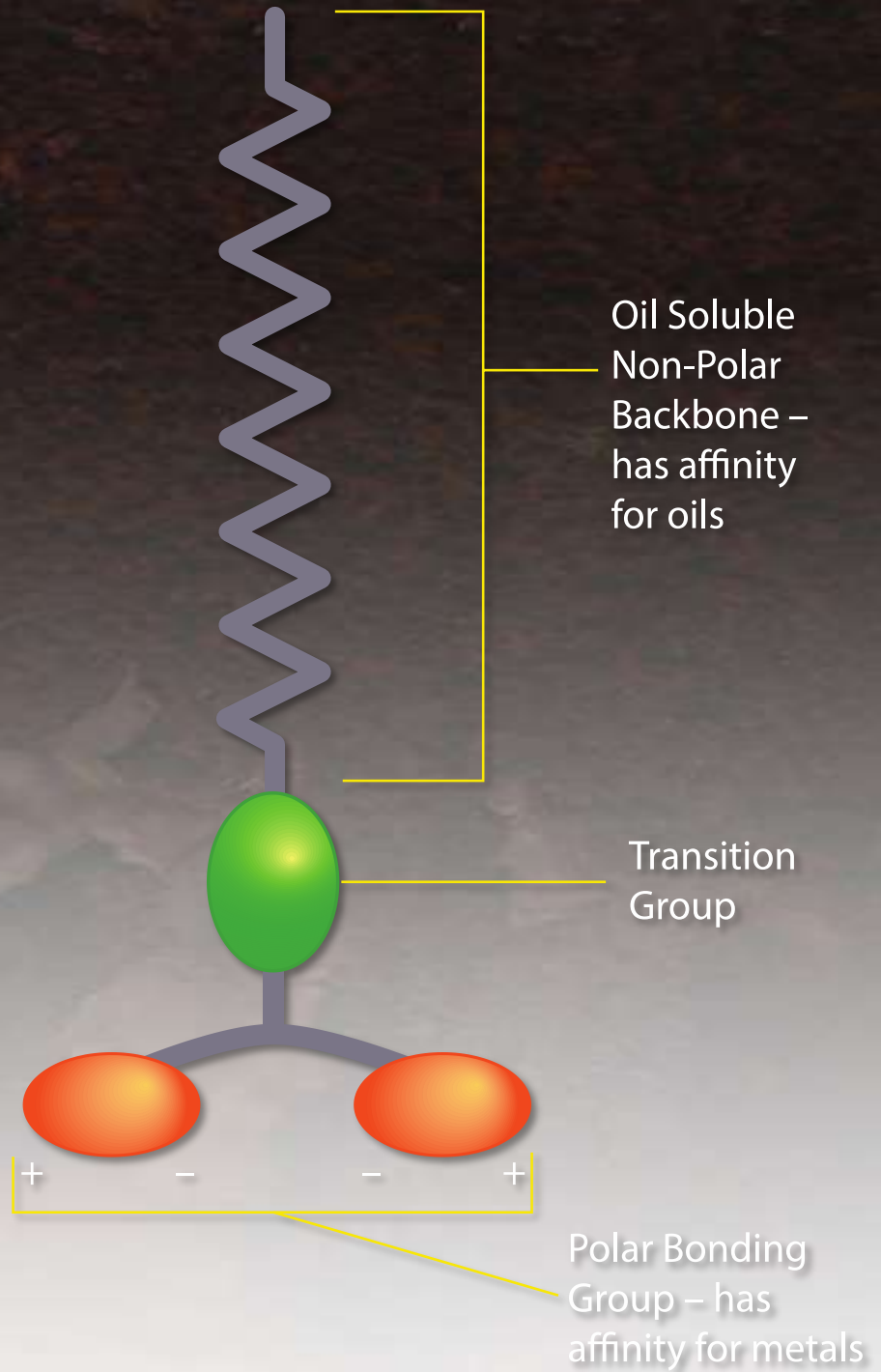
Only One Mil Spec Approved Product Uses FTFC Technology

CORROSION TECHNOLOGIES

How CorrosionX® Works

The CorrosionX molecule

Polar Bonding is the key!



How CorrosionX® Works

The CorrosionX molecule

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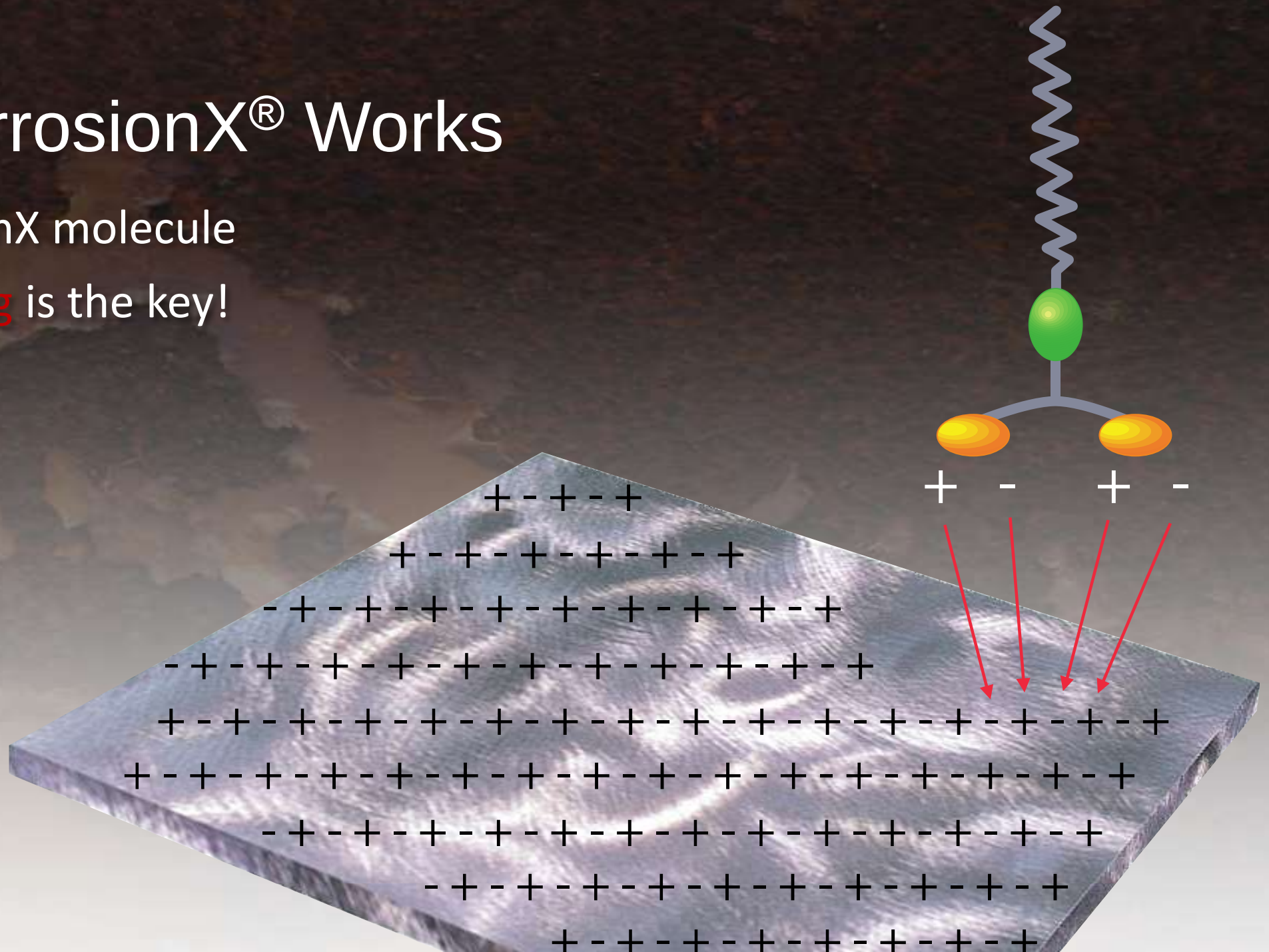

How CorrosionX® Works

The CorrosionX molecule

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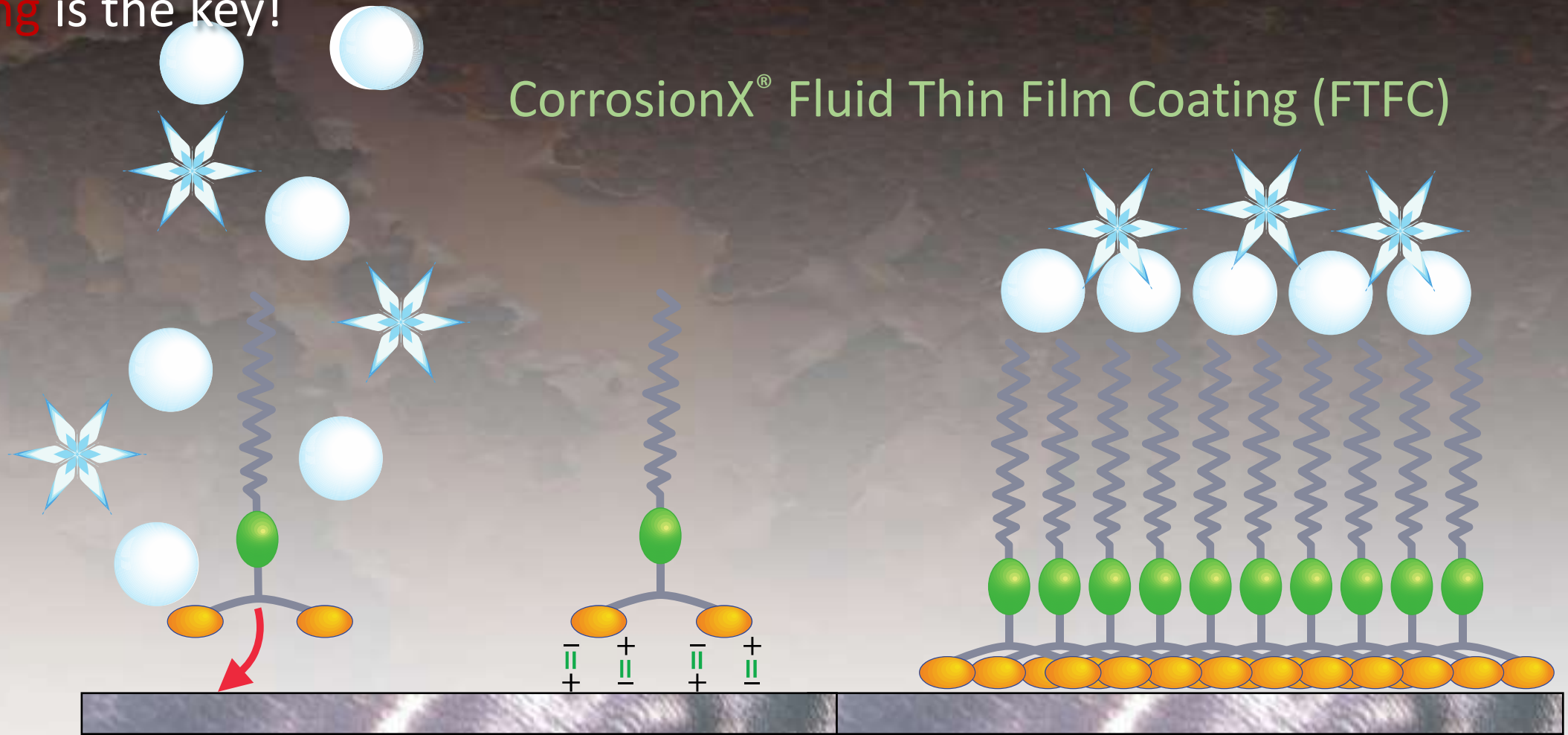
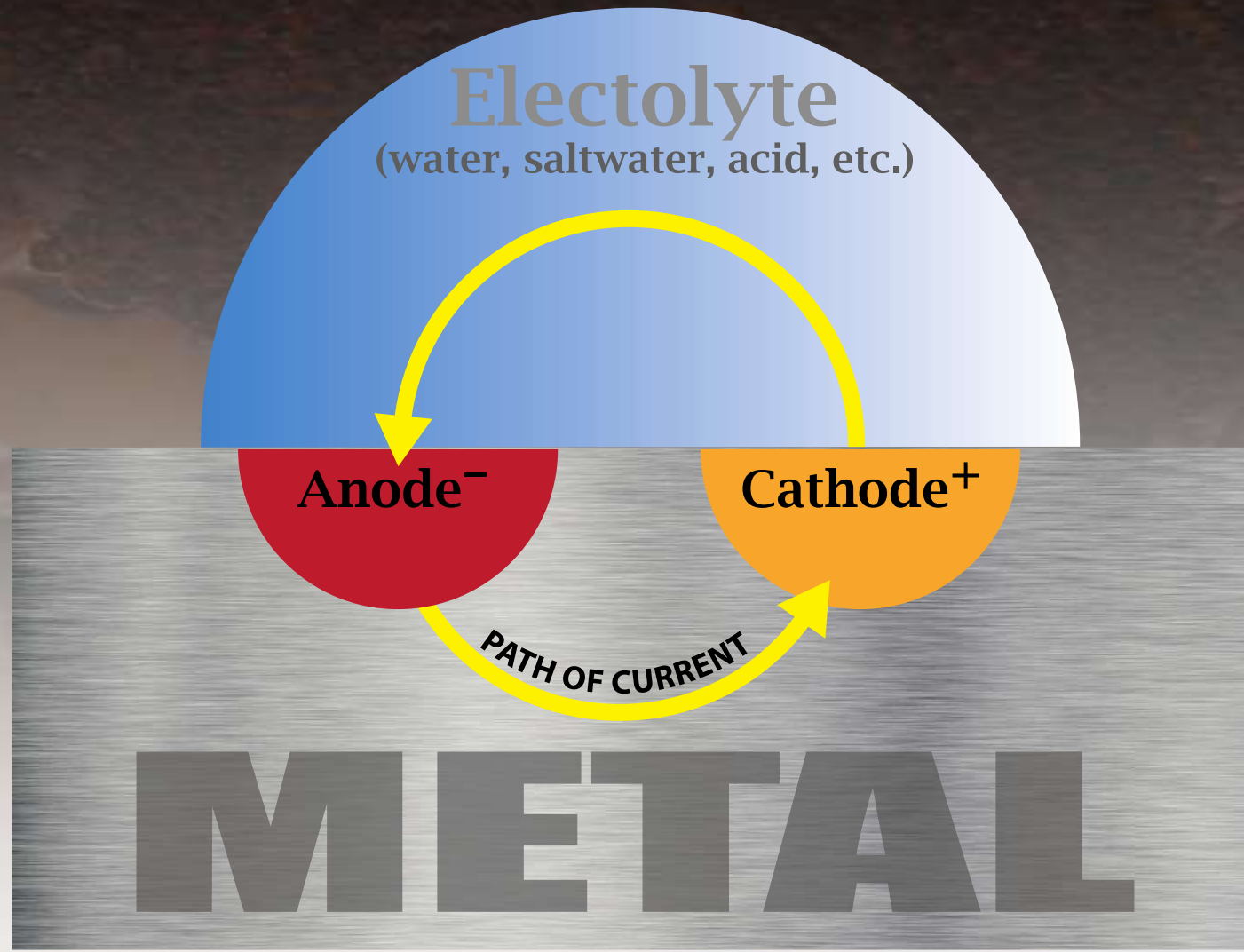


CorrosionX® Fluid Thin Film Coating (FTFC)

Corrosion Components

The corrosion “cell” is like a tiny battery. It contains:

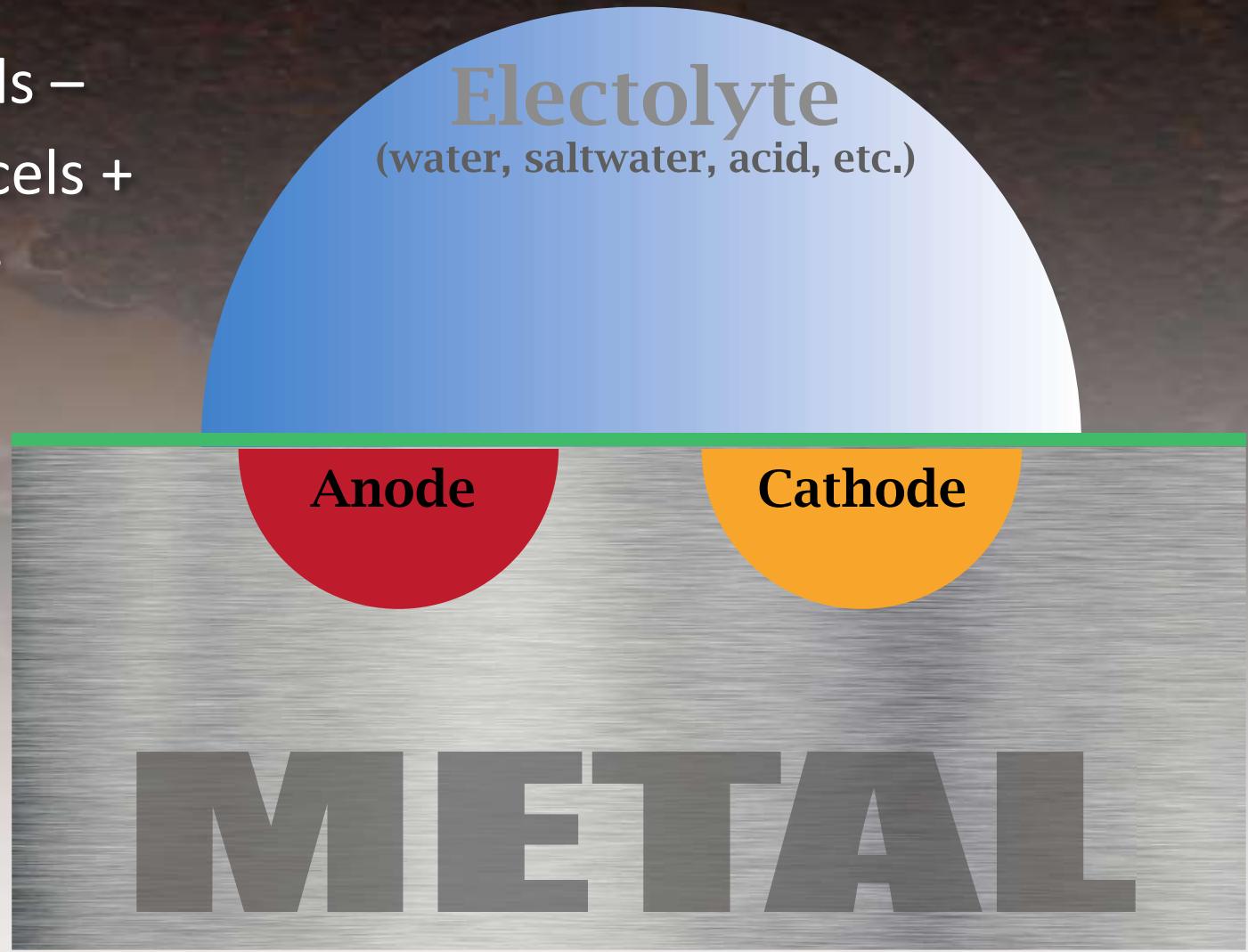
1. Anode
2. Cathode
3. Path of current
4. Electrolyte
   - Remove / interfere with any 1 component and corrosion cannot occur



How CorrosionX® Works

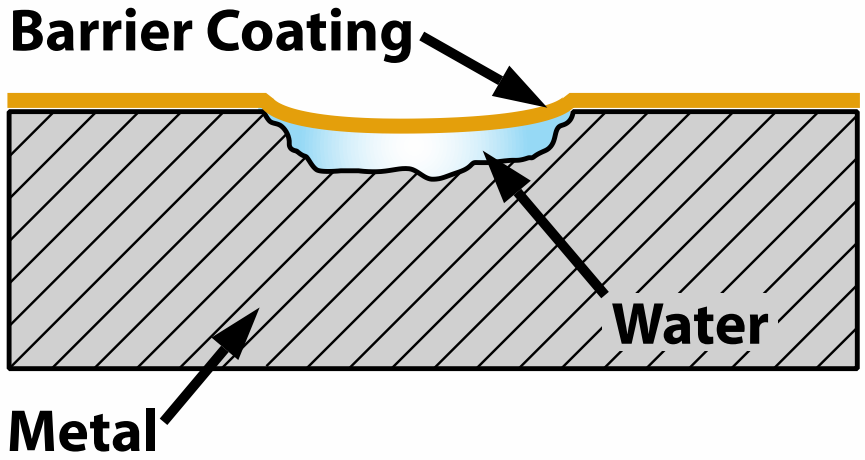
CorrosionX® Kills Corrosion

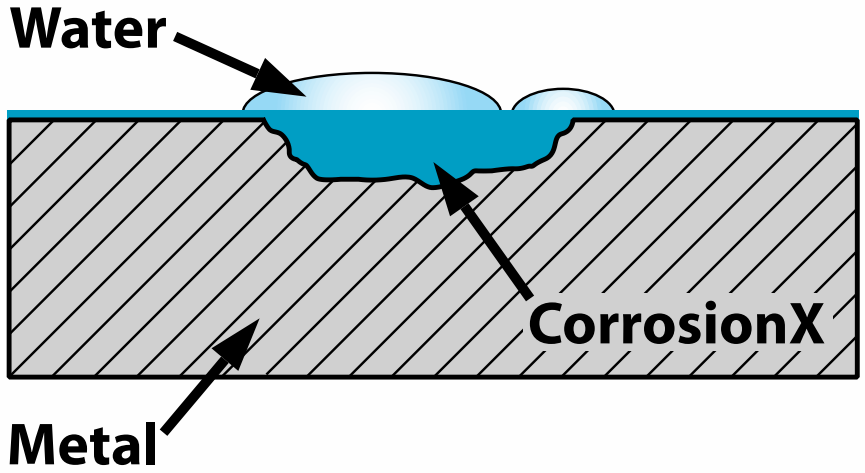
1. Anode: Passivates surface, cancels –
2. Cathode: Passivates surface, cancels +
   - Makes common metals and metal alloys behave more noble
3. Path of current: Eliminates with massive > 39,000V dielectric
4. Oh yeah, and it's also a fantastic 'inhibitor' – isolating metal from corrosion-causing electrolytes with self-healing FTFC



How CorrosionX® Works

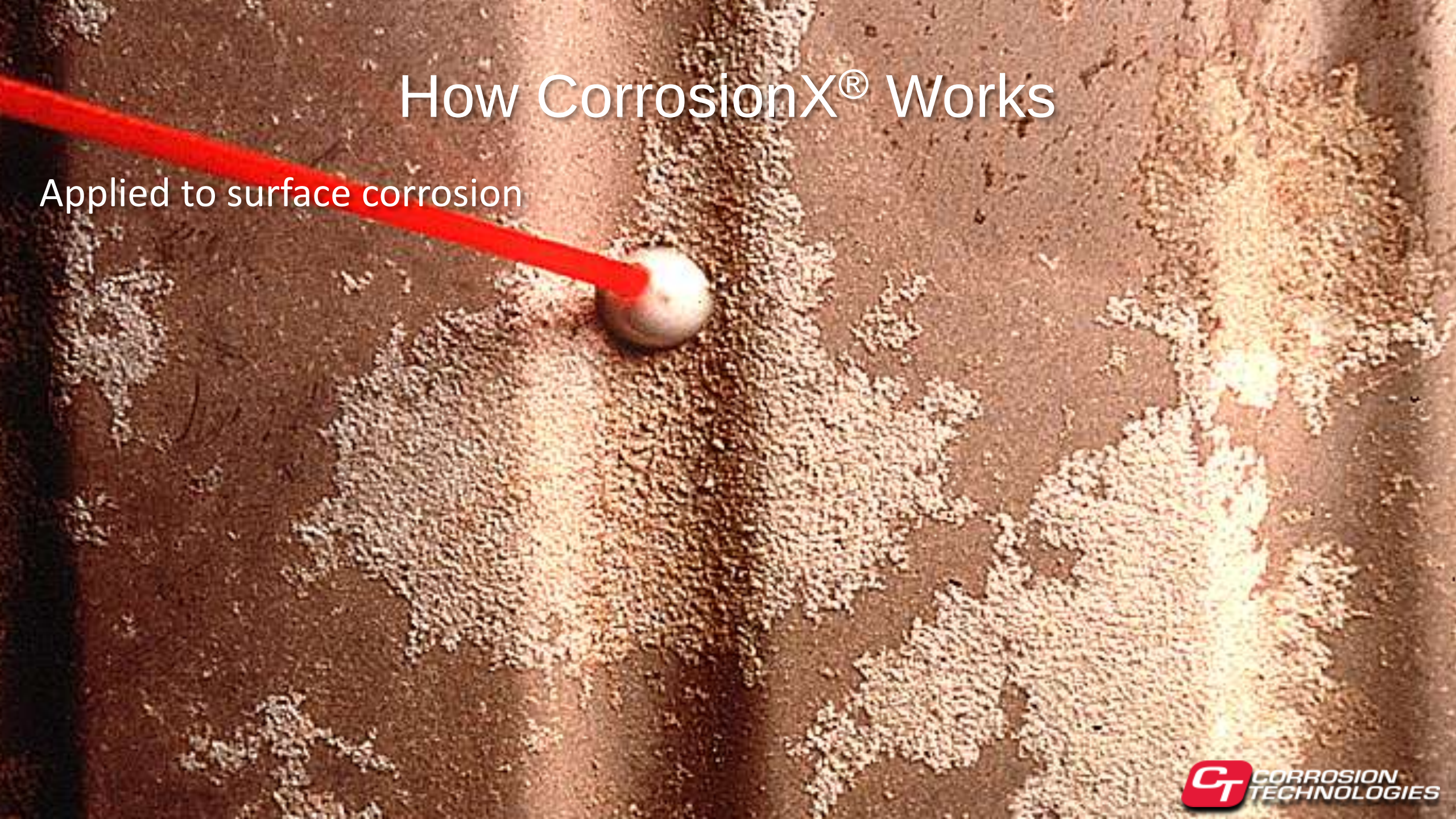
Here's what all that chemistry and technical mumbo-jumbo translates to in real-world applications





How CorrosionX® Works

Applied to surface corrosion



How CorrosionX® Works

Applied to surface corrosion

- 30 seconds later

CORROSION TECHNOLOGIES

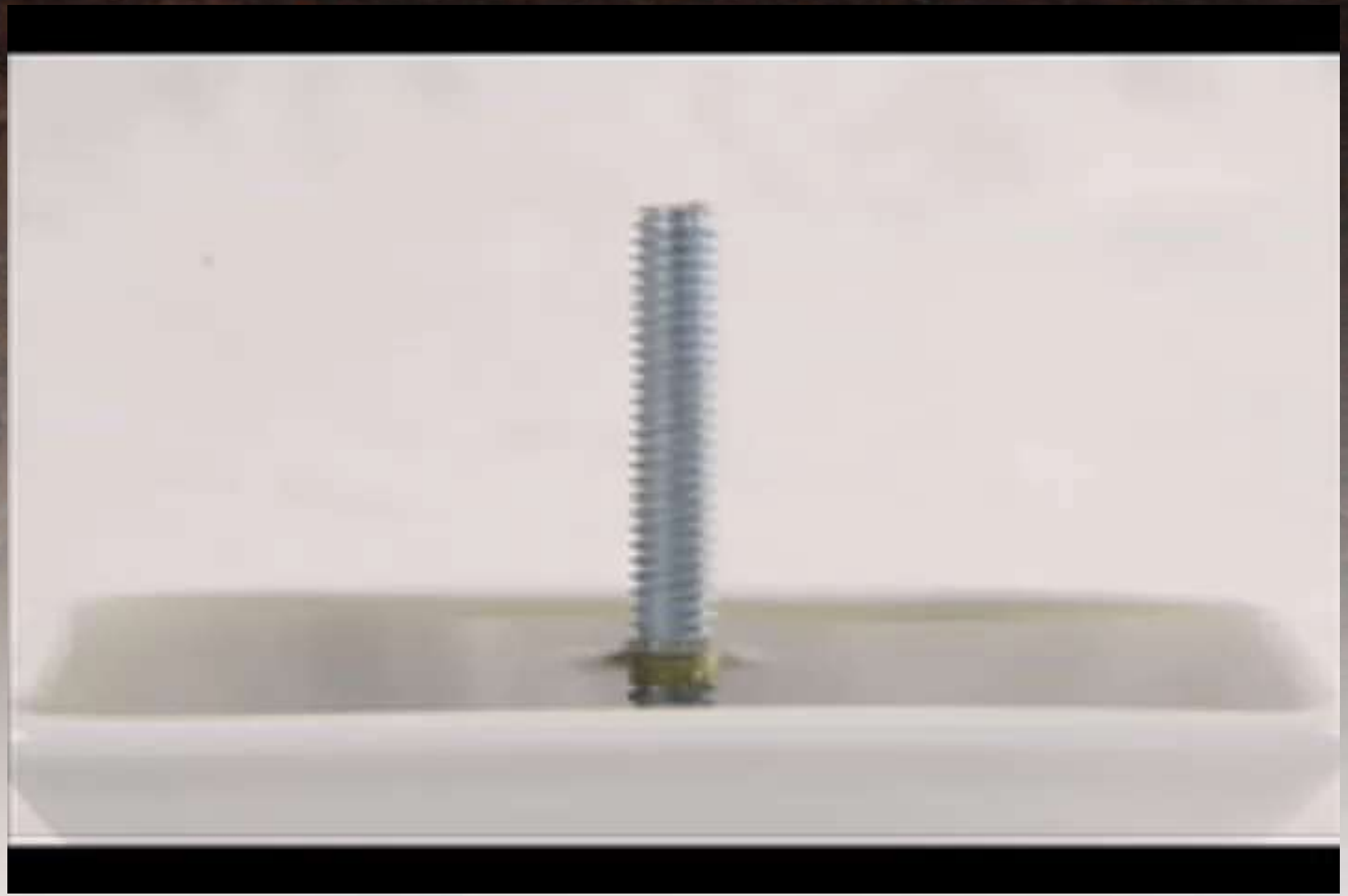
How CorrosionX® Works

Applied to surface corrosion

- After 5 minutes

CORROSION TECHNOLOGIES

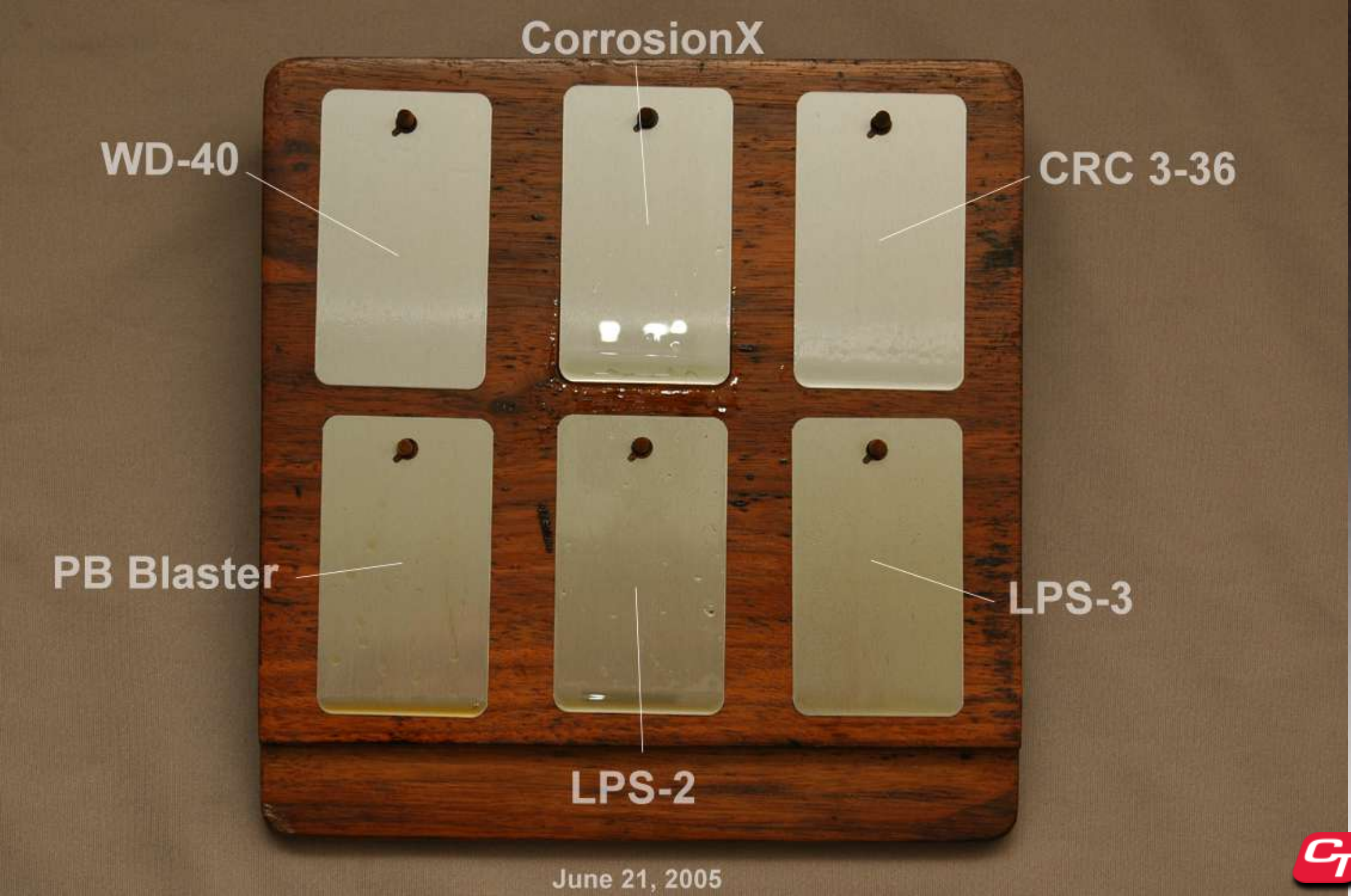
How CorrosionX® Works

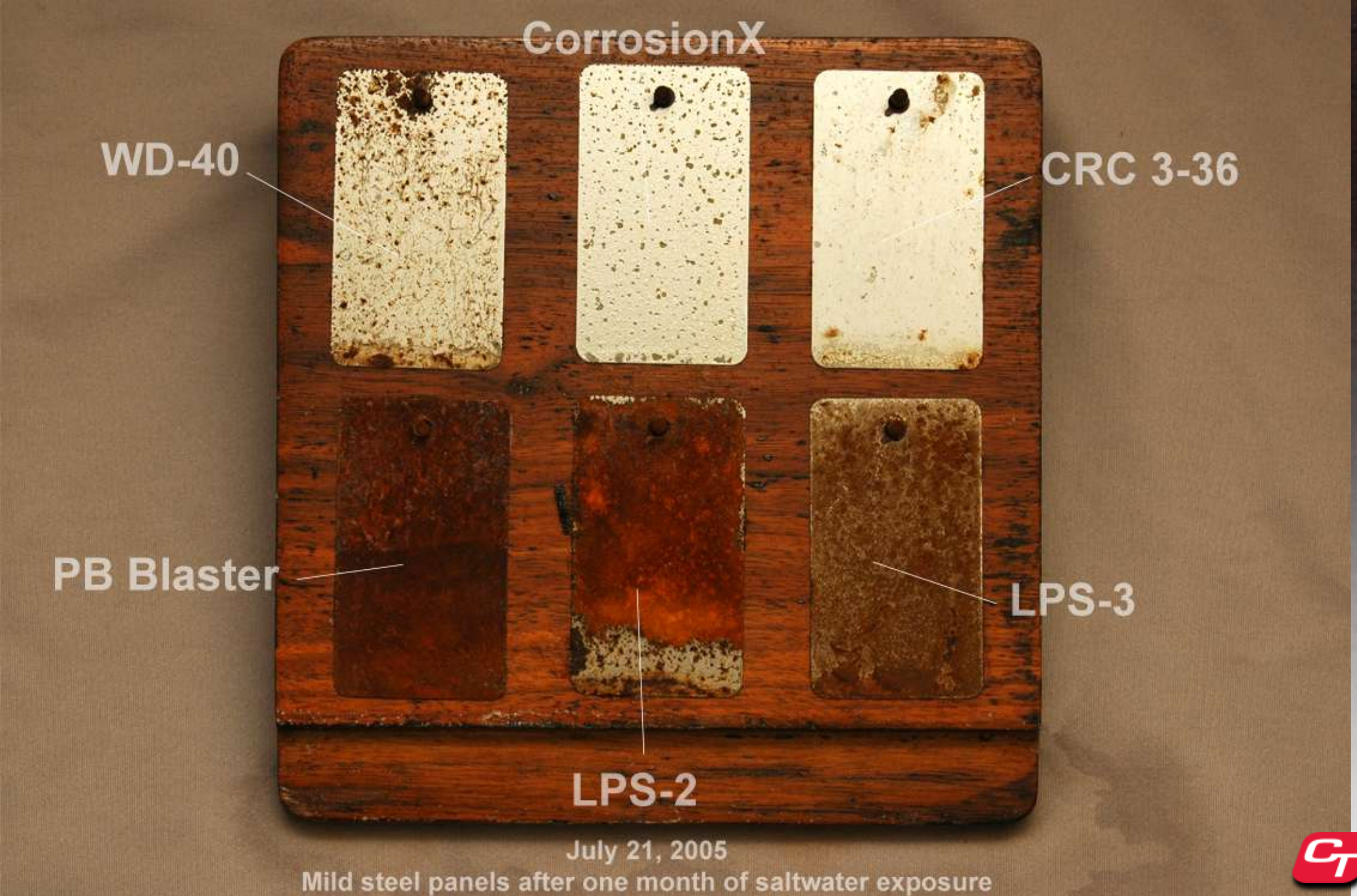


How CorrosionX® Works

How CorrosionX® Works

High dielectric also assures safety near electrical components

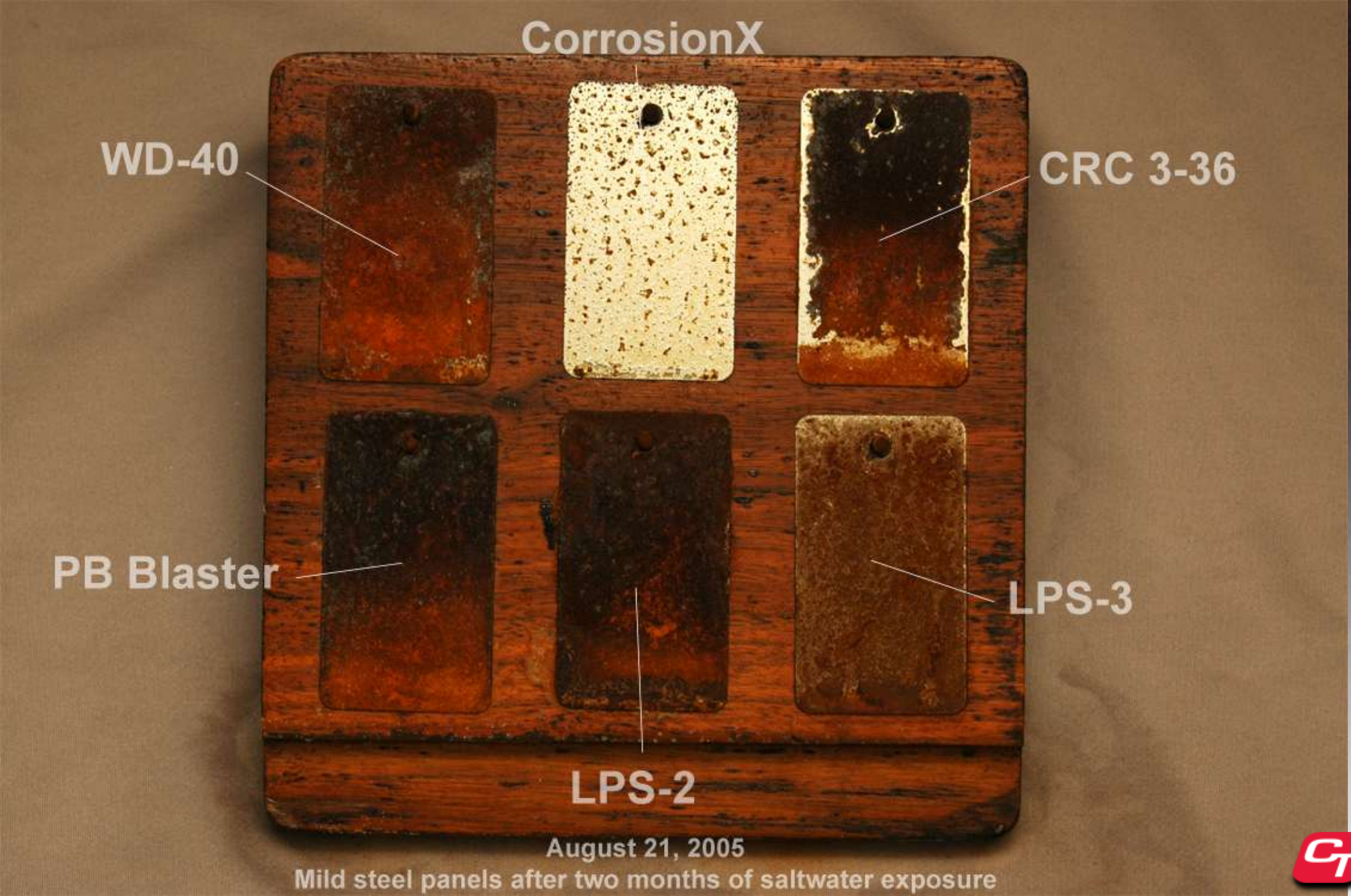

CorrosionX
WD-40
CRC 3-36
PB Blaster
LPS-3
LPS-2
June 21, 2005



July 21, 2005

Mild steel panels after one month of saltwater exposure

CORROSION TECHNOLOGIES


CorrosionX
WD-40
CRC 3-36
PB Blaster
LPS-3
LPS-2
August 21, 2005
Mild steel panels after two months of saltwater exposure

Handi-Spray Application System

- Atomizes CorrosionX and other corrosion preventive compounds into microdroplet “smoke”
- 40 – 60 psi
- 3 – 4 cfpm
- Various sizes available
- Can purchase individually or as part of the CorrosionX Aviation Official Treatment Center Program

CT CORROSION TECHNOLOGIES


CORROSION
TECHNOLOGIES

Success In The Real World

- Approved for use by Boeing, Cessna, Learjet, Mooney, Raytheon, Saab, Sikorsky and many others
- Hundreds of GA aircraft treated every year by shops in most states
- Nearly 200 Official Treatments Centers in U.S. and abroad

CT CORROSION TECHNOLOGIES

Questions?

CorrosionX Poland

www.corrosionx.pl