

Field Repair of IVD Aluminum Coatings on High-Strength Steels Using Kinetic Metallization™

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Sacrificial Coatings for High-Strength Steels

- ▶ **Cadmium & Chromate Conversion Sealants**
 - ▶ Historical corrosion protection coatings
 - ▶ Environmentally Hazardous
 - ▶ EO 13148
 - ▶ All Federal Agencies
 - ▶ Toxic Chemicals, Hazardous Substances, and Pollutants
Reduced by 50% by 12/31/2006

Cd Alternatives

- ▶ Ion Vapor Deposition (IVD) of Aluminum
 - ▶ Class I, Type II chromate conversion sealant
 - ▶ IVD process is **NOT** applicable for field repairs
- ▶ AlumiplateSM (toluene based plating)
 - ▶ Primarily applicable to fasteners
 - ▶ AlumiplateSM is **NOT** applicable for field repairs
- ▶ Electroplating
 - ▶ Zn, Zinc-Ni & Zinc-Sn
 - ▶ Brush plating for field repairs

Technology
Search for
Environmentally
Sustainable
Field Repair
of IVD-AI
Coatings

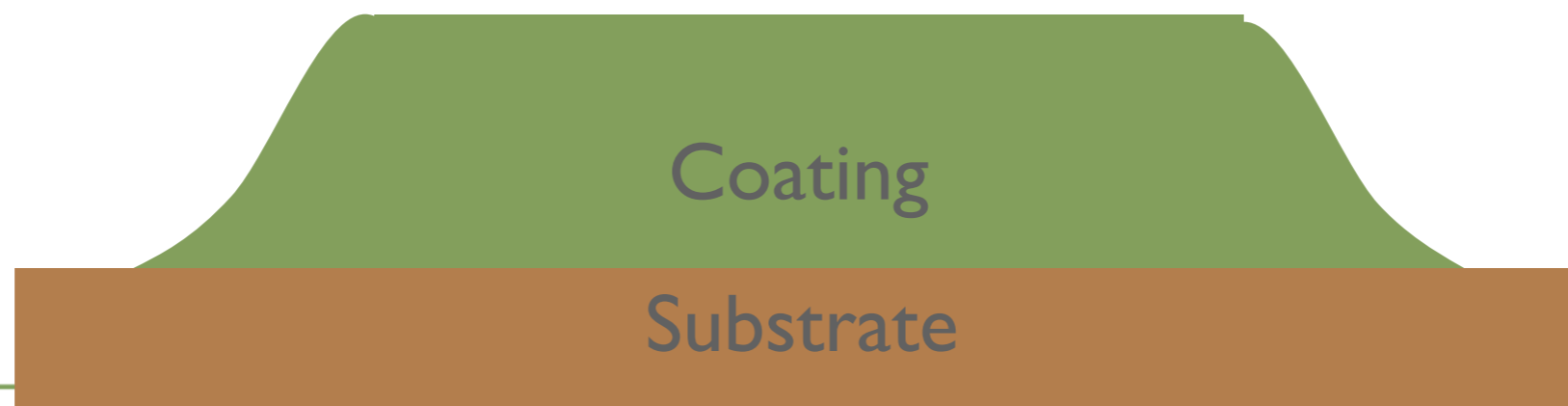
Field Repair Process for IVD-AI

- ▶ NAVAIR SBIR Solicitation - N04-023
 - ▶ Field repair technology development for IVD-AI
 - ▶ Meeting current environmental laws/regulations
 - ▶ Performance requirements at Navy Maintenance levels
- ▶ **Kinetic Metallization™** NAVAIR Funded Project
 - ▶ Phase I SBIR - 2004 (KM feasibility project)
 - ▶ Phase IIA SBIR - 2005 (field repair development)
 - ▶ Al based coating formulations using KM process
 - ▶ Portable KM handheld gun & spraying techniques
 - ▶ Phase IIB SBIR - 2006 (JTP-2003 Qualification Testing)

What Is Kinetic
Metallization™ ?

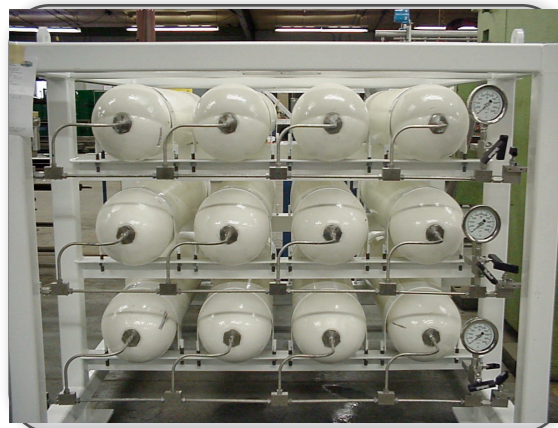
Kinetic Metallization Basics

- ▶ Impact Consolidation Process
 - ▶ Feed-stock: fine powder,
 - ▶ Accelerant: inert light gas
- ▶ Solid-state Consolidation
 - ▶ No melting
 - ▶ No liquid chemicals
- ▶ KM Sonic Nozzle
 - ▶ Friction compensated
 - ▶ Low pressure (50 psig)
 - ▶ Low gas flow (7.5 SCFM)
- ▶ Environmentally Innocuous
 - ▶ No hazardous substances

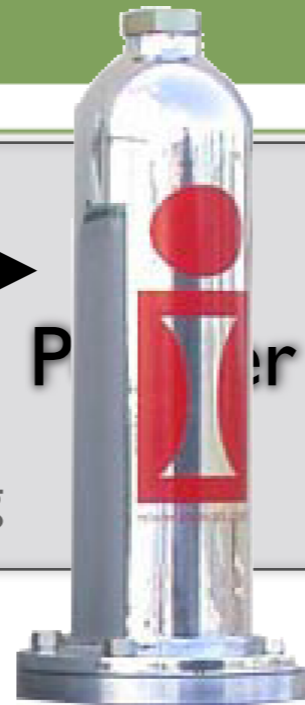


KM Flow Path

Helium Storage System



Powder Fluidizing Unit



Thermal Conditioning Unit

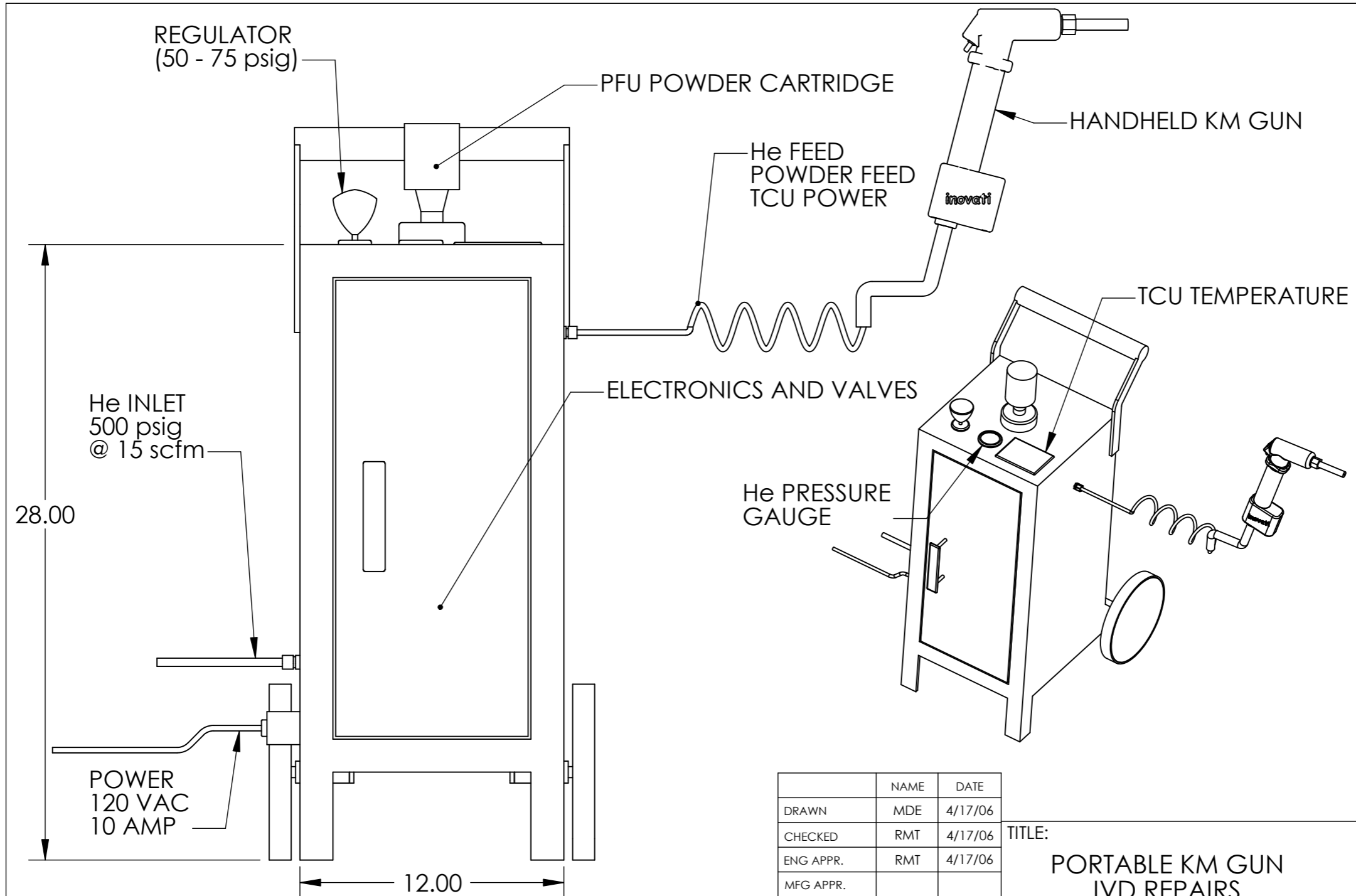


Deposition Nozzle

Kinetic Energy
Energy



Field Repair
Techniques
using
Handheld
Kinetic
Metallization™
Gun



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UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS ARE IN INCHES
 TOLERANCES:
 FRACTIONAL ±
 ANGULAR: MACH ± BEND ±
 TWO PLACE DECIMAL ± .010
 THREE PLACE DECIMAL ± .005

	NAME	DATE
DRAWN	MDE	4/17/06
CHECKED	RMT	4/17/06
ENG APPR.	RMT	4/17/06
MFG APPR.		
Q.A.		

COMMENTS:
 CONCEPTUAL DESIGN

TITLE: PORTABLE KM GUN IVD REPAIRS		
SIZE A	DWG. NO.	REV
		SHEET 1 OF 1

5

4

3

2

1

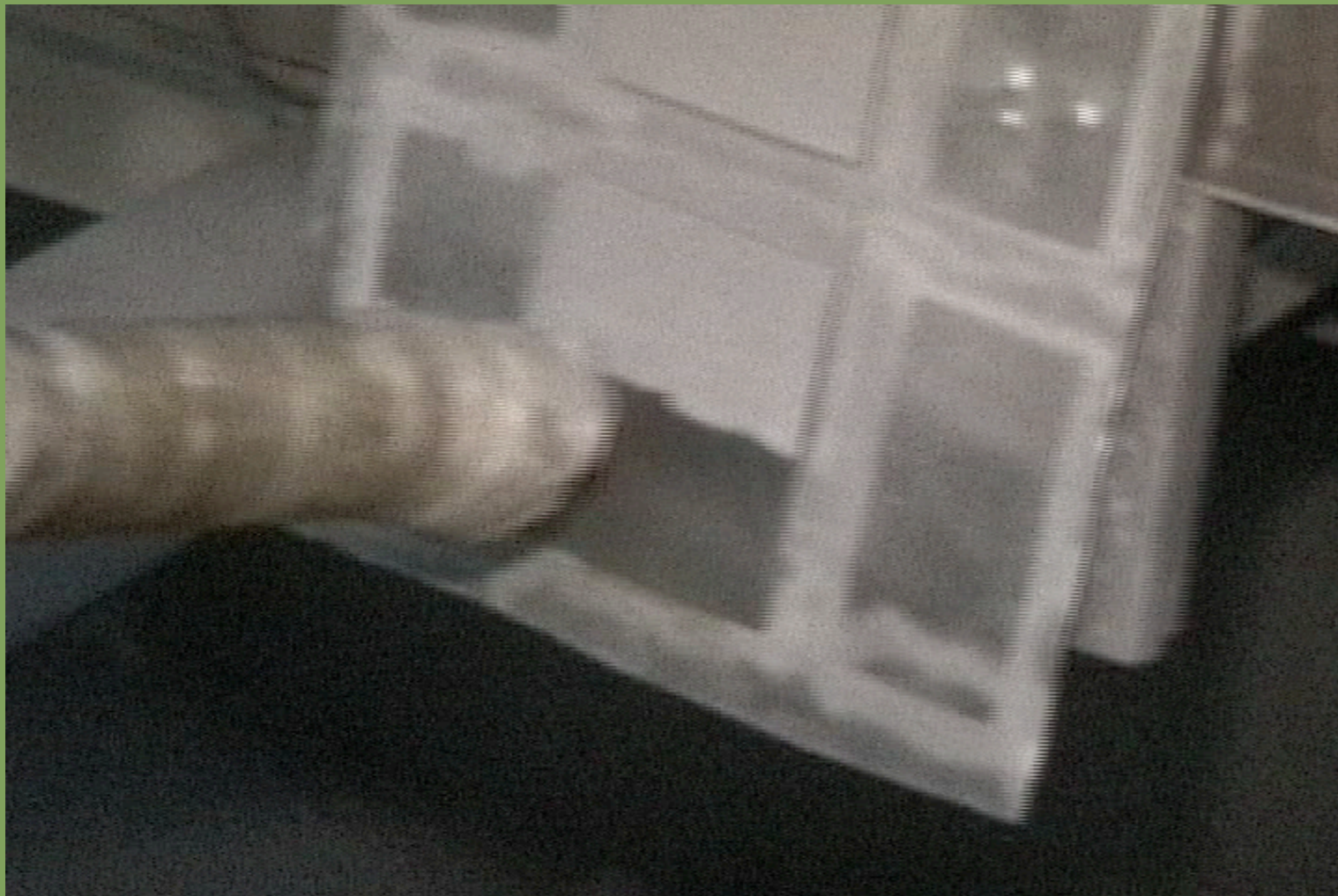
Handheld KM Gun



- ▶ Portable KM System
 - ▶ Enable Field Repairs



Portable KM Gun



- ▶ Handheld Gun
 - ▶ Real Time
 - ▶ 1-cm Standoff
 - ▶ 5-mm Stripe
 - ▶ Overlapping Strokes
 - ▶ Multi-layers

KM
AI-Trans[®]
Properties
&
Performance

KM Al-Trans[®]

- ▶ Aluminum + Transition Metal Composite
 - ▶ Blended Powder Feedstock
 - ▶ Transition Metal Admixtures - Cr, Ni, Co, V, Ti, Cu
 - ▶ Admixture Concentration: 25-30% by Volume
- ▶ Al-Trans[®] (Cr) Formulation Developed 1999
 - ▶ Electrically conductive coating for telecommunication racks
 - ▶ Replacement of Zn-Chromate conversion coatings
 - ▶ Improved coating adhesion compared to CP-Al for KM process

KM Al-Trans[®]

- ▶ Al-Trans[®]

- ▶ Aluminum

- ▶ Chromium

- ▶ Adhesion

- ▶ Steel, ASTM B571

- ▶ Paint, ASTM D2794, 120 ft-lb

- ▶ Corrosion

- ▶ ASTM B117, 5000 hours

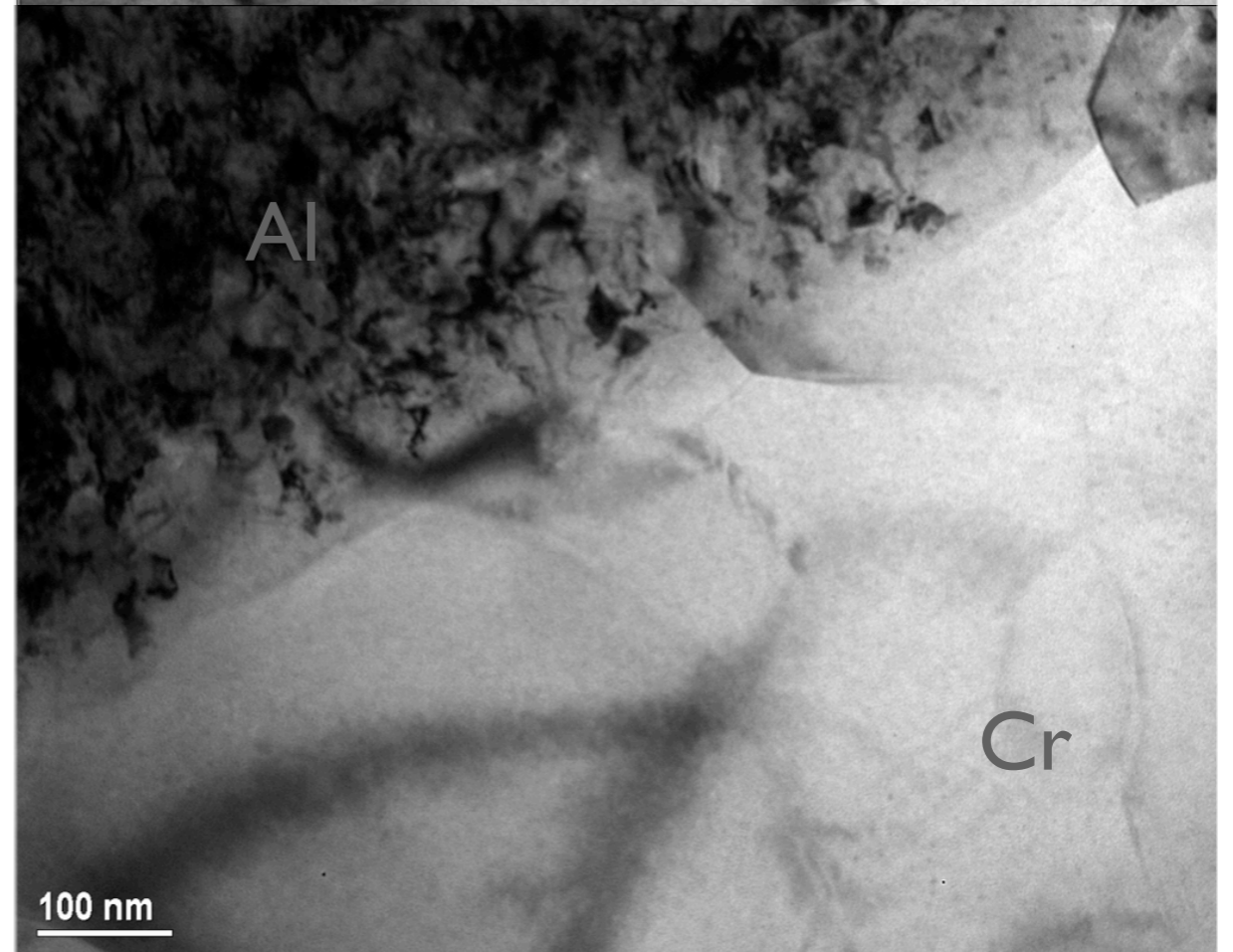
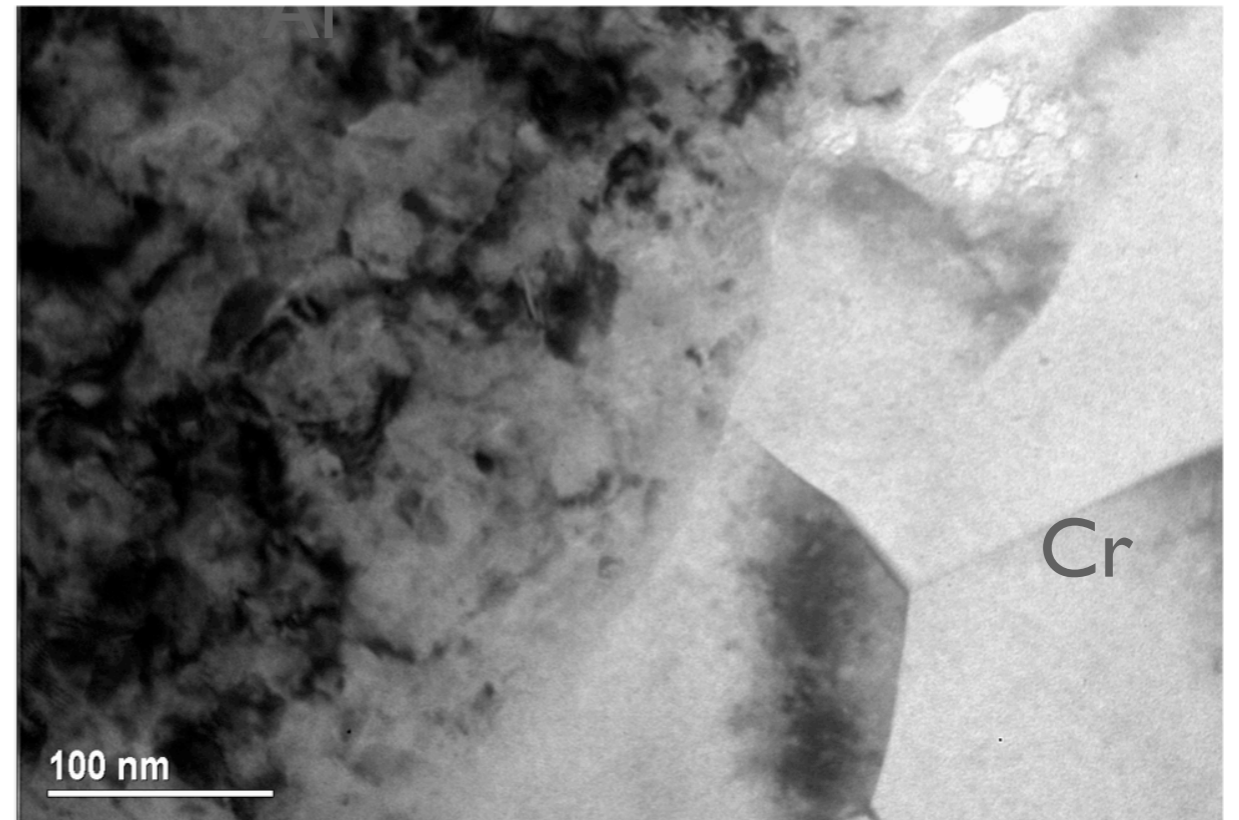
Steel Substrate

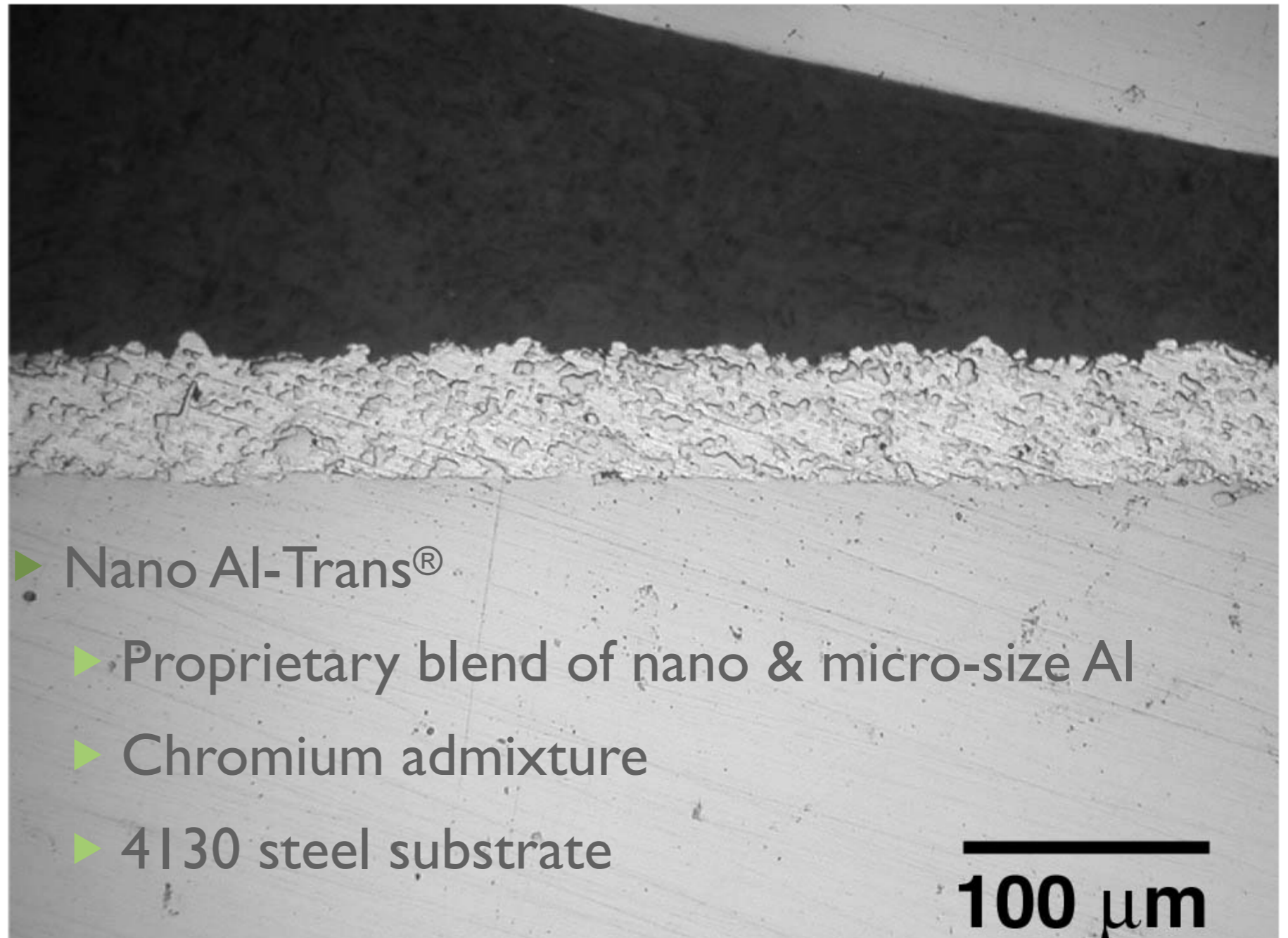
TEM

Tight Al-Cr interface

Superb cohesion

Upper image | 40,000X original





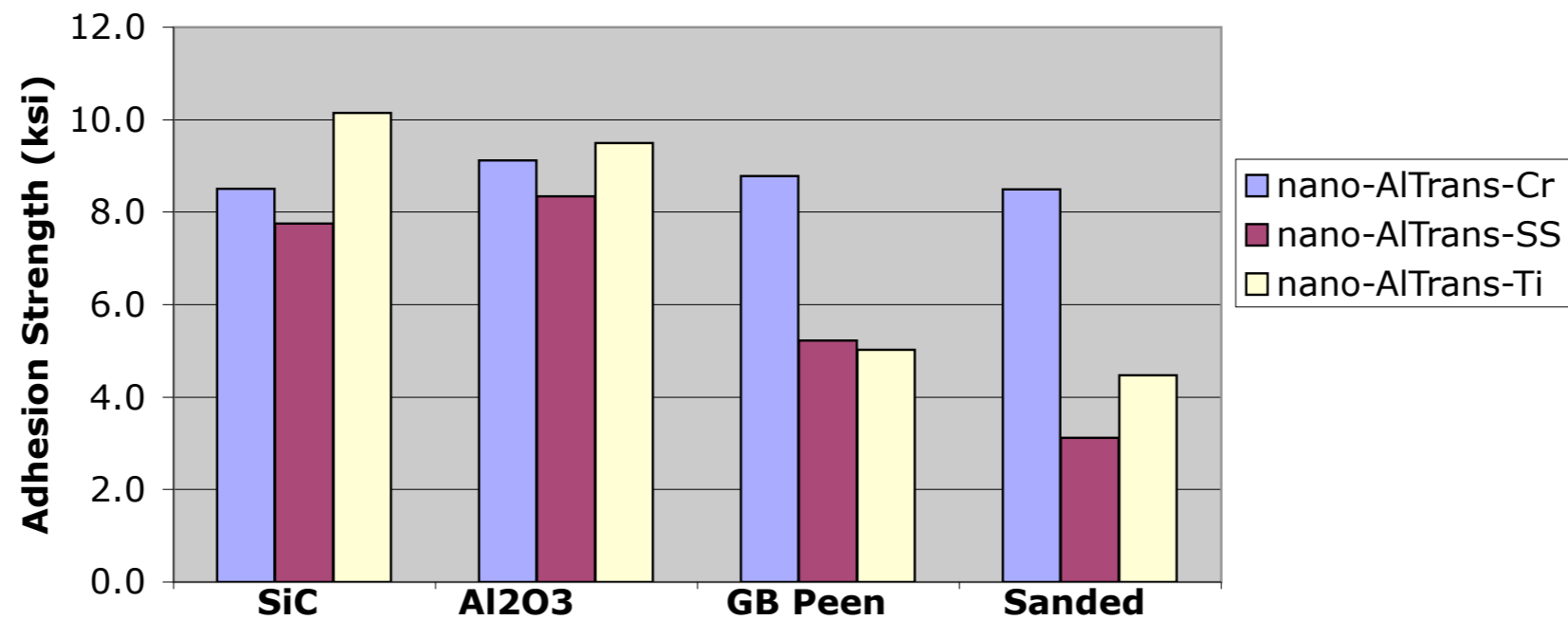
- ▶ Nano Al-Trans®
 - ▶ Proprietary blend of nano & micro-size Al
 - ▶ Chromium admixture
 - ▶ 4130 steel substrate

100 μm

Nano Al-Trans®

Surface Preparation Effects on Adhesion

Adhesion Strength: nano-AlTrans Formulations
Epoxy Strength = 9.3 +/- 1.4 (ksi) Bare Stds
IVD Strength = 7.8 +/- 2.0 (ksi)



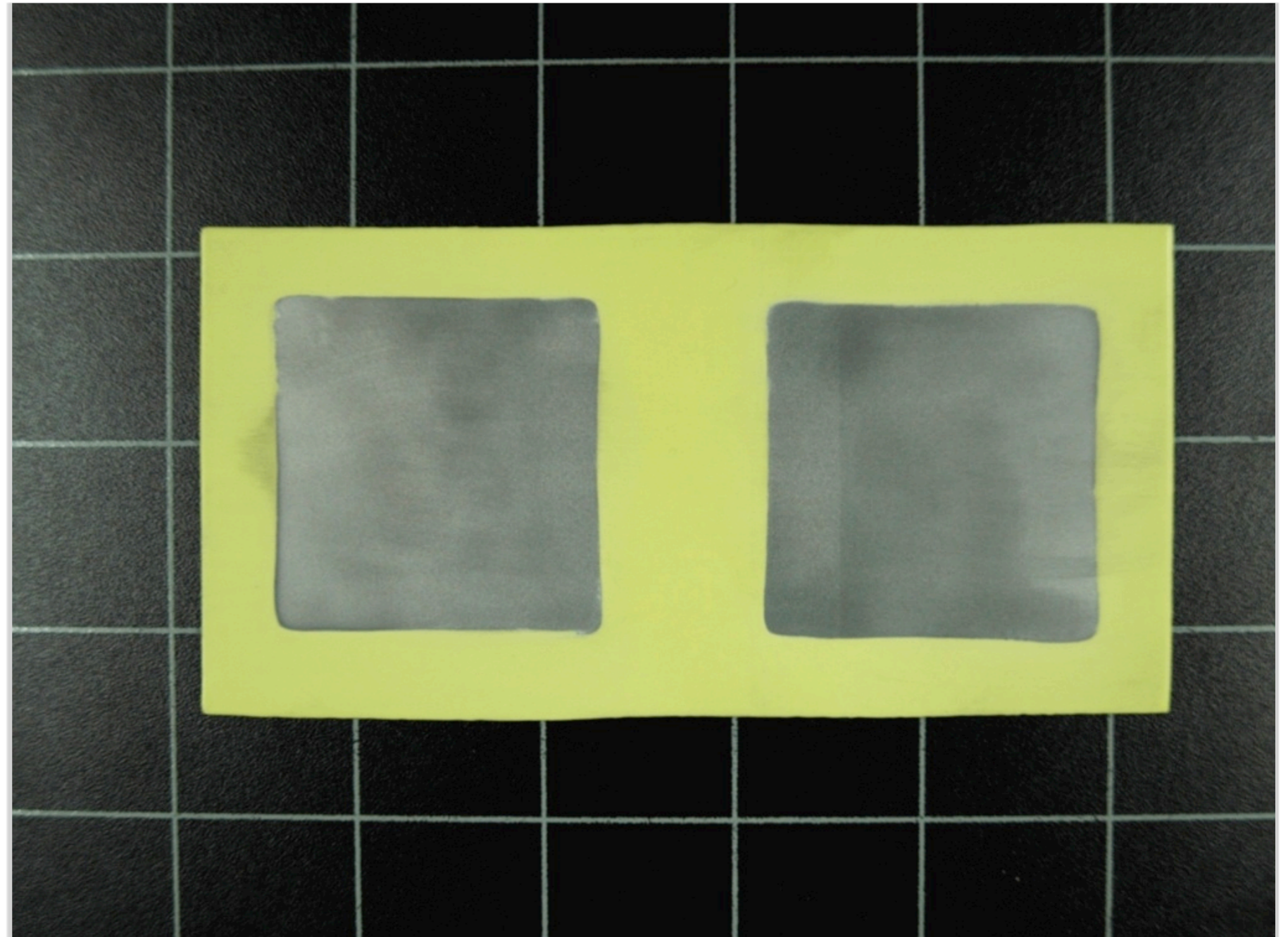
nano-Al-Trans[®]/Cr

nano-CP-Al

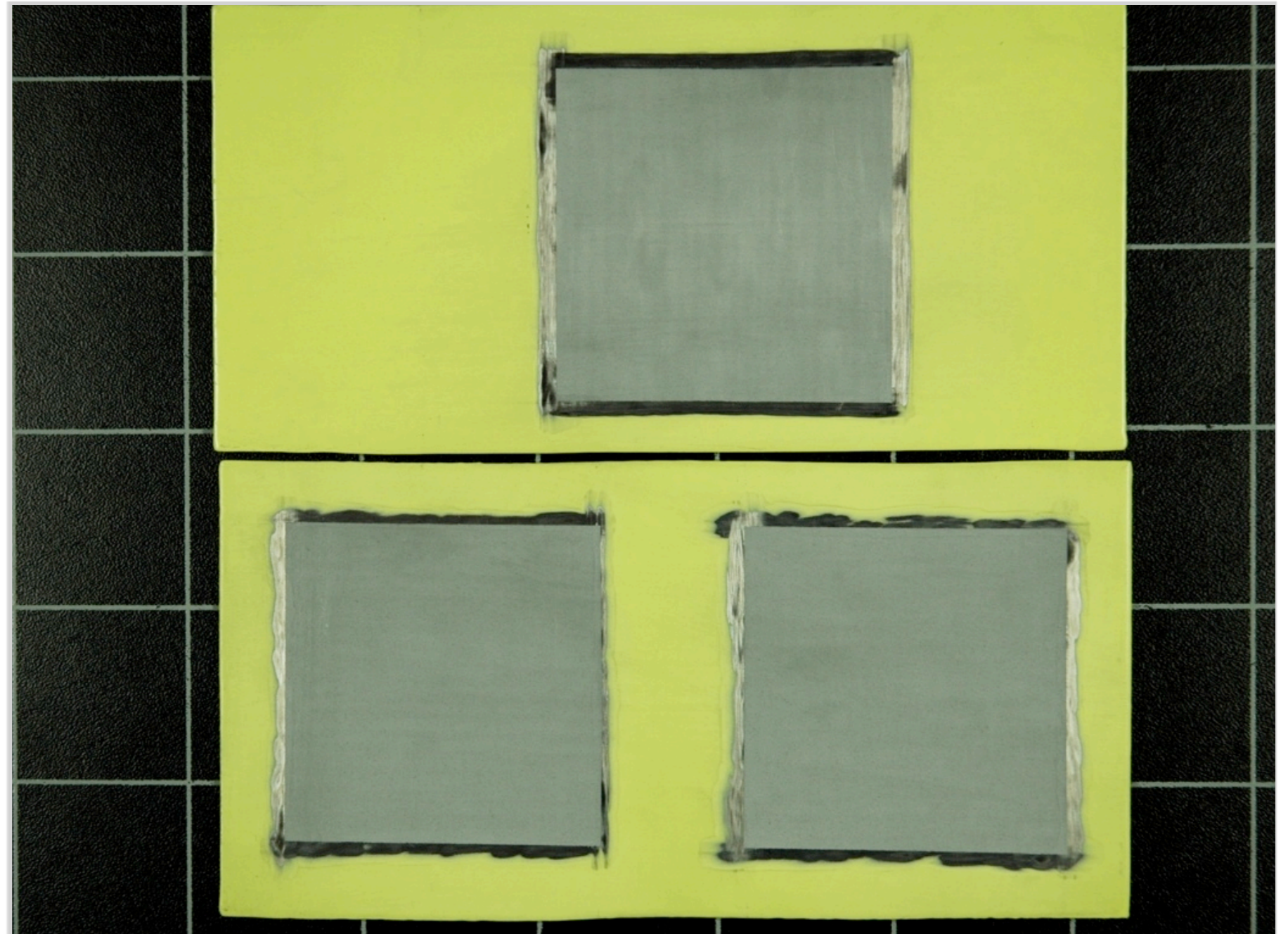
Neutral Salt Spray - 3000 Hrs
ASTM B117



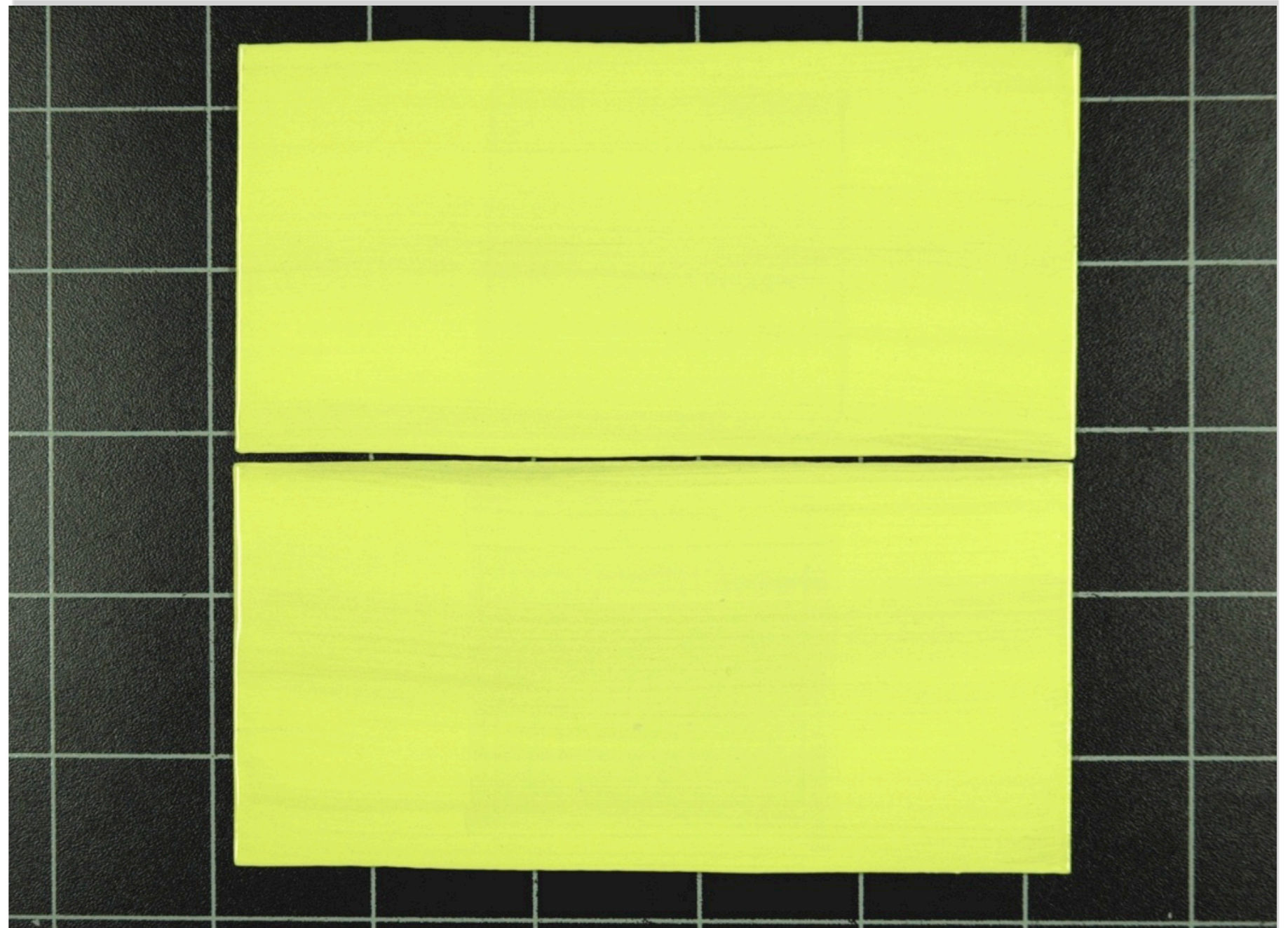
SO₂ Salt Spray
G85- 500 Hrs



Patch Preparation Areas
IVD-AI with Epoxy Primer Topcoat



KM Al-Trans[®]/Cr Patch Repairs with
Feather IVD-Al Border



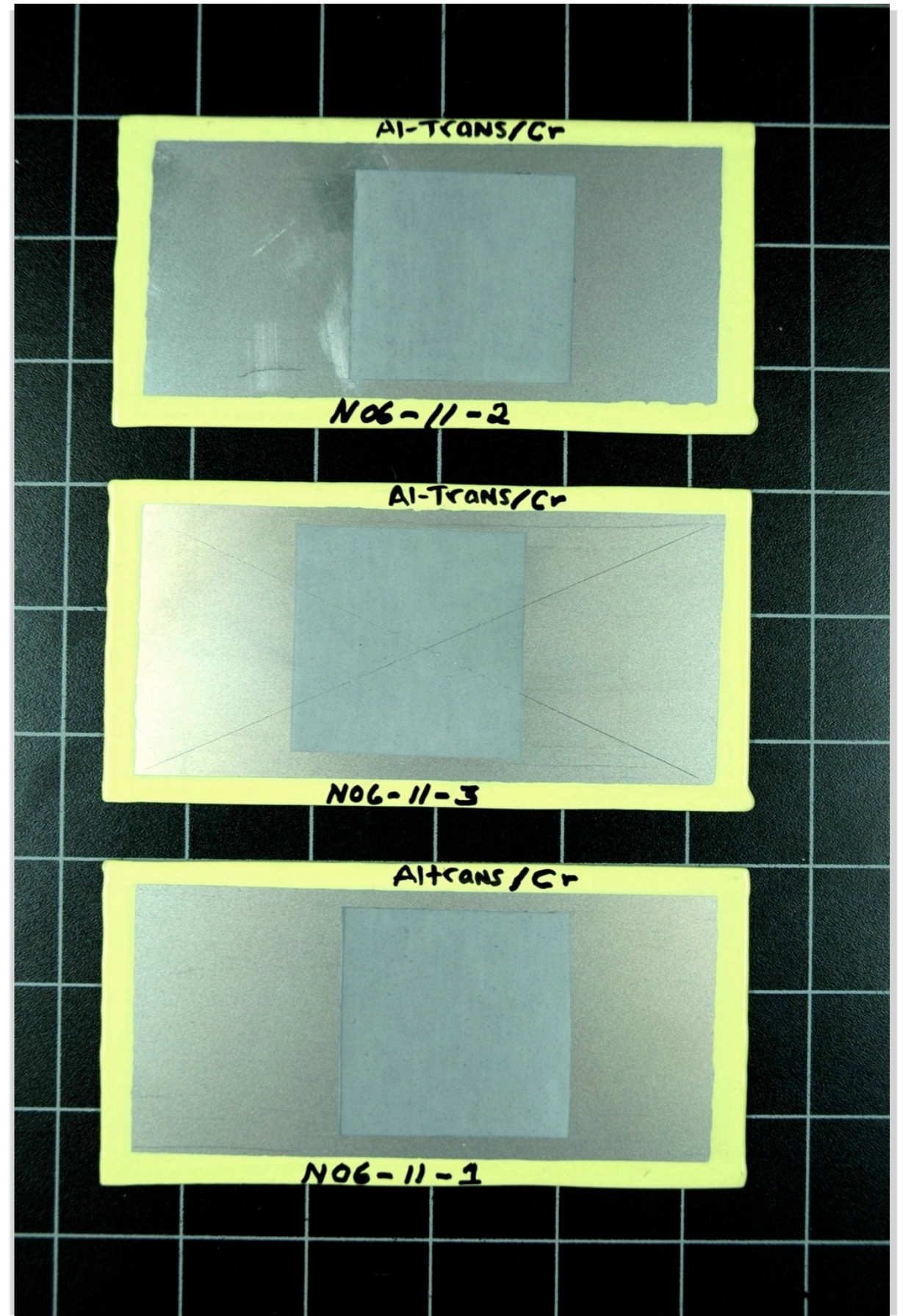
KM Al-Trans[®]/Cr Repair of IVD-Al Patch Areas
after Topcoat of Epoxy Primer

Neutral Salt Spray
1000 Hrs ASTM B117

Handheld KM Gun
Spray 1.0-1.5 mils
Al-Trans[®]/Cr Coating
on 4130 Steel



Handheld KM Gun
Spray 1.0-1.5 mils
Al-Trans®/Cr Coating
on 4130 Steel



KM Al-Trans[®] Future

- ▶ Qualification and Development
 - ▶ NAVAIR SBIR Phase IIB Award May 2006
 - ▶ IVD and AlumiplateSM repair process
 - ▶ Portable Kinetic Metallization unit
 - ▶ Coating qualification per JTP-2003
- ▶ Market Portable KM Units
 - ▶ Repair kit for commercial aircraft
 - ▶ Al-Clad, IVD and AlumiplateSM repairs
 - ▶ Repair unit for industrial applications