

Cr(VI)-free decorative and POP chromium plating A major step towards sustainable surface finishing

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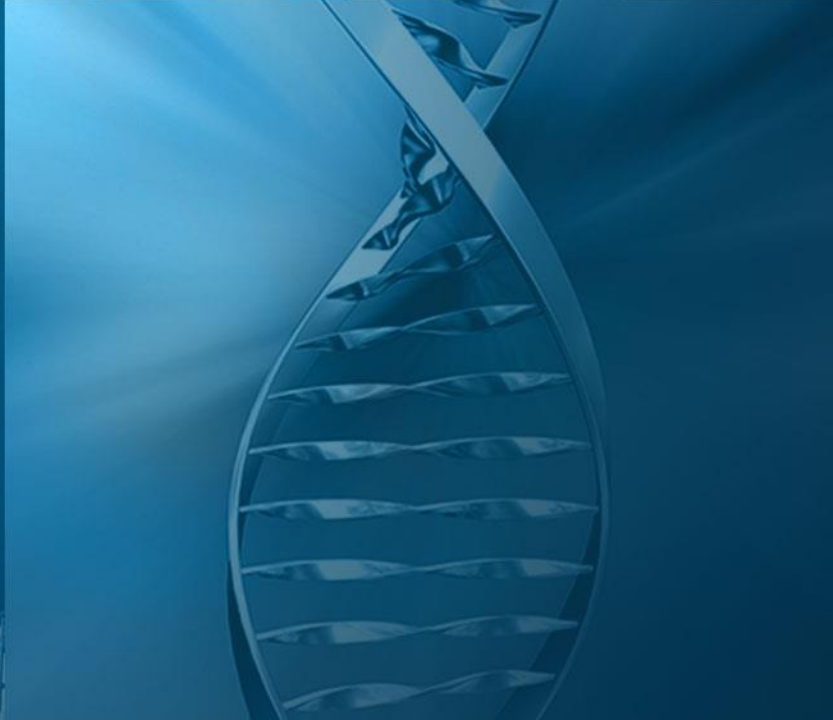


- The future without Cr(VI) and without PFAS
- POP Cr-free etching: Covertron[®] 600
- Decorative Cr(VI)-free chrome plating: TriChrome[®]
- Outlook and summary

A future without Cr(VI) & PFAS

Cr-free etching for plastics:
Covertron[®]

Trivalent chromium plating:
TriChrome[®]



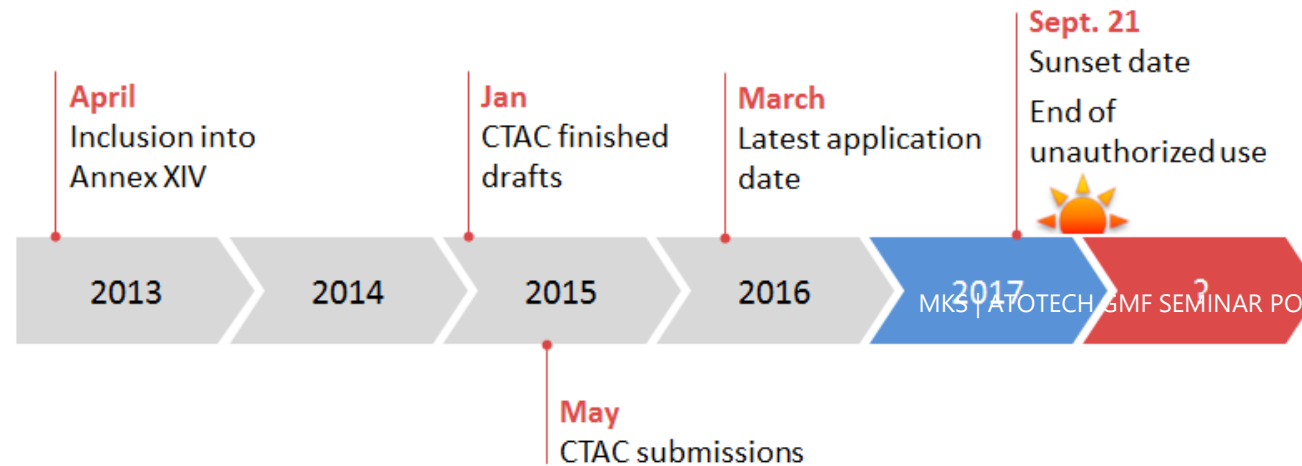
Sustainable chrome plating

Chromium trioxide | REACH | CTACSub

- **REACH** legislation in EU requires Cr(VI) substances to be authorized for use
- The **sunset** date for authorization was **September 21, 2017**
- **CTACSub current situation (Use 3: DECO/POP): Delay in decision, Substitution Plan** reviewed (next update expected: Q4-2023)

Users can legally continue the use of Cr(VI) under the specific CTAC application

- Escalation of individual applications since 2019: Consortia & individual companies applying for **authorization** for specific **uses**



CTAC: Chromium Trioxide Authorization Consortium

Cr(VI)-free and PFAS-free solutions for plating on plastics

Many steps to the final finish

1.

Plastic pretreatment

Preparation of the plastic:
metal layer adhesion

Making the
plastic
conductive



Covertron®

2.

Decorative plating

Multi-metal layer plating will provide:
appearance, corrosion resistance

Plating
the
metallic
layers

Copper

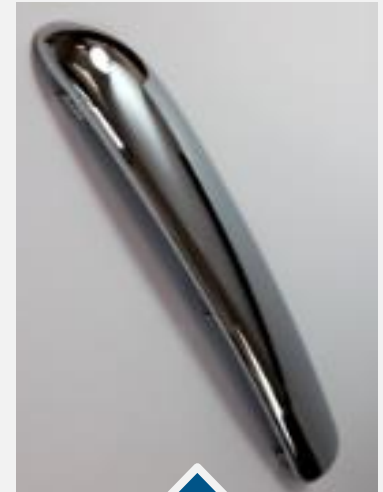


Cupracid® UP

Nickel



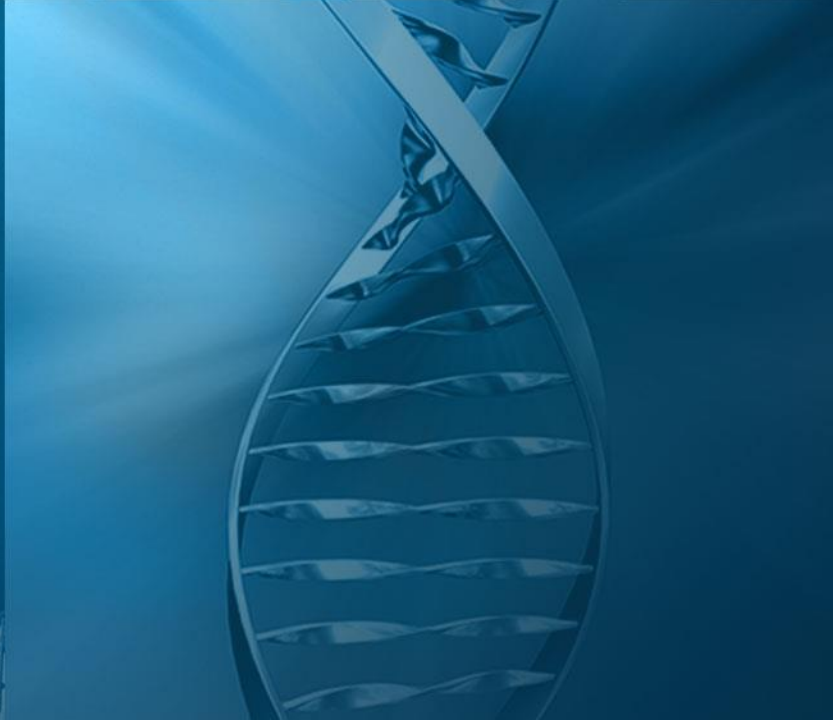
Chrome



TriChrome®

Covertron® 600

Cr-free
plating on plastics



Covertron® 600: Chrome-free etch for ABS, ABS/PC, others

At a glance

- Chrome-free process
- Key feature: Similar etching pattern compared to benchmark

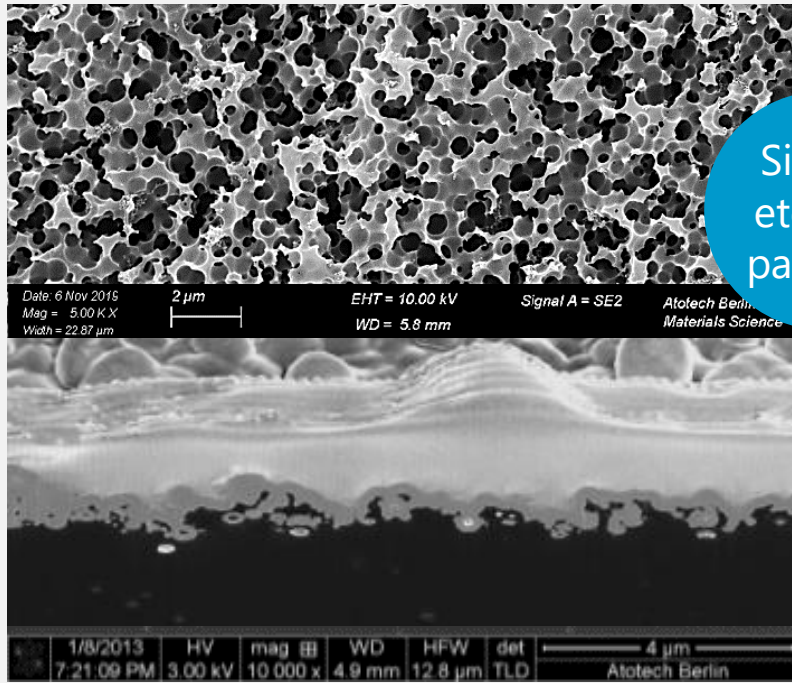
- Chemical, oxidant pretreatment

PFAS-free

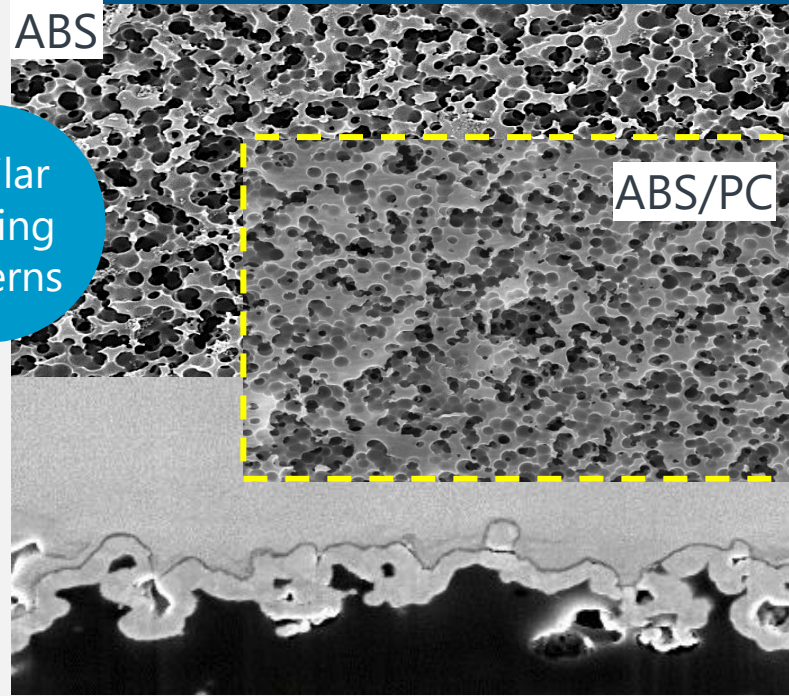
Fulfills the standard industry requirements:

- Appearance/cosmetic
- Adhesion
- Thermocycle tests from multiple OEMs
- Compatibility with existing plastics, including ABS and ABS/PC
- Selectivity 2K/3K

Cr(VI) etch



Covertron® 600 – Cr(VI)-free



Similar etching patterns

ASTM B533 standard industry requirements for peel strength testing:

Covertron® 600 - Cr-free etching:

ABS	15 – 20 N/cm
ABS/PC	7 – 10 N/cm

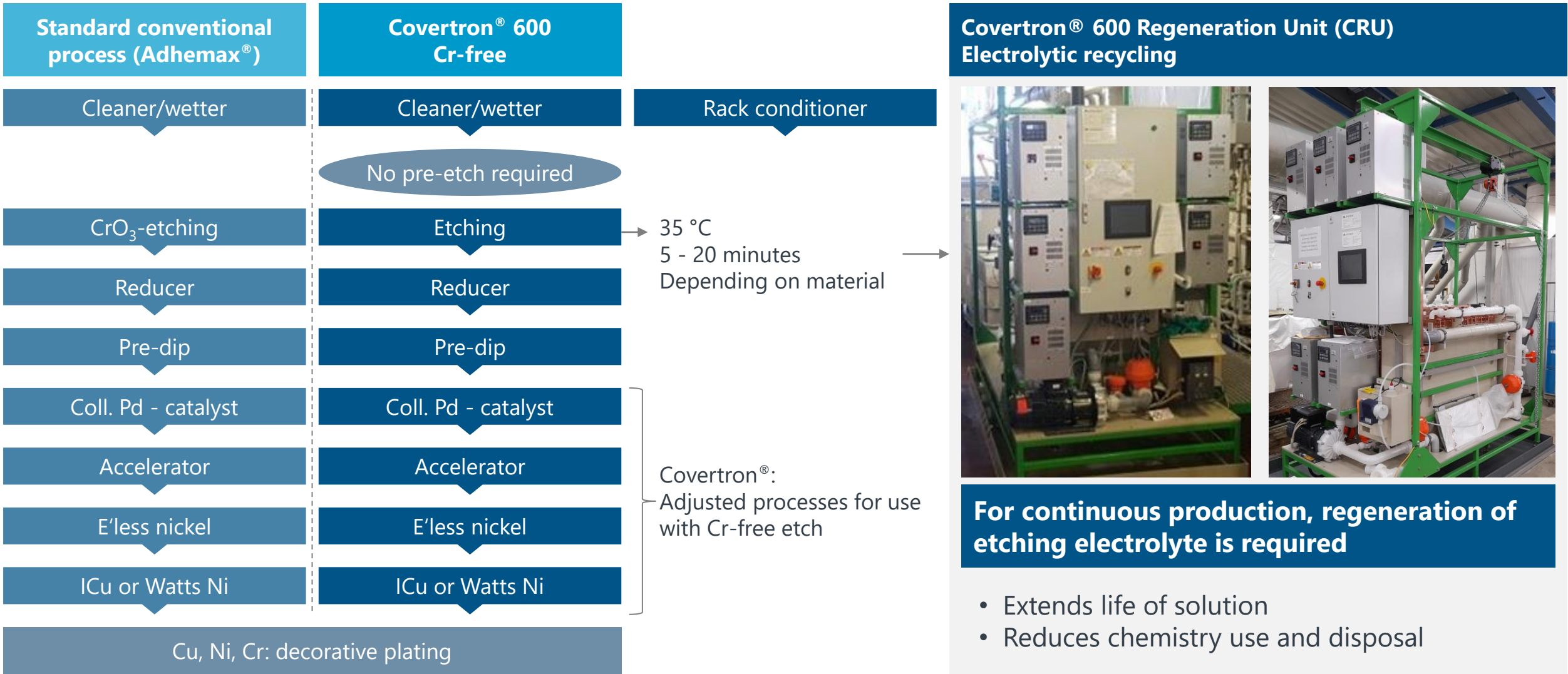
Typical specification:

ABS	> 9.0 N/cm
ABS/PC	> 4.5 N/cm

SEM = Scanning Electron Microscope

FIB = Focused Ion Beam

Covertron® 600: Process sequence (excluding rinses)

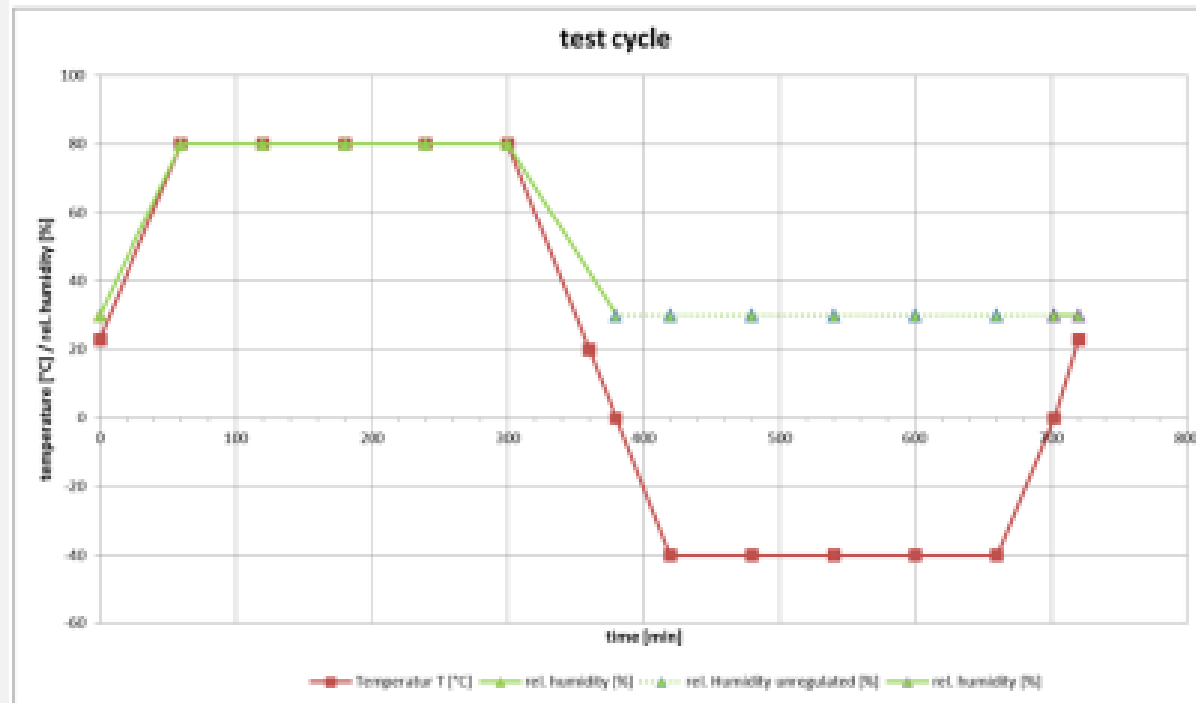


Covertron® 600 | Thermocycle/-shock tests

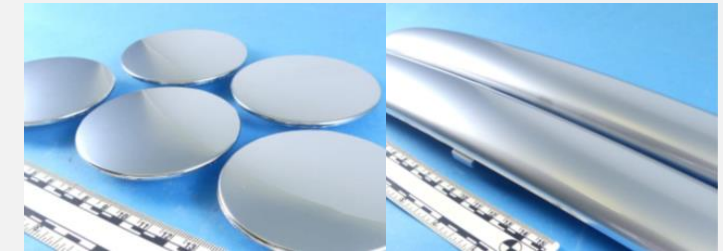
- Thermal cycle and thermoshock tests fulfilled (including Toyota TCT, VW PV1200/TL528, Volvo STD, Daimler DBL 8465, Nissan, Stellantis, GM and many more)
>>> No blisters, no cracks, no delamination

Example of thermocycle test

Several 12 h cycles between -40°C and 80°C



Thermocycle test PV1200



ABS and ABS/PC parts without any change after PV1200

Cr-free etch of ABS and ABS/PC

Plastics compatibility

Process



Examples of plastics ABS and ABS/PC resins:

- Novodur, Starex, Polylac, Lupoy, Bayblend, Terluran, Cicolac, Kuhmo, Infino, Sabic MC, UMG ABS, Xantar, Techno-UMG, etc.
- Over 300,000 samples plated in Atotech POP lines*

Other materials tested: PP, PEEK, PEI, 3D printing, etc.

Compatibility with 2K/3K materials

- Verified on a large number of references
- Suitable for stop off paint
- Case-by-case validation, similar to chromosulfuric etch

The resin, the part geometry, and the injection molding process all play an important role



*Details of customers' activities under Non-Disclosure Agreements

Covertron® 600 | Field experience | Covered by NDA

Automotive customers

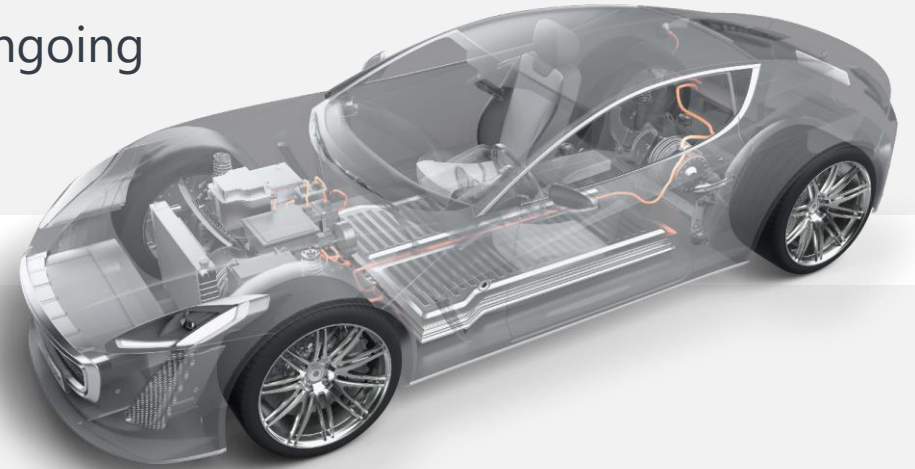
- Validated performance on **ABS and ABS/PC** for multiple OEMs
- **Selectivity** confirmed also for multiple 2K/3K references
- **Appearance, adhesion, thermocycles;** passing all requirements
- Internal and external pre-validations completed; passing all requirements
- Installed at **multiple customers in many countries** (Europe, Asia)
- Multiple PPAPs already achieved with multiple OEMs, a lot more ongoing
- **In production for exterior and interior;** including ABS, ABS/PC, 2K and 3K parts

Non-automotive customers

- Validation under production conditions achieved
- **In production**

In
production

Over 20
installations
worldwide



Technical benchmark with other processes in the industry

Ability to work with **ABS** and **ABS/PC**, wide working window, no need for specific resins — **Not all technologies can offer this, especially with ABS/PC** —

Industry requirements (including automotive), appearance, adhesion and thermocycle tests **passed** for both ABS and ABS/PC – in production for automotive



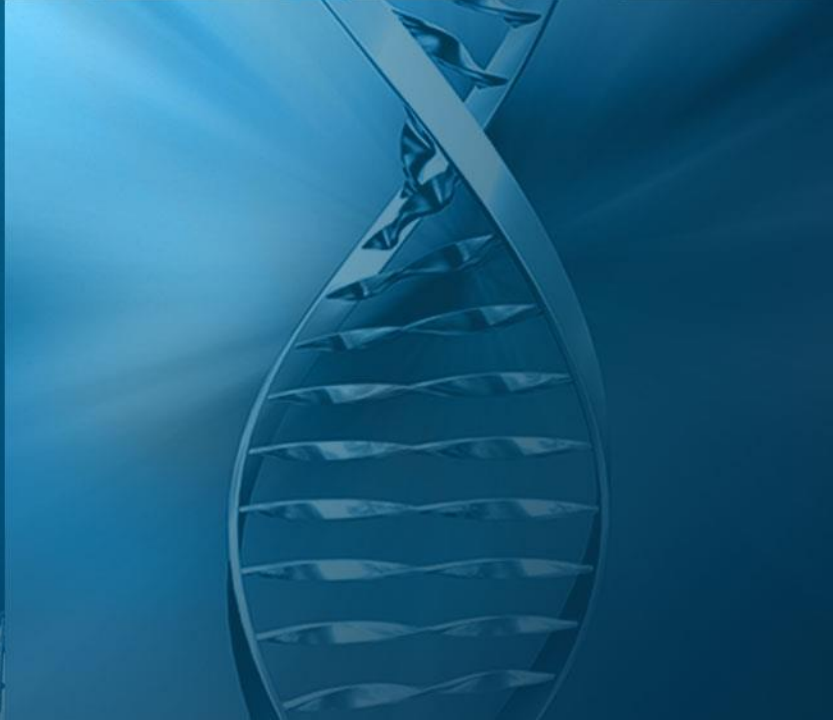
Ability to plate on **other plastic materials**, such as PP, PEEK, PEI, 3D printing, etc.

Compatibility/selectivity with **2K/3K materials** validated on many references

TriChrome[®]

Trivalent chromium
family

from Cr(VI)-like color
to dark finishes



TriChrome[®] processes

Overview

PFAS-free

Alternatives to hexavalent chrome

TriChrome[®] Plus

- High plating speed
- Passes CaCl₂/Russian Mud test
- Good corrosion resistance
- Use of graphite anodes

TriChrome[®] Ice

- Bright color, closest to Cr(VI)
- Good throwing power
- Good corrosion resistance
- Use of IMO anodes

Dark fashion finishes*

TriChrome[®] Smoke 2

Warm light grey color

TriChrome[®] Shadow

Light grey color

TriChrome[®] Titan

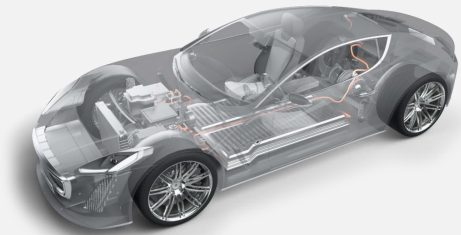
Deep neutral grey color

TriChrome[®] Graphite

Dark warm grey color

TriChrome[®] Phantom

Darker warm grey color



Our processes fulfill the requirements of the automotive industry and are approved by many OEMs.

Learn more online:
[Automotive approvals](#)

*based on TriChrome[®] Plus, similar features

TriChrome[®] Ice and Plus

Features and benefits

in production for multiple markets,
including automotive OEMs



Bright chrome finishes

TriChrome[®] Ice

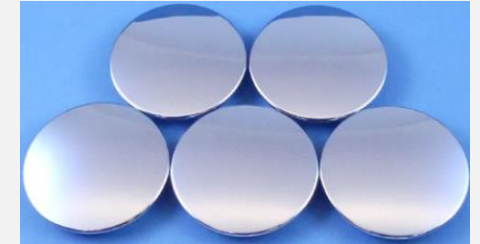
TriChrome[®] Plus

TriChrome[®] Ice and Plus
with multilayer nickel, microporous nickel,
STEP adjustments and Cr(VI)-free post-treatment

CASS	> 80 h
NSS	> 480 h*
CaCl ₂	Pass for TriChrome [®] Plus
Color	Depends on process

- Bright trivalent chromium processes
- TriChrome[®] Plus: long experience, fast plating speed and excellent resistance to calcium chloride corrosion, in production for automotive for over 10 years and other markets for over 40 years
- TriChrome[®] Ice: ideal for components where the color needs to match hexavalent chromium

720 h NSS, o10



NSS test

TriChrome[®] Ice +
TriSeal[®] 500

Kesternich, o10



Kesternich test

TriChrome[®] Ice + TriSeal[®] 300

* with Cr(VI)-free TriSeal[®]

TriChrome[®] Smoke 2, Shadow & Graphite

Features and benefits

in production for multiple markets,
including automotive OEMs



Dark chrome finishes

TriChrome[®] Smoke 2

TriChrome[®] Shadow

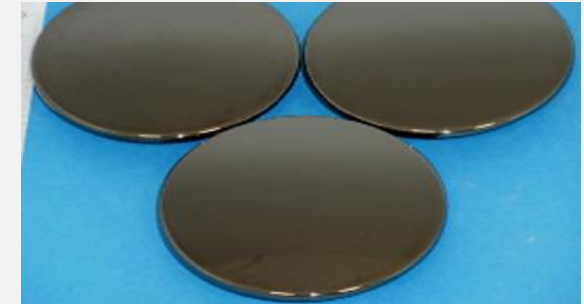
TriChrome[®] Graphite

TriChrome[®] Smoke 2, Shadow & Graphite
with multilayer nickel, microporous nickel,
STEP adjustments and Cr(VI)-free post-treatment

CASS	> 80 h
NSS	> 480 h*
CaCl ₂	Pass
Color	Depends on process

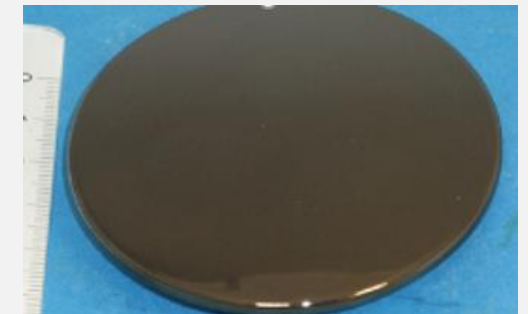
- Dark trivalent chromium processes
- Stable color and plating speed in production
- Ideal processes for automotive designers looking for darker colors

96 h CASS, o10



CASS test
TriChrome[®] Graphite

120 h CaCl₂



CaCl₂ test
TriChrome[®] Graphite

* with Cr(VI)-free TriSeal[®]

TriChrome® Titan and Phantom

Features and benefits

NEW finishes!
In production for multiple OEMs



Dark chrome finishes

TriChrome® Titan

TriChrome® Phantom

**TriChrome® Titan and Phantom
with multilayer nickel, microporous nickel,
STEP adjustments and Cr(VI)-free post-treatment**

CASS	> 80 h
NSS	> 480 h*
CaCl ₂	Pass
Color	Depends on process

- Dark trivalent chromium processes
- Stable color and plating speed in production
- Ideal processes for automotive designers looking for darker colors
- Automotive approvals: multiple OEMs already granted



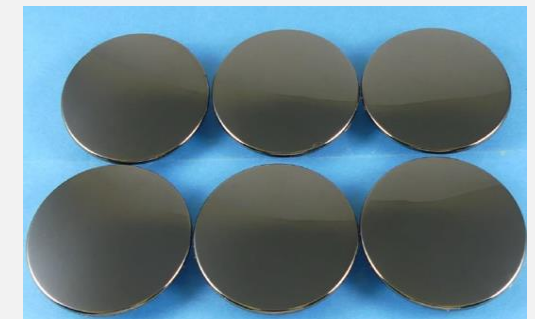
**Comparison of color tone vs
TriChrome® Graphite**

96 h CASS, o10



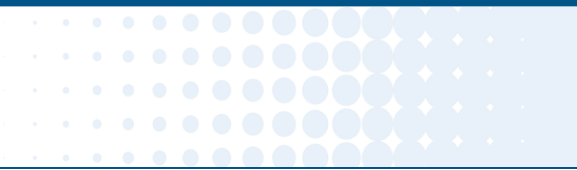
CASS test
TriChrome® Titan

480 h NSS, o10



NSS test
TriChrome® Phantom

* with Cr(VI)-free TriSeal®



TriSeal[®] 500

- Cr(VI)-free post-treatment for all TriChrome[®] processes
- Applicable to:
 - TriChrome[®] Ice and Plus
 - TriChrome[®] Smoke 2, Shadow, Graphite, Titan and Phantom
- NSS resistance: minimum > 480 h (o10) ✓



It is more than just TriChrome®



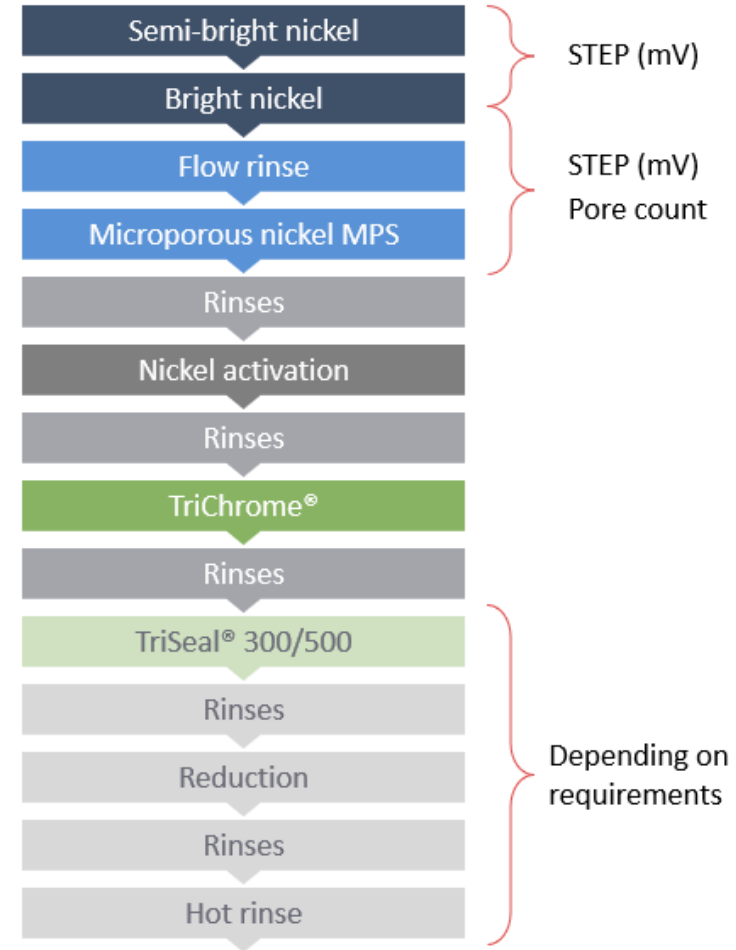
The final chrome layer is part of a multilayer system

Over 40 years of experience with TriChrome®

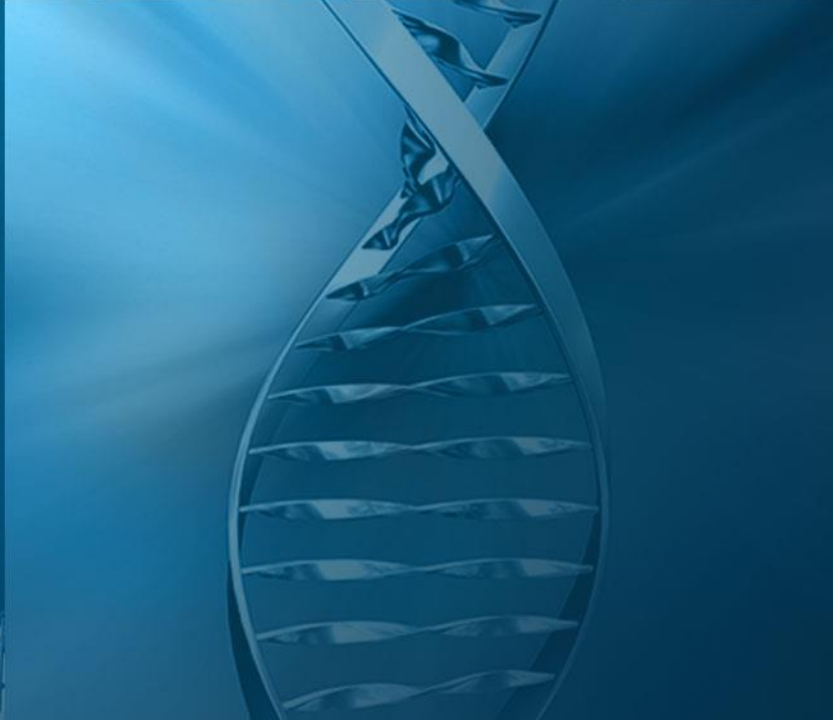
Appearance and corrosion resistance start from the Cu / Ni layers!

The patented Atotech multilayer system and TriChrome® solution helps to reach the high corrosion requirements of the automotive industry for exterior applications

Over 200 customers worldwide



Outlook and summary



Beyond the REACH for many. Not for us.

Completely Cr(VI)-free decorative chrome plating – from pretreatment to post-treatment



Over 40 years
of experience
with
TriChrome®

**PFAS-
free**

Covertron®
for Cr-free
etching of
plastics

**All from
one
source**

