2017 Continued Advancements in Decorative PVD Chromium Coatings

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Van Etten, NY  USA
2017 Updates for SUPERCHROME PVD Coating
Discussion Topics

- Current/Future Status: Chrome in EU
  - REACH Initiative
  - ECHA European Chemicals Agency
  - Volumes
- PVD advantages
- Recent SUPERCHROME PVD Coating developments
- Summary
REACH and ECHA - Refresher

- REACH (EC 1907/2006): The Regulation also calls for the progressive substitution of the most dangerous chemicals (referred to as "substances of very high concern") when suitable alternatives have been identified.

- Cr6 or Chrome Trioxide is a substance of very high concern.

- **Late 2016 and early 2017:**
  Very Active dialogue between ECHA and concerned parties on both sides of the POP/Industrial equation: **Traditional Chrome platers and PVD Chrome alternatives** - TBD what extensions may be granted......
Global POP Market Growth Trends*

- In 2016:
  - 91 million square meters
  - $403 million USD

- In 2023:
  - 142 million square meters
  - $650 million USD

- Europe & Asia: 73%, USA 21%
- ABS, PC, ABS/PC: 91%
- Automotive market: 80%

*Source: Global Market Insights, Inc. 2016
Advantages of SUPERCHROME PVD Coating

- Bright or dark, gloss or matte
- REACH-conform
- Environmentally-friendly
- Corrosion resistance
- Safety
Chrome Plating

Bright Nickel
Semibright Nickel
Acid Copper

0.2 – 0.3 μm
Electroplated Cu + Ni ~ 35 μm

Base (Plastic)

Bright Chrome
Microporous Nickel
High "5" Nickel
Copper strike
Metallizing electroless

PVD Metallizing
Traditional Triple Stack:
Base Coat/PVD/Top Coat

UV / Thermal Top Coat
UV / Thermal Primer Base Coat
PVD Metal Coating

Base (Plastic)
SUPERCHROME PVD Coating vs. Triple Stack Coating

**PVD Metallizing**

**Traditional Triple Stack:**
- Base Coat/PVD/Top Coat

**Double Stack:**
- Base Coat/PVD
- No Top Coat necessary

**SUPERCHROME PVD Coating**

**Double Stack:**
- Base Coat/PVD
- No Top Coat necessary

**SUPERCHROME 0.3 – 1.15 μm**

**Top Coat alters visual appearance**

**Natural Chrome Color**
Functionality and Design Choices

- **Substrate materials:** PC/ABS, ABS,
- **Temperature range:** -40° to 85°C
- **Full integration** into paint lines using UV-cured base coat
- **Day/Night Design** with laser etching
- **Radar-Transparency** metalized components do not block crash avoidance and lane changing monitoring systems
- **Integration of Capacitance Sensing**
SUPERCHROME PVD Coating
Versatile & Durable

Two Layer Decorative Coating for Automotive Interior/Exterior Parts:

- Substrate + UV-Base Coat + SUPERCHROME PVD Coating: No top coat necessary
- Possibility to apply on different plastics and metal alloys
- Several UV-cured base coats (Mankiewicz) for different SUPERCHROME PVD Coating finishes tested and approved
- No corrosion risk, excellent adhesion, thermal stability and humidity resistance
UV Base Coat for SUPERCHROME PVD Coating PVD Coating

- Superior product properties
  - Specification-compliant properties: mechanical and chemical resistance
  - Excellent surface for support and adhesion of PVD coatings
- Short process times
  - CYCON® UV coatings are fully cured within seconds
  - Complete elimination of oven drying
- Low capital expenditure requirements:
  - Requires less production floorspace
- Shorter processing saves energy and investment costs
- Low VOC
UV Streamlines Manufacturing for Profitability

- Short, fast processing time
- Low scrap rate
- Smaller footprint than thermal cure paint lines
- Integrates into LEAN synchronous manufacturing

3 – 5 min
Technical Performance: Met or Exceeded

- Formal Specifications
  - Appearance
  - Adhesion
  - Weathering
  - Mechanical
  - Chemical resistance

- New Attributes
  - Weight savings
  - Flexibility
  - Laser etch day/night
  - Capacitive sensing
## Test Results – Visual, Adhesion, Weathering

<table>
<thead>
<tr>
<th>Standards Tested - Visual, Adhesion, Weathering</th>
<th>SUPERCHROME with UV Base Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Appearance Interior VW TL226</td>
<td>PASS</td>
</tr>
<tr>
<td>Initial Adhesion Interior VW TL226 &amp; Exterior VW TL211/528</td>
<td>PASS</td>
</tr>
<tr>
<td>Visual Appearance after 2d 60°C Interior VW TL226</td>
<td>PASS</td>
</tr>
<tr>
<td>Adhesion after 2d 60°C Interior VW TL226</td>
<td>PASS</td>
</tr>
<tr>
<td>Visual Appearance after 24 h 90°C Interior TL226</td>
<td>PASS</td>
</tr>
<tr>
<td>Visual Appearance after Constant Climate 240h 40°C, &gt;96% relative humidity Interior VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Adhesion after Constant Climate 240h 40°C, &gt;96% relative humidity VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Artificial Aging UVB Procedure A PSA B72 0200/2013-04</td>
<td>PASS</td>
</tr>
<tr>
<td>Water Absorption BAC FORD PSA B72 0200/2013-04</td>
<td>PASS</td>
</tr>
<tr>
<td>PV1200 Climate Change Test VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Neutral Salt Spray VW TL528</td>
<td>PASS</td>
</tr>
<tr>
<td>Salt Spray ASTM B117-11</td>
<td>PASS 1000 Hours</td>
</tr>
<tr>
<td>CASS</td>
<td>PASS 120 Hours</td>
</tr>
<tr>
<td>PV3930 Florida Sunshine VW TL211</td>
<td>PASS 2400 Hours</td>
</tr>
<tr>
<td>Russian (CaCl2)Mud per ASTM B995</td>
<td>PASS 336 Hours</td>
</tr>
<tr>
<td>Hydrolysis 95°C, 95% RH, 72 hour</td>
<td>PASS</td>
</tr>
</tbody>
</table>
# Test Results - Mechanical

<table>
<thead>
<tr>
<th>Standards Tested - Mechanical</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to Gritting Renault 47-03-003/L-2013</td>
<td>PASS</td>
</tr>
<tr>
<td>Stone Chipping, VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Stone Chipping, PSA B72 0200/2013-04</td>
<td>PASS</td>
</tr>
<tr>
<td>Gravelometer/70 CASS</td>
<td>PASS</td>
</tr>
<tr>
<td>Resistance to Scratching by Abrasion Renault 47-03-003/L-2013</td>
<td>PASS</td>
</tr>
<tr>
<td>Crockmeter BMW Exterior</td>
<td>PASS</td>
</tr>
<tr>
<td>Car Wash Brush Resistance VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Abrex</td>
<td>PASS</td>
</tr>
<tr>
<td>Martindale</td>
<td>PASS</td>
</tr>
</tbody>
</table>
## Test Results - Chemical

<table>
<thead>
<tr>
<th>Standards Tested - Chemical</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cream A Interior VW TL226</td>
<td>PASS</td>
</tr>
<tr>
<td>Cream B Interior VW TL226</td>
<td>PASS</td>
</tr>
<tr>
<td>High Pressure Cleaning VW TL 211</td>
<td>PASS</td>
</tr>
<tr>
<td>Hydrolysis Interior BMW</td>
<td>PASS</td>
</tr>
<tr>
<td>FAM test fuel VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Gasoline E10 VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Diesel B7 VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Isopropanol VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Ethanol/Water Exterior BMW</td>
<td>PASS</td>
</tr>
<tr>
<td>Sodium Hydroxide 5% VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Sulfuric Acid 10% VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Hydrochloric Acid 10% VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Hydrochloric Acid 30% Suspended in Vapors</td>
<td>PASS 24 Hours</td>
</tr>
<tr>
<td>Bird Droppings VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Liquid Tree Pitch VW TL211</td>
<td>PASS</td>
</tr>
<tr>
<td>Vomit Exterior BMW</td>
<td>PASS</td>
</tr>
<tr>
<td>Deionized Water Exterior BMW</td>
<td>PASS</td>
</tr>
<tr>
<td>Wheel Cleaner Exterior BMW</td>
<td>PASS</td>
</tr>
<tr>
<td>Underbody Sealant BMW</td>
<td>PASS</td>
</tr>
</tbody>
</table>
SUPERCHROME PVD Coating System
Integrated production - Batch

SUPERCHROME 660
PVD Coating System

- Batch-type rapid cycle metallizer
- Sputter-coating
- Deposit metals such as chromium, aluminum, brass, copper, stainless steel, nickel - chrome alloys, etc.
SUPERCHROME PVD Coating System
Integrated production - Batch

SC 660 PVD Coating System

- Single-point loading and safety enclosure
- Robotic load/unload available
Substrate Coating Zone

- Coating zone 2.725 square meters
- Single or dual axis rotation, optimizes coating zone
- Load/Unload fixtures off line
- Double door design minimizes open vacuum chamber time
- 4 cycles per hour, 22,880 cycles per year or 62,348 coated square meters per year
- Capital Expense for painting and PVD equipment ($2mm) amortized 5 years = $3.21 per square meter
Latest Developments

- US Patent Approved, EU/Asia Pending
- Daimler grants S1 Approval, S2 trials currently underway with parts on cars.
- Field test at Volvo Trucks and Opel ongoing
- First European installation and commissioning of SUPERCHROME PVD Coating system in France: Société de Peinture sur Pièces Plastiques (SPPP) Tier 2 Supplier to EU Tier 1’s
Latest Developments

- Matte finishes continue to be improved
- SUPERCHROME PVD Coating on Steel and Aluminum Wheels in USA
- “Black Chrome” Advancements
- Cost models continue to demonstrate 10-20% savings over POP
Conclusions

- PVD process and equipment technology is making strong headway for safe replacement of some applications of electroplated chromium on plastic substrates
- SUPERCHROME PVD Coatings are gaining acceptance for internal and external automotive applications as well as for use in sanitary and appliance markets
Thank You!

Our European distributor for sales and service
Toni Jochum and team at A5152:

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