SuperChrome™ PVD Coating

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SPE Decorating & Assembly TopCon
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Vergason Technology, Inc.

- Design, assembly, process development and commissioning of PVD/PECVD plasma equipment and turn key solutions
- Service and Distribution partners in Europe, Asia, Central/South America
- Job Coating Services available in USA
- First Rapid Cycle Coater built: 1988
  - 37 second cycle time, LEAN manufacturing
- > 200 Systems installed worldwide
- 35 Years experience in PVD technology
  - Tribological, shielding, reflective, decorative coatings
- Sales & Service in Europe provided by jobaTEC GmbH

Vergason Technology, Inc. Van Etten, New York
Physical vapor deposition (PVD) describes deposition methods used to deposit thin films by the condensation of a vaporized form of the desired film material (e.g. aluminum, chrome) onto the substrate surfaces (e.g., automotive plastic parts).

The coating method involves physical processes such as high-temperature vacuum evaporation with subsequent condensation, or plasma sputter bombardment. Includes: thermal, sputtering and cathodic arc deposition.
Advantages of PVD

- **Shiny or dark, gloss or matte:**
  broad spectrum of color shades and effects in chrome from bright chrome to dark chrome and colored PVD

- **REACH-conformal:**
  both in production and disposal avoiding Cr$^{3+}$, Cr$^{6+}$ and Ni

- **Environmentally-friendly:**
  clean technology, few waste issues

- **Corrosion resistance:**
  applies to automotive test requirements in combination with or without top coat

- **Safety advantage:**
  The thin PVD coating and the use of flexible substrates enables safety-relevant applications e.g. impact protection airbag emblems and others
PVD Metallizing versus Chrome Plating

Chrome Plating

- Base Coat
- Bright Nickel
- Microporous Nickel
- High "S" Nickel
- Copper strike
- Metallizing electroless

PVD Metallizing

- Base Coat
- PVD
- Top Coat
- UV / Thermal Primer Base Coat
- UV / Thermal Top Coat

Traditional Triple Stack:
Base Coat/PVD/Top Coat

0.2 – 0.3 μm
Electroplated
Cu + Ni
~ 35 μ
SuperChrome™ PVD versus Triple Stack Coating

**PVD Metallizing**

Traditional Triple Stack:
Base Coat/PVD/Top Coat

- UV / Thermal
  - Top Coat 15 – 25 μm

- UV / Thermal
  - Primer Base Coat 15 – 25 μm

**Base (Plastic)**

- PVD Metal Coating
  - 0.04 – 0.10 μm

**SUPERCHROME PVD Coating**

Double Stack:
Base Coat/PVD
No Top Coat necessary

**SUPERCHROME 0.3 – 1.15 μm**

**Base (Plastic)**

- UV / Thermal
  - Primer Base Coat 15 – 50 μm

Top Coat Darkens, Color Loses Depth

True Deep Chrome Color
Functionality and Design Choices

▪ Large variety of substrate materials: PC/ABS, PC, ABS, PPE, PA, ASA, PC/PBT, BMC

▪ Temperature range: up to 85°C

▪ Full integration into paint lines using UV-cured base coat

▪ Versatile Production Asset: Other coatings aluminum, chrome, titanium, stainless steel, nickel chrome, copper, silver, gold, brass etc.

▪ To Be Proven
  ▪ Integration of Capacitance Sensing
  ▪ Radar-Transparency metalized components do not block crash avoidance and lane changing monitoring systems

▪ Possibilities
  ▪ Day/Night Design with laser etching
  ▪ Light Transparency: based on partially transparent PVD coatings
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

• 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 floor space
• Shorter processing saves energy and investment costs
• Low VOC
SuperChrome: Versatile & Durable

Two Layer Decorative Coating for Automotive Interior/Exterior Parts

• Environmentally compatible alternative to galvanic Chrome (conforms with REACH)

• Can be altered in appearance to achieve certain design effects (bright/medium/dark Chrome)

• SUPERCHROME PVD Coating meets major test requirements for automotive interior and exterior parts.
UV Streamlines Manufacturing for Profitability

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

Cleaning → Spraying UV paint → Flash-off → UV Curing → PVD Coating

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 4800 Hours</td>
</tr>
<tr>
<td>Russian (CaCl2)Mud per ASTM B995</td>
<td>PASS 336 Hours</td>
</tr>
<tr>
<td>Hydrolysis 90°C, 95% RH, 72 hour</td>
<td>PASS</td>
</tr>
</tbody>
</table>
## Test Results - Mechanical

<table>
<thead>
<tr>
<th>Standards Tested - Mechanical</th>
<th></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>Result</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>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
Conclusions

- PVD process and equipment technology is making strong headway for safe replacement of some applications of electroplated chromium on plastic substrates.
- Key work for chromium coatings on plastic substrates with no top coating was started four decades ago.
- SUPERCHROME PVD Coatings are gaining acceptance for internal and external automotive applications as well as for use in sanitary and appliance markets.
- Batch and Inline-Systems available.
- Job coating services available in USA.