SuperChrome ™ PVD Coating

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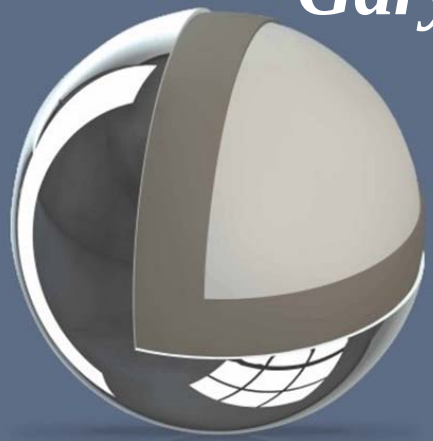


ITB Smart Automotive Surfaces

September 28-29, 2016

Vergason Technology, Inc.

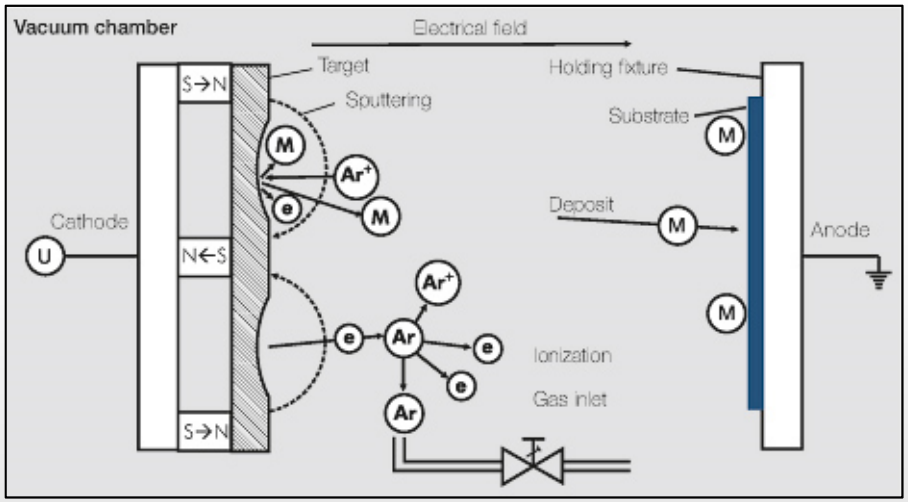
- Design, assembly, process development and commissioning of PVD/PECVD plasma equipment and turn key solutions
- Service and Distribution partners in Europe, Asia, Central/South America
- Job Coating Services available in USA
- First Rapid Cycle Coater built: 1988
  - 37 second cycle time, LEAN manufacturing
- > 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

Introduction to PVD Technology

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.

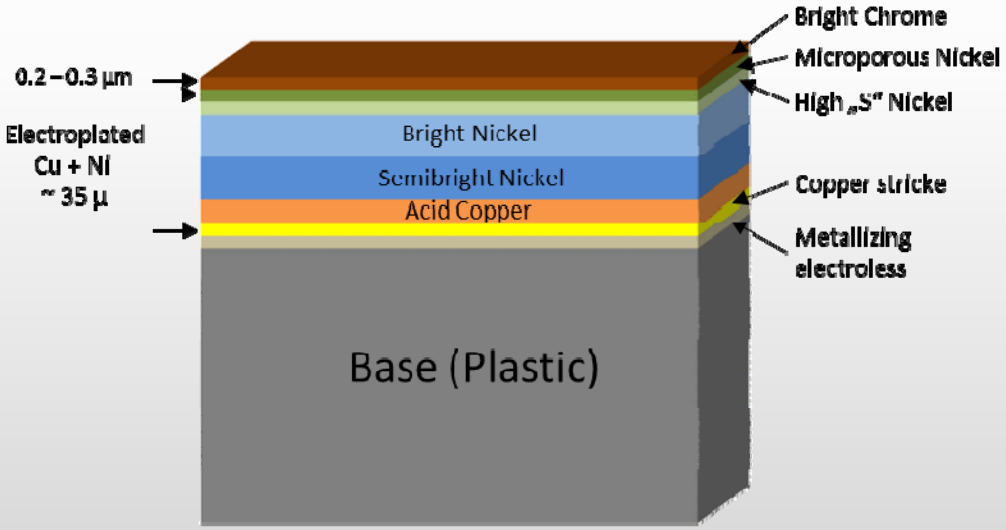


Advantages of PVD

- **REACH-conform:**
  both in production and disposal avoiding Cr3+, Cr6+ and Ni
- **Environmentally-friendly:**
  clean technology, few waste issues
- **Color flexibility:**
  broad spectrum of color shades and effects in chrome from bright chrome to dark chrome and colored PVD
- **Corrosion resistance:**
  applies to automotive test requirements in combination with or without top coat
- **Safety aspect:**
  The thin PVD coating and the use of flexible substrates enables safety-relevant applications e.g. impact protection airbag emblems and others

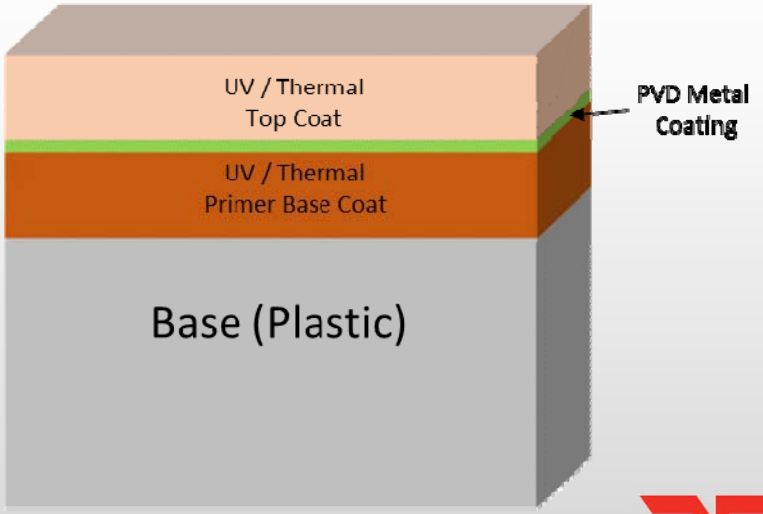
PVD Metallizing versus Chrome Plating

Chrome Plating



PVD Metallizing

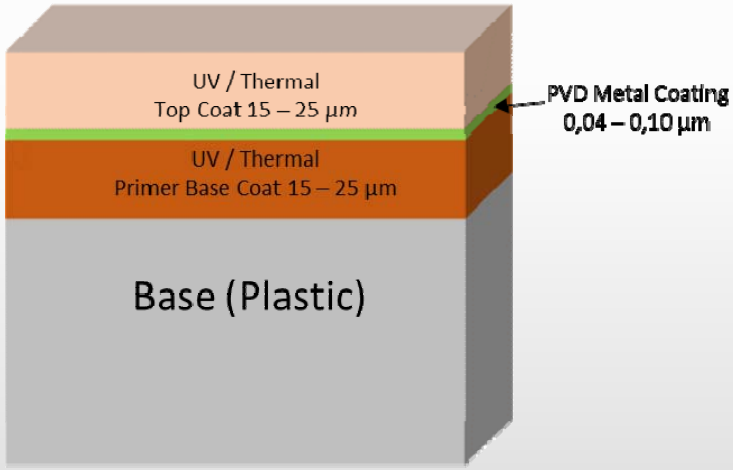
Traditional Triple Stack:
Base Coat/PVD/Top Coat



SuperChrome™ PVD vesrsus Triple Stack Coating

PVD Metallizing

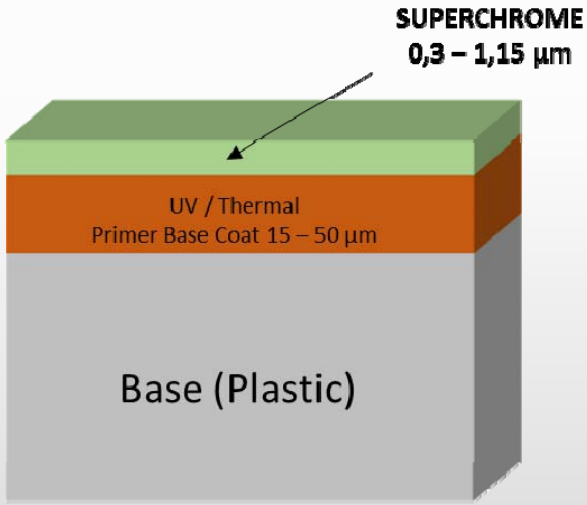
Traditional Triple Stack:
Base Coat/PVD/Top Coat



Top Coat Darkens, Color Loses Depth

SUPERCHROME PVD Coating

Double Stack:
Base Coat/PVD
No Top Coat necessary



True Deep Chrome Color

Functionality and Design Choices

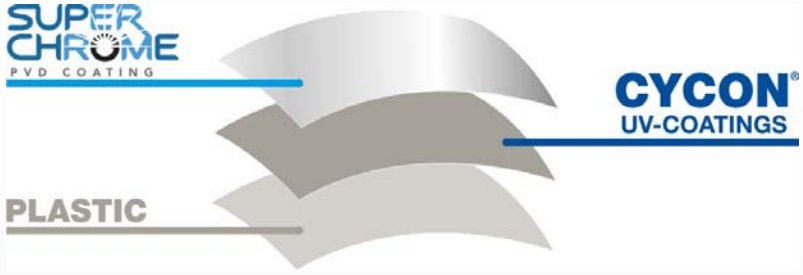
- **Large variety on substrate materials:** PC/ABS, PC, ABS, PPE, PA, ASA, PC/PBT, BMC
- **Day/Night Design** with Laser etching
- **Radar-Transparency** metalized components to not block crash avoidance and lane changing monitoring systems

- **Light Transparency:** based on partially transparent PVD coatings
- Integration of **Capacitance Sensing**
- **Temperature range:** 40° to 85°C
- **Full integration** into paint lines using UV-cured base coat
- **Variety of metal targets:** aluminum, chrome, titanium, stainless steel, nickel chrome, copper, silver, gold, brass etc.

SuperChrome: Versatile & Durable

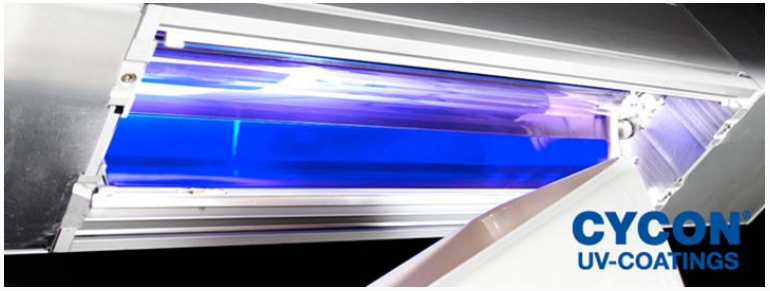
Two Layer Decorative Coating for Automotive Interior/Exterior Parts

- 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

- 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

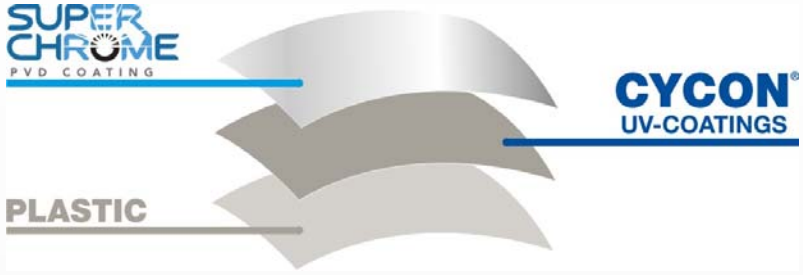


MANKIEWICZ
Coating Concepts of the Future

SuperChrome: Versatile & Durable

Two Layer Decorative Coating for Automotive Interior/Exterior Parts

- Environmentally compatible alternative to galvanic Chrome (REACH – conform)
- 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

3 – 5 min

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

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

Technical Performance: Met or Exceeded

- Formal Specifications
  - Appearance
  - Adhesion
  - Weathering
  - Mechanical
  - Chemical resistance
- New Attributes
  - Weight savings
  - Flexibility
  - Laser etch➢day/night
  - Capacitive sensing

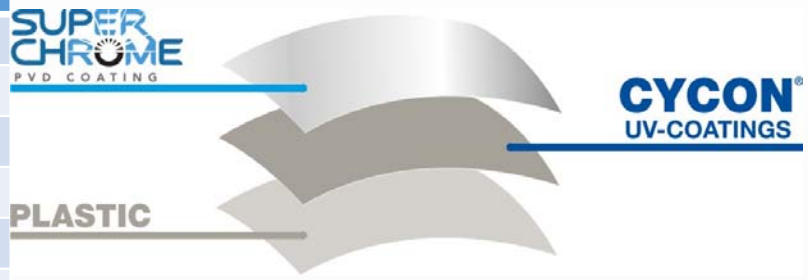






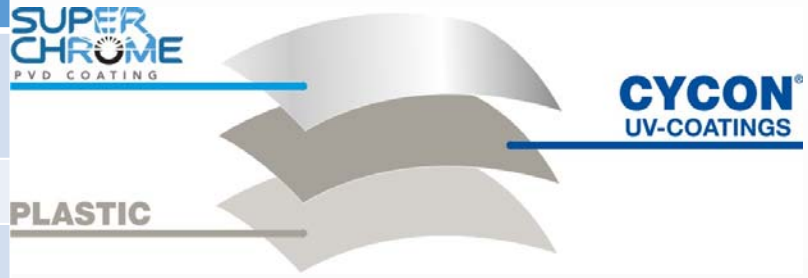
Test Results – Visual, Adhesion, Weathering

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



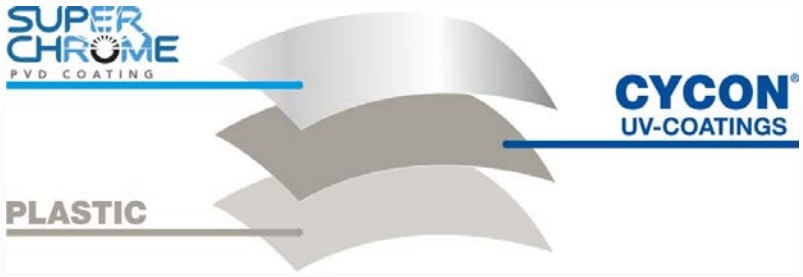
Test Results - Mechanical

Standards Tested - Mechanical	
Resistance to Gritting Renault 47-03-003/L-2013	PASS
Stone Chipping, VW TL211	PASS
Stone Chipping, PSA B72 0200/2013-04	PASS
Gravelometer/70 CASS	PASS
Resistance to Scratching by Abrasion Renault 47-03-003/L-2013	PASS
Crockmeter BMW Exterior	PASS
Car Wash Brush Resistance VW TL211	PASS
Abrex	PASS
Martindale	PASS



Test Results - Chemical

Standards Tested - Chemical	
Cream A Interior VW TL226	PASS
Cream B Interior VW TL226	PASS
High Pressure Cleaning VW TL 211	PASS
Hydrolysis Interior BMW	PASS
FAM test fuel VW TL211	PASS
Gasoline E10 VW TL211	PASS
Diesel B7 VW TL211	PASS
Isopropanol VW TL211	PASS
Ethanol/Water Exterior BMW	PASS
Sodium Hydroxide 5% VW TL211	PASS
Sulfuric Acid 10% VW TL211	PASS
Hydrochloric Acid 10% VW TL211	PASS
Hydorchloric Acid 30% Suspended in Vapors	PASS 24 Hours
Bird Droppings VW TL211	PASS
Liquid Tree Pitch VW TL211	PASS
Vomit Exterior BMW	PASS
Deionized Water Exterior BMW	PASS
Wheel Cleaner Exterior BMW	PASS
Underbody Sealant BMW	PASS



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.

Molding → Cleaning → CYCON UV-Coating Paint Line → SUPERCHROME PVD Batch System

SUPERCHROME PVD Coating System
Integrated production - Batch

SC 660 PVD Coating System

Single-point loading and safety enclosure

Robotic load/unload available

Molding → Cleaning → CYCON UV-Coating Paint Line → SUPERCHROME PVD Batch System

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