UV + PVD: PERFORMANCE AND DESIGN SOLUTIONS FOR THE AUTOMOTIVE INDUSTRY

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SAE INTERNATIONAL

RED SPOT

What Is PVD?

- ***P***hysical ***V***apor ***D***eposition

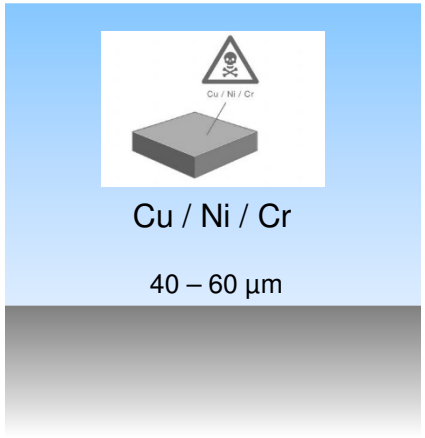
- PVD is deposition of a metal onto a substrate through changes in they physical state of the metal
  - Encompasses thermal evaporation, sputtering and cathodic arc methods

- Decorative PVD technology combines organic coating layer(s) and a thin inorganic metal layer deposited through a vacuum process

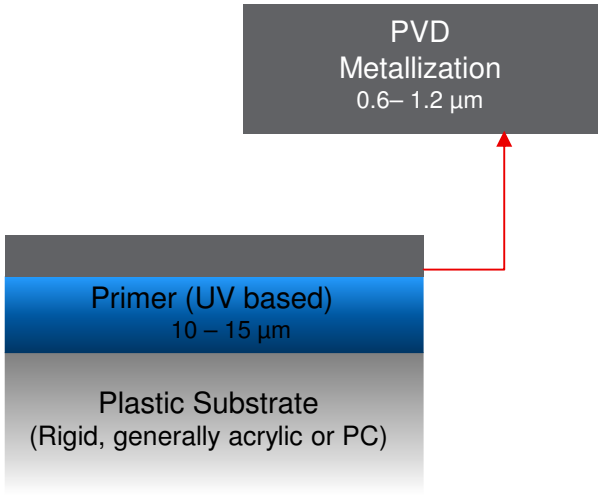
- PVD can be used as an alternative to electroplating; it is not a direct replacement

PVD vs. Traditional Electroplating

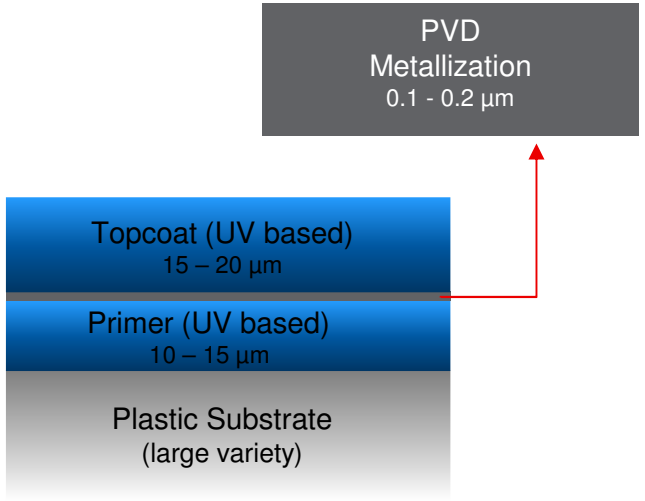
Electroplate



PVD + UV Primer



PVD + UV Sandwich



Advantages and Disadvantages of PVD

Advantages

- Environmental friendly process and coatings, no harsh chemical disposal
- Consumer safety, no sharp edges or shatter tendencies
- Design functionality capabilities not possible with electroplate
- Extensive range of appearance possibilities
- Expanded possibilities for substrate use

Disadvantages

•Difficult to exactly and cost effectively match appearance to current chrome plate standards

•OEM specification standards and field correlation not well known

•Appearance changes to an approved system need to be more critically tested

•Process controls are more critical to success

•Finishing line capabilities are limited, especially in North America

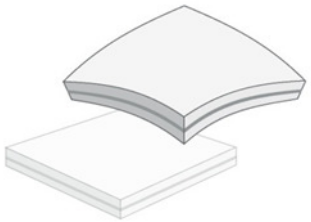
Environmental Advantages of PVD

- **Environmentally-friendly processes and coatings:**
- **High solids / low VOC**
- **No use of Cr-6+, Ni or any other toxic components**
- **All coated components are environmentally-friendly and recyclable despite their metallic character**
- **No chemical disposal**

Consumer Safety Benefits of PVD

No change in the substrate breaking strength

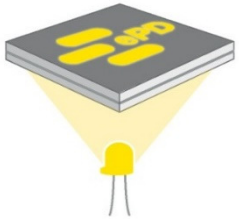
No splinters, flying metal particle or sharp edges



Applications: door handles, air bag emblems, overhead components, body security parts

Design Functionality of PVD

Day/Night Design in metal look using laser etching and hidden display

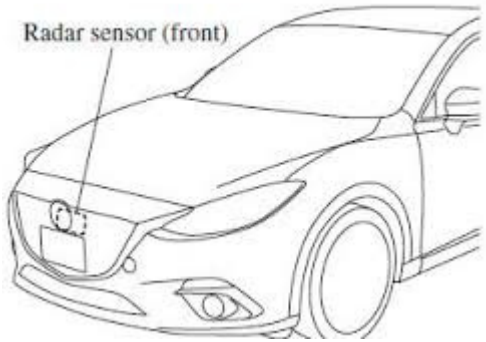


- Hidden Display inside a metal appearance
- Pad or Screen Print capable
- Laser Etch capable

Design Functionality of PVD

Realization of advanced functionalities:

- Highly non-conductive metal layers (<100 kΩ)
- Application for functionalized deco-components
- Hidden antenna or sensor technology
- Suitable also for capacitive or IR sensor technology



Extensive Range of Appearance Possibilities

Decorative Coatings

Metallic effects at different gloss levels

Full gloss chrome, matte/satin chrome, transparent chrome

Decorative Hard Coatings (metal ceramics)

Alter the color of PVD layer through deposition process

Dark Chrome/Black Chrome

Extensive Range of Appearance Possibilities

Decorative Coatings

Tinting of the topcoat provides almost limitless color palette

PVD + UV Coatings… what is required?

Choose the PVD Equipment Supplier

Machine Characteristics:

- Part geometry and dimensions (chamber size)
- Batch system or In-line system
- Cycle time
- Capability
  - Chamber Coverage
  - Fixture rotation and motion
  - Multiple targets/Multiple layers
  - Color capability
- Maintenance
- Technical Support
- Market/Industry Position and Reputation
- Price
- Ability and willingness to customize, co-develop or tailor solutions

Choose the PVD Equipment Supplier

Batch – PVD systems
“single chamber”

Cycle Time: 6 – 25 minutes

Inline PVD Technology
“modular multi chamber”

Cycle Time: 60 – 80 seconds

Choose a Qualified Integrator

Company Expertise:

- Design and Footprint
- Automation
- Service and Maintenance
- Market/Industry Position and Reputation
- Price
- Ability and willingness to customize and tailor solutions

Choose a Paint Provider

Coating Options to encapsulate PVD

Thermal Cure

Longer Processing Times (90 min+)

Post Cure Effect, may require longer dwell time prior to PVD step

Pot Life

Lower Cross-link Density

UV Cure

Quick Process Times (20 min)

Short dwell time prior to PVD step

Low Temperature – Large Substrate Selection

Long/No pot life

One component, potential reclaimability

High Cross-link Density – variety of PVD metals

Dual Cure

Combines aspects of thermal cure and UV cure

Relatively quick processing

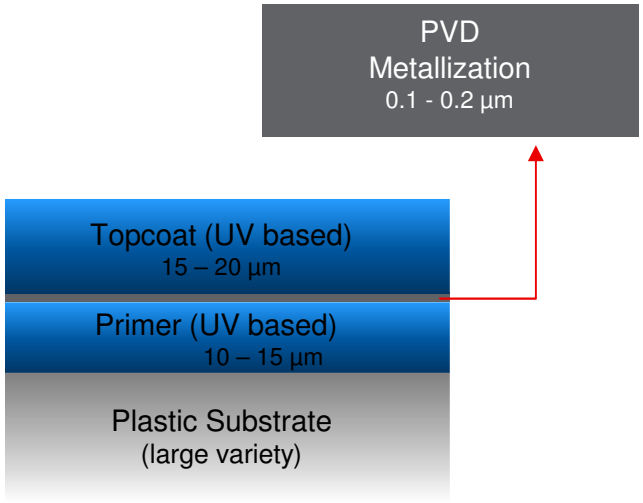
Pot Life similar to thermal cure systems

Evaluating Performance

To evaluate PVD accurately, the application/performance target must be framed accordingly and then measured appropriately

- PVD is not intended t be a chrome replacement
- Color appearance for chrome plate and PVD are different and should be handled accordingly from a design perspective
- PVD can offer more design flexibility than chrome plating
- Commonly accepted substrates for chrome plating are not necessarily optimal for PVD

Performance Evaluation of PVD



Potential Failure Modes:

- Loss of adhesion to substrate
- Loss of PVD metal to basecoat (delamination)
- Loss of topcoat to PVD metal
- Cohesion failure of the topcoat
- Cracking of the PVD Layer
- Whitening/Hazing of the topcoat
- Crazing/Chalking of topcoat

Performance Evaluation

Test Methods to evaluate weaknesses:

Adhesion and Cohesion Failures

Moisture and Temperature

PVD Cracking

Thermal Expansion (temperature and moisture)

Whitening/Hazing of Topcoat

Moisture and Temperature

Crazing/Chalking of Topcoat

UV Resistance, moisture, temperature

PVD creates reflective surface and magnifies UV exposure

Performance Evaluation

Additional Performance Criteria of Importance:

Scratch Resistance

- Topcoat is organic coating and has performance like coatings
- PVD layer is reflective and magnifies scratches

Corrosion/Chemical Resistance

- Topcoat is not impervious and moisture/chemicals will migrate through the coating to the metal layer
- Inert metals will provide good corrosion and chemical resistance, better than chrome plating
- Avoid aluminum, even though this will provide brightness

Impact/Chip Resistance

Common Commercial Applications