Paint Materials and Processes from an Automotive OEM Perspective

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Different Paint for Different Parts

Body paint (applied by auto manufacturer)

Flexible paint (applied by Tier 1 or 2 supplier)
Automotive Body Paint System

Clearcoat  45 um

Basecoat  10-20 um

Primer  25 um

Electrocoat  20um

Phosphate  5 um

Substrate (EG Steel, Aluminum, CRS…)

Gloss, protects basecoat from UV light

Color, metallic flakes

Smoothes E-coat, protects E-coat from light, promotes adhesion

Provides corrosion protection

Provides corrosion protection

Note: Some commercial vehicles use monocoat paint systems for solid colors.
Automotive Trim Paint System

- **Clearcoat**: 45 um
  - Gloss, protects basecoat from UV light

- **Basecoat**: 10-20 um
  - Color, metallic flakes

- **Conductive Primer**: 25 um
  - Provides adhesion to TPO (or other plastic substrates)

- **TPO (Fascia)**
Processing Exceptions

- Lower body (rocker panels) sometimes get an extra layer of anti-chip primer. PVC based material.
- Tinted clearcoats: Mostly on reds, some blue or yellow.
- Tri-coats: Basecoat layer separated into groundcoat (pigment) and effect flakes (mica). Pearlescent effect on whites and neutrals.
- Repaints: First time through varies but is 90-95% in good paint shops. 5-10% of vehicles get repainted (basecoat & clearcoat only or primer, basecoat and clearcoat). A small fraction get repainted twice.
- Tu-tones: Less popular now than in the past. Lower body sides on trucks. A few vehicles on roof.
- Moldings can be either painted or mold-in-color plastic.
## Differences Between Body and Trim Paint

<table>
<thead>
<tr>
<th>Body Paint</th>
<th>Trim Paint</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Topcoat cures at 140°C</td>
<td>• Topcoat cures at 80°C</td>
</tr>
<tr>
<td>• Hard, Less Flexible</td>
<td>• Softer, More Flexible</td>
</tr>
<tr>
<td>• Clearcoat $T_g \sim 80\degree C$</td>
<td>• Clearcoat $T_g \sim 20\degree C$</td>
</tr>
</tbody>
</table>
Supply Chain Strategy

• In North America most assembly plants paints are sourced to a single supplier.
  – One supplier provides all the layers of the paint system.
  – Axalta, BASF, PPG have 90%+ of the market. Asian transplants use a little paint from Kansai Paint or Nippon Paint.

• In Europe most assembly plants allow the layers to be split among different suppliers.
  – Example: Axalta e-coat, Axalta primer, BASF 4 basecoat colors, PPG two basecoat colors, Bollig and Kemper 2 basecoat colors, PPG clearcoat.

• Sourcing changes are rare: incumbent supplier often stays for many, many years.
• These strategies are true for body paint and trim paint.
• Technology changes are also rare. Resin chemistries have been stable recently.
Clearcoat Chemistry

• All clearcoats are based on acrylic copolymers (BA, MA, HEMA, MMA, MAA...) for superior durability.

• Crosslinking
  – Hydroxyl + Melamine = Ether crosslink
  – Carbamate + Melamine = Urethane crosslink
  – Epoxy + Carboxylic Acid = Ester crosslink
  – Hydroxyl + Isocyanate = Urethane crosslink
  – Silane + Water = Siloxane crosslink
IR Spectra of Different Clearcoat Chemistries

Acrylic/Silane/Melamine

Carbamate/Melamine
Infrared Spectroscopy

Spectrum Changes with Exposure

Exposed

Unexposed

Wavenumbers (cm$^{-1}$)
UVA Molecules for Automotive Clearcoats

![Chemical structures of OXANILIDE, BENZOTRIAIZOLE, and TRIPHENYLTRIAZINE](image)

- OXANILIDE
- BENZOTRIAIZOLE
- TRIPHENYLTRIAZINE
Micro-UV Spectroscopy

Cut a strip from the steel weathered or unweathered paint panel. Bend the strip until the paint system pops free.

Glue reference film to paint system using solvent-free adhesive.

Microtome a 10 µm Cross-Section of the paint system using a rotary microtome.
Scan reference film first. Reference film is a clearcoat with known UVA concentration. It is used to check actual thickness of micromilled sample and control.
Distribution of UVA after Weathering

Unweathered

22 months FL exposure
Basecoats

• Core colors are stable for many (5+ years): white, pearl white, black, grey silver.
• Chromatic colors change more rapidly (2-3 year life): blue, red, green, orange, yellow, tinted clearcoats, chromatic tri-coats.
• Chemistry: Acrylic copolymers, some polyesters, crosslinked with melamine.
# Basecoats

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<tr>
<th>M.NO.</th>
<th>ALPHA CODE</th>
<th>WERS CODE</th>
<th>SALES CODE</th>
<th>WERS SUFFIX</th>
<th>COLOR NAME</th>
<th>20xx COLORS</th>
<th>EXT PRIMERS</th>
<th>20xx COLORS</th>
<th>EXT PRIMERS</th>
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<tr>
<td>6466</td>
<td>4WFAWHA</td>
<td>PNYW3</td>
<td>YZ</td>
<td>54WF</td>
<td>Oxford White CC</td>
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<td>7188</td>
<td>8DYEWHA</td>
<td>PN3J9</td>
<td>L6</td>
<td>58DY</td>
<td>Kona Blue</td>
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<td>9VJGWHA</td>
<td>PN3KP</td>
<td>UG</td>
<td>59VJ</td>
<td>White Platinum Tricoat</td>
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<tr>
<td>7211</td>
<td>9AYEWHA</td>
<td>PN3KQ</td>
<td>UH</td>
<td>59AY</td>
<td>Tuxedo Black Metallic</td>
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<td>7226</td>
<td>APFEWHA</td>
<td>PN4AG</td>
<td>UX</td>
<td>5APF</td>
<td>Ingot Silver Metallic</td>
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<td>7236</td>
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<td>CCUEWTA</td>
<td>PNMAG</td>
<td>Z9</td>
<td>5CCU</td>
<td>Blue Candy Tinted Clear</td>
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<td>DFROWHA</td>
<td>PNEAL</td>
<td>LP</td>
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<td>PNEAM</td>
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<td>G9ZEWHA</td>
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<td>G1</td>
<td>5G9Z</td>
<td>Absolute Black (Shadow Black)</td>
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<td>7362</td>
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<td>GN</td>
<td>5HGH</td>
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<td>7365</td>
<td>HCSEWHA</td>
<td>PN4E3</td>
<td>N6</td>
<td>5HCS</td>
<td>Blue Lightning (Lightening Blue)</td>
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<tr>
<td>7383</td>
<td>HRREWHA</td>
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<td>Blue Metallic (Blue Diamond)</td>
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<td>FC</td>
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</tbody>
</table>
Color Masters

• Master panels that are guaranteed to be an exact match to the color of a vehicle.

• ACT Test Panel in Hillsdale, MI. Can get exact chemistry associated with a particular assembly plant or generic color w/o correct chemistry on coil coated aluminum.

• Thierry Corp. in Royal Oak, MI. Coil coated aluminum w/o correct chemistry.
Market Report from Covestro

- Published annually
  - Coating supplier for each NA assembly plant
  - Coating chemistry for each NA assembly plant
  - Vehicles produced / volumes for each NA assembly plant

- Could be valuable resource

- Covestro (formerly Bayer Materials Science) supplies isocyanates and resins to paint companies.

- No color information
Contact Information

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