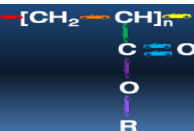


# Paint Materials and Processes from an Automotive OEM Perspective

Mark Nichols

Technical Leader, Paint and Corrosion Research  
Ford Research and Advanced Engineering

July 20, 2016

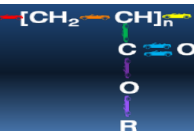


# Different Paint for Different Parts

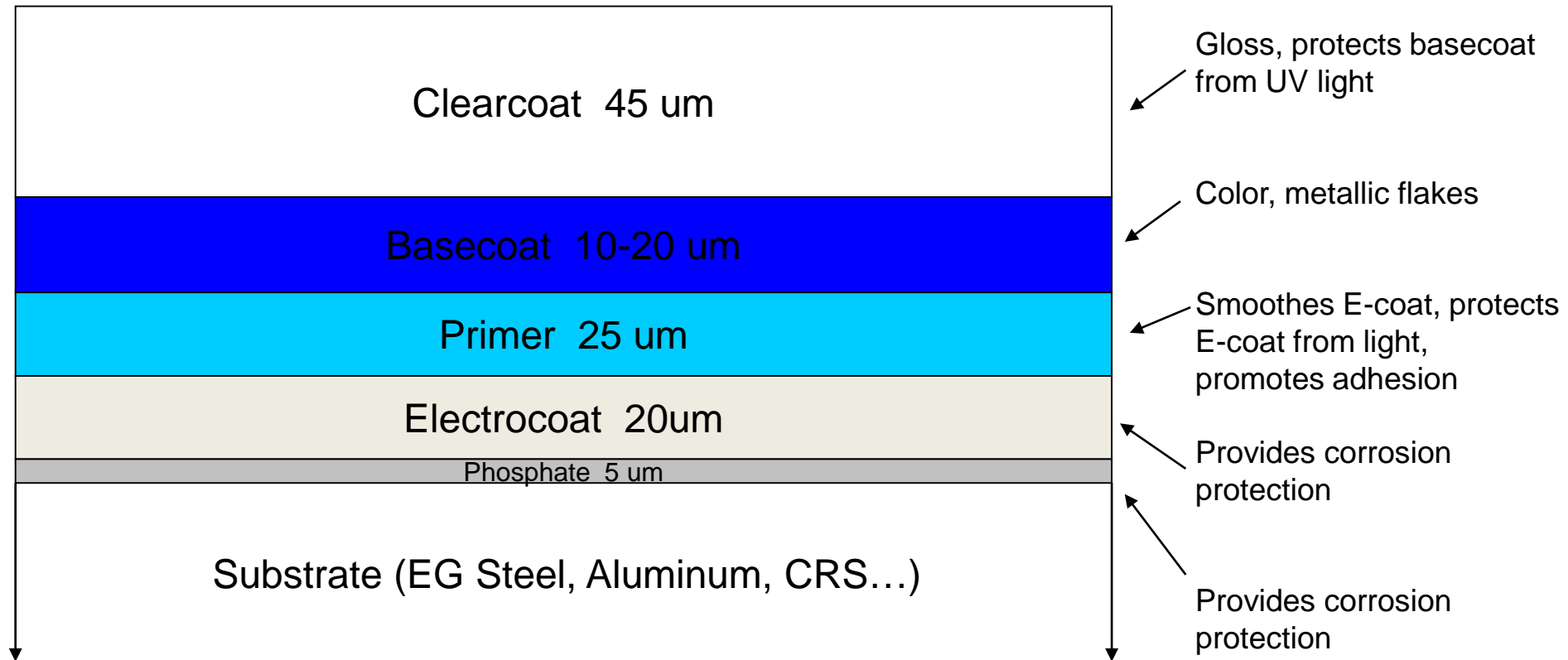
Body paint (applied by auto manufacturer)



Flexible paint (applied by Tier 1 or 2 supplier)

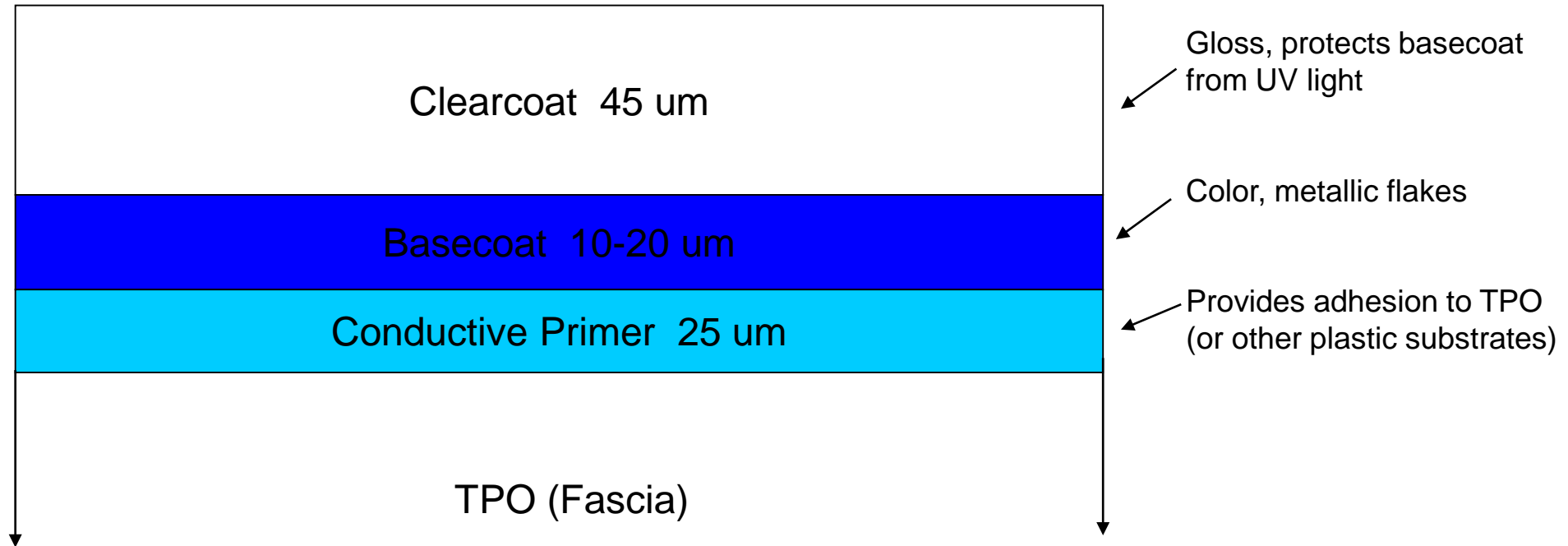


# Automotive Body Paint System



Note: Some commercial vehicles use monocoat paint systems for solid colors.

# Automotive Trim Paint System



# 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.



Paint or MIC plastic

Paint



# Differences Between Body and Trim Paint

## Body Paint

- Topcoat cures at 140°C
- Hard, Less Flexible
- Clearcoat  $T_g \sim 80^\circ\text{C}$

## Trim Paint

- Topcoat cures at 80°C
- Softer, More Flexible
- Clearcoat  $T_g \sim 20^\circ\text{C}$

# Supply Chain Strategy

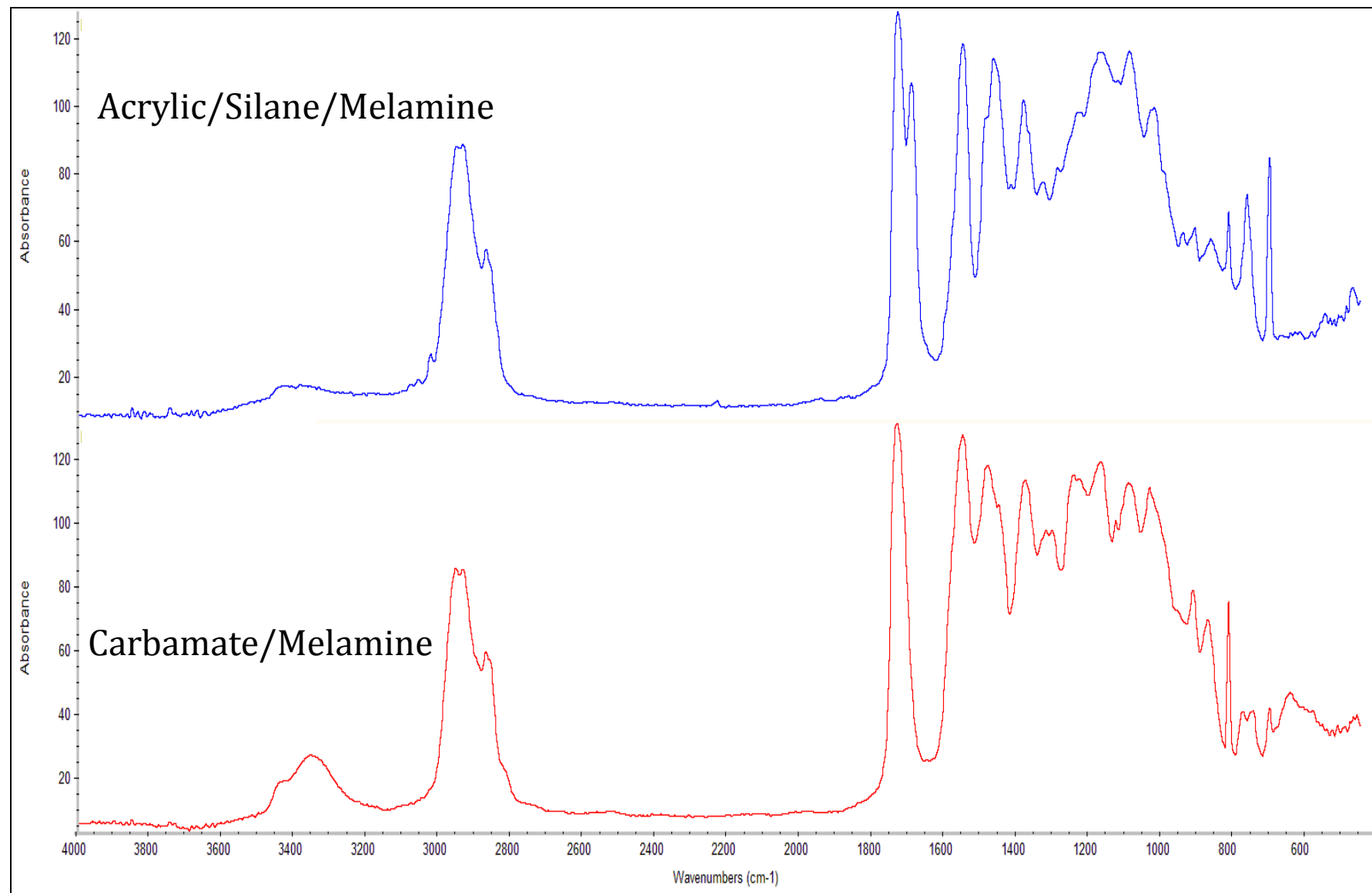
- In North America most assembly plants paints are sourced to a single supplier.
  - One supplier provides all the layers of the paint system.
  - Axalta, BASF, PPG have 90%+ of the market. Asian transplants use a little paint from Kansai Paint or Nippon Paint.
- In Europe most assembly plants allow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

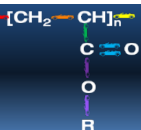
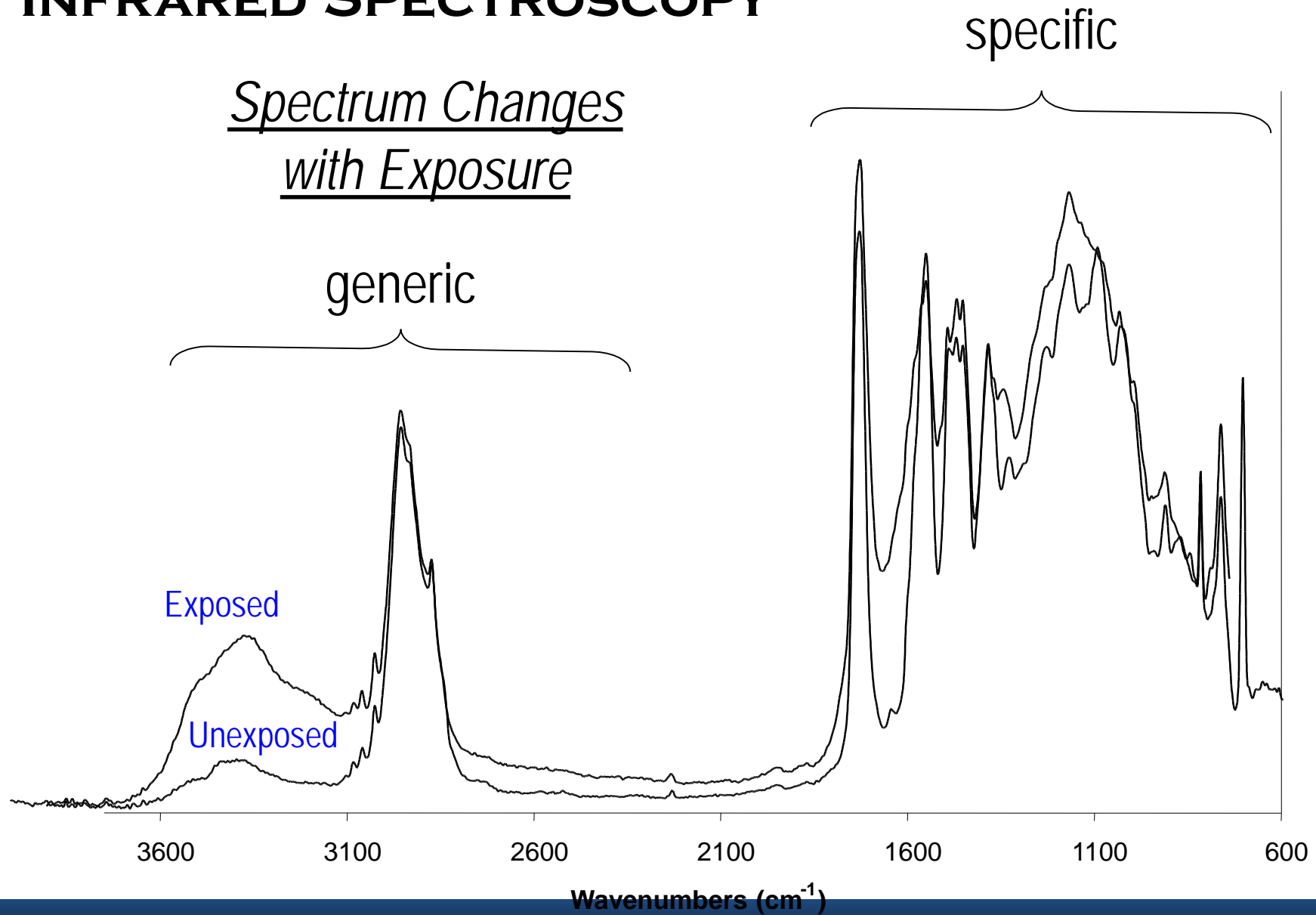


# IR Spectra of Different Clearcoat Chemistries

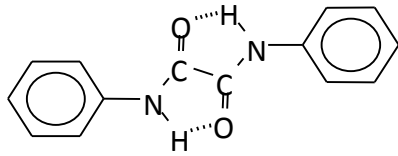


# INFRARED SPECTROSCOPY

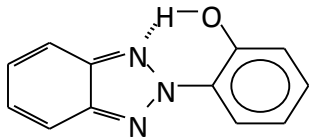
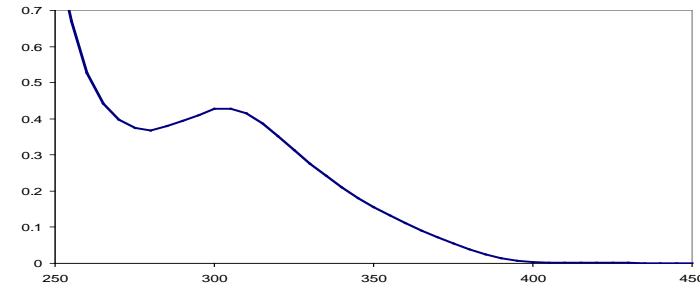
Spectrum Changes  
with Exposure



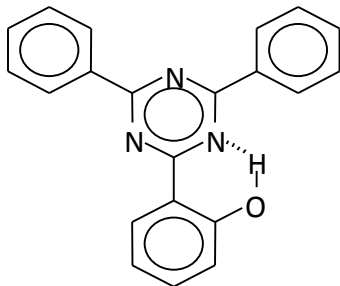
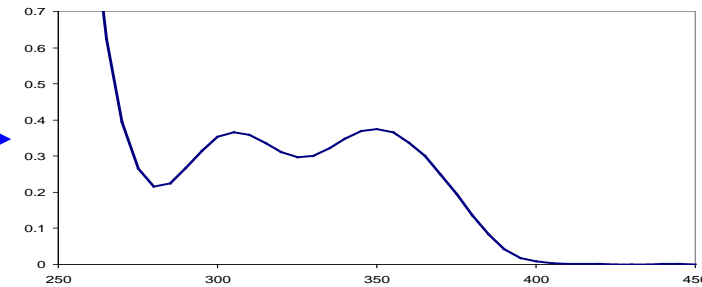
# UVA Molecules for Automotive Clearcoats



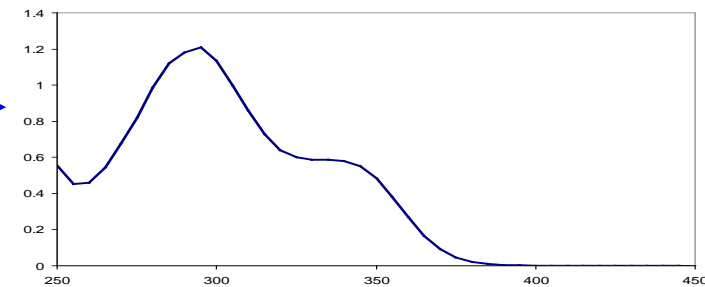
**OXANILIDE**



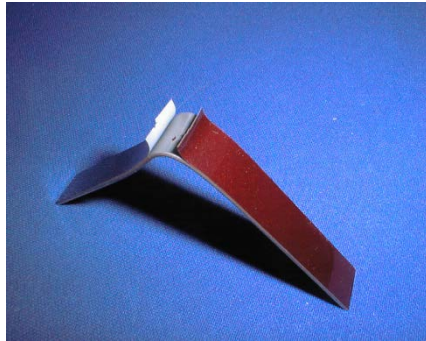
**BENZOTRIAZOLE**



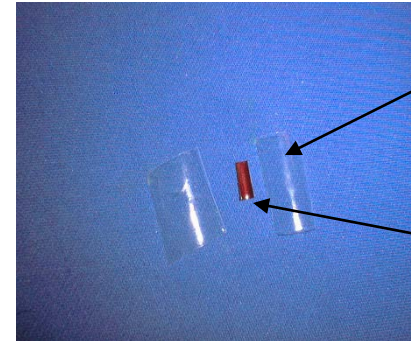
**TRIPHENYLTRIAZINE**



# Micro-UV Spectroscopy



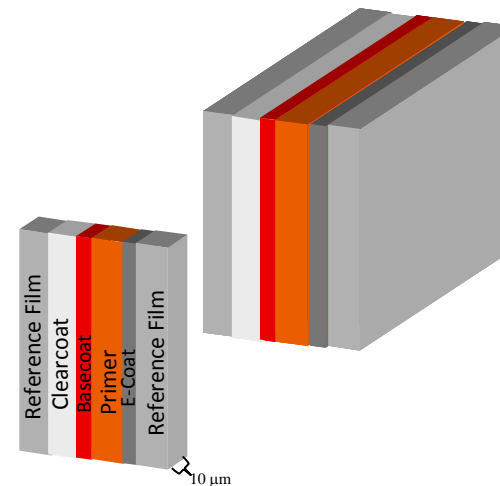
Cut a strip from the steel weathered or unweathered paint panel. Bend the strip until the paint system pops free.

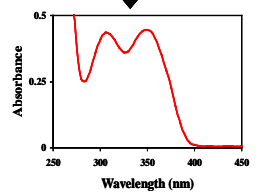
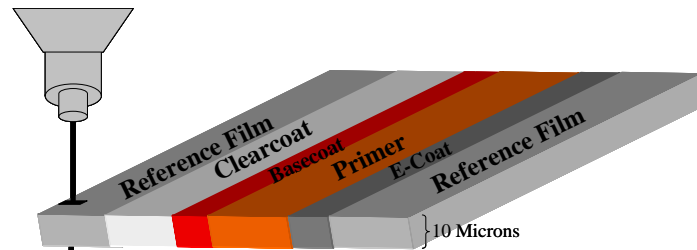


Reference Film

Paint system

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

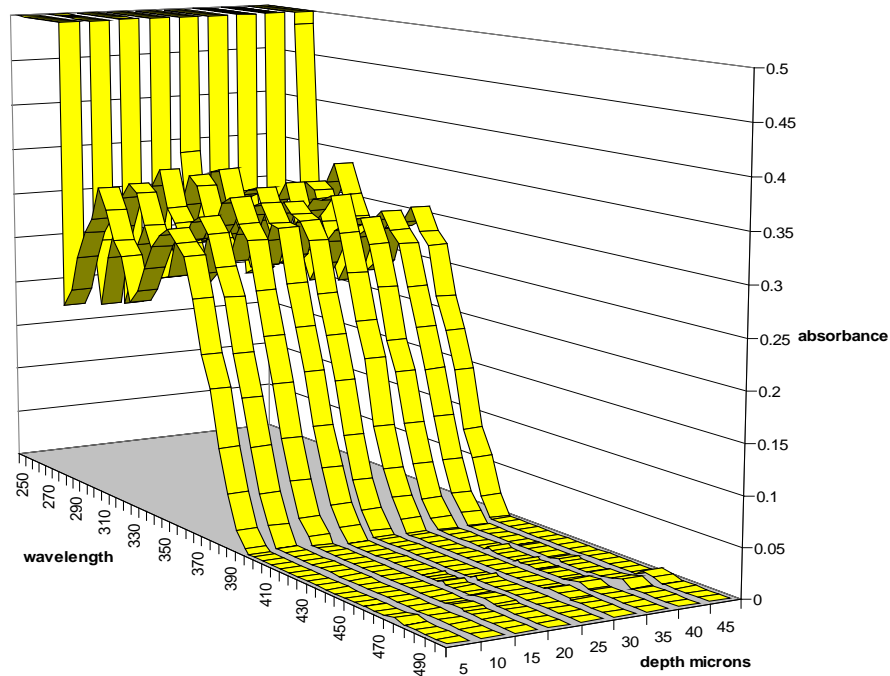




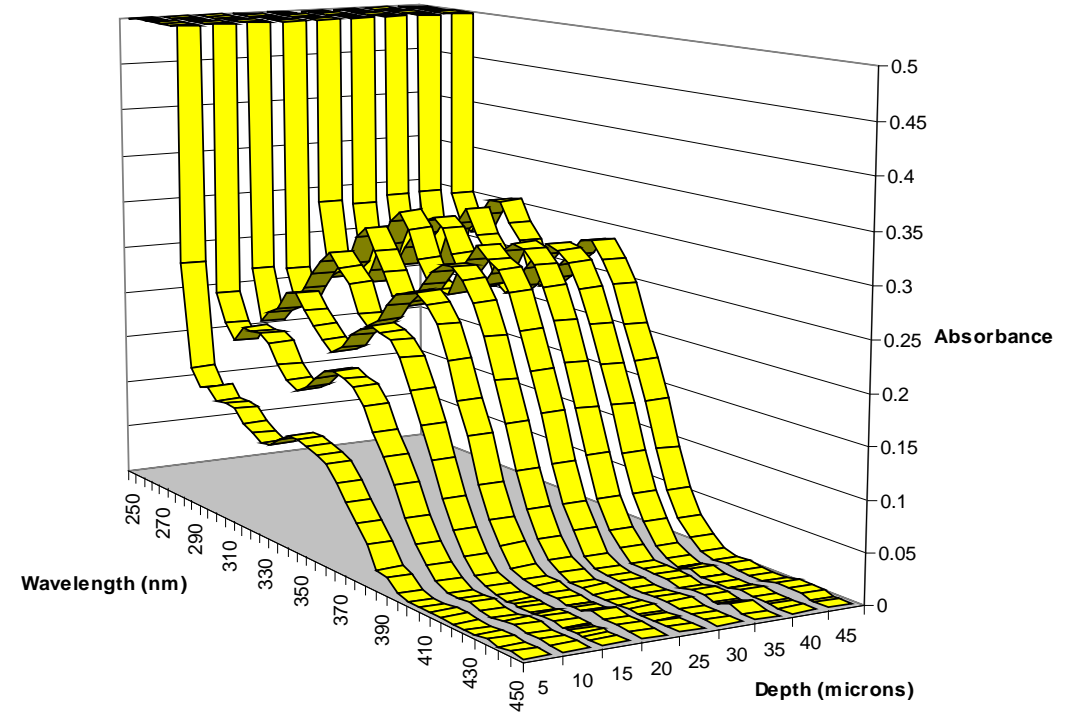
Scan reference film first.  
Reference film is a clearcoat  
with known UVA concentration.  
It is used to check actual thickness  
of microtomed sample and correct

# Distribution of UVA after Weathering

Unweathered



22 months FL exposure

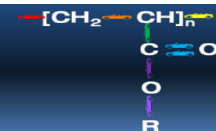


# Basecoats

- 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

M NO.	ALPHA CODE	WERS CODE	SALES CODE	WERS SUFFIX	COLOR NAME	20xx COLORS	EXT PRIMERS	20xx COLORS	EXT PRIMERS
6466	4WFAWHA	PNYW3	YZ	54WF	Oxford White CC	FC	6534	FC	6534
7188	8DYEWHA	PN3J9	L6	58DY	Kona Blue	FC	6534	delete	6534
7204	9VJGWA	PN3KP	UG	59VJ	White Platinum Tricoat	FC	6534	FC	6534
7211	9AYEWHA	PN3KQ	UH	59AY	Tuxedo Black Metallic				
7226	APFEWHA	PN4AG	UX	5APF	Ingot Silver Metallic	FC	6534	FC	6534
7236	BRQAWHA	PN4A7	PQ	5BRQ	Race Red	F		delete	
<b>7252</b>	<b>CCUEWTA</b>	<b>PNMAG</b>	<b>Z9</b>	<b>5CCU</b>	<b>Blue Candy Tinted Clear</b>	F	6534	delete	6534
7280	DFRGWHA	PNEAL	LP	5DFR	Electric Gold 3C	delete			
7283	DSTEWTA	PNEAM	RR	5DST	Ruby Red TC	FC	6534	delete	6534
7325	FM6EWHA	PN4DQ	J7	5FM6	Magnetic	FC	6534	FC	6534
7310	DKFCWWA	PN4B3	HI	5DKF	Tectonic Silver	delete			
<b>7338</b>	<b>FEBGWHA</b>	<b>PN4DR</b>	<b>H3</b>	<b>5FEB</b>	<b>Triple Yellow 3C</b>	F*	6534	F*	6534
7343	G9ZEWHA	PNZAT	G1	5G9Z	Absolute Black (Shadow Black)	FC		FC	
<b>7362</b>	<b>HQHEWHA</b>	<b>PN4E1 - PN4EW</b>	<b>GN</b>	<b>5HQH</b>	<b>White Gold (Palladium Gold )</b>	FC	6534	FC	6534
<b>7365</b>	<b>HCSEWHA</b>	<b>PN4E3</b>	<b>N6</b>	<b>5HCS</b>	<b>Blue Lightning (Lightening Blue)</b>			F	6534
<b>7383</b>	<b>HRREWHA</b>	<b>PN4E8</b>	<b>BA</b>	<b>5HRR</b>	<b>Chrome Copper</b>	delete	6534		6534
<b>7395</b>	<b>JGREWTA</b>			<b>5JGE</b>	<b>Outrageous Green TC</b>			F	6534
<b>7403</b>	<b>J5CEWTA</b>	<b>PN4FP</b>	<b>EA</b>	<b>5J5C</b>	<b>Hot Pepper Red TC</b>			FC	6534
<b>7411</b>	<b>JCTEWHA</b>			<b>5JCT</b>	<b>Blue Metallic (Blue Diamond)</b>			FC	6534





# 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

- Mark Nichols
  - [mnichols@ford.com](mailto:mnichols@ford.com)
  - 313-594-6723