Advances in Innovative Coatings for Plastics

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Diane E. Marret

Red Spot Paint and Varnish, Co., Inc.

Who is Red Spot?

Red Spot is a global leader in the development and production of high performance coatings. Our goal is to anticipate and provide innovative coating solutions to industry current and future needs.

Automotive OEM approvals include, but are not limited to: GM, Ford, FCA, Toyota, Honda, Nissan, Hyundai, VW, BMW, Tesla, etc.

In-house Test Lab (ISO/IEC17025) and Analytical Lab

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What are we trying to achieve with paint today?

- Goal of the Consumer:
  - High end look & feel with durable finishes
- Goal of Paint Supplier:
  - Develop products that support and drive the wants and needs of the industry
- Goal of the Finisher:
  - High transfer efficiency, low VOC, ease of processing, price sensible
- Goal of the OEM:
  - All of the above! Overall quality, safe and cost effective finishes

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What does this mean for coatings?

- Now more than ever, coatings will be required to be multifunctional, not just decorative!
  - Scratch resistant
  - Chemical resistant
  - Anti-fingerprint
  - Easy clean
  - Dirt/Dust repellent
  - Anti-fogging
  - Etc.

Common Plastic Substrates:

- Polypropylene (treated)
- Polycarbonate
- Polystyrene
- Acrylic (PMMA)
- PET
- PETG
- ABS
- SAN
- Bulk Molded Compound (BMC)
- Nylon
- Blends (i.e. PC/ABS)

Substrates, additional notes…

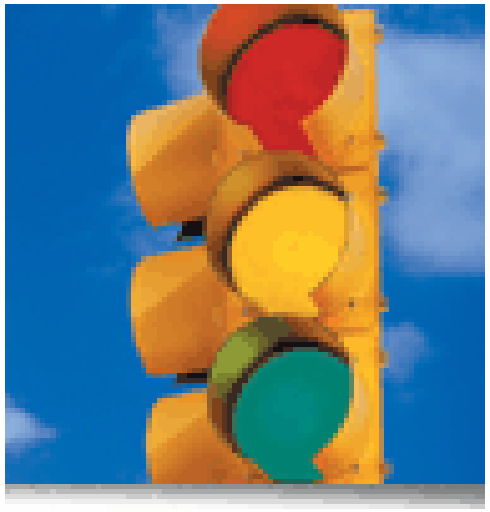
- Substrate needs to be specified down to the supplier level due to differences in material fill components.
- Sustainability goals of added recycled content can create material variation.
- Influx of new Compounders is resulting in unknown fill content.
- New substrates for specific applications, like lightweighting/heavyweighting or addressing birefringence, often don’t behave like “parent substrate”.

Basic Comparison – Thermal vs. UV Curable Coatings

Thermal	UV Cure
• Requires thermal bake to cure • Coatings may have a pot life • Multiple reaction types, but typical time requirement is 30 – 60 minutes • Coatings continue to post cure up to 72 hours • Systems typically require more floor space (increased work in process) • Coatings typically have higher VOC content	• Requires UV light to cure • Coatings typically are single component and no pot life • Process usually requires heated flash to evacuate solvent/water, but total processing time is 4 – 20 minutes • Systems require less floor space (reduced work in process) • Coatings typically can be formulated low to high solids (lower VOC content) • Coatings potentially can be reclaimed (collection and reuse of overspray)

UV Cure – High Performance Hardcoats

- Example: Automotive Lighting, Solar films, etc.
- Highly weatherable
- Scratch & Chemical resistance



UV Cure - Packaging Examples

- Cosmetic & Personal Care packaging
- Beverage closures
- Ability to post-decorate often required (foils & inks)
- Color matched topcoats

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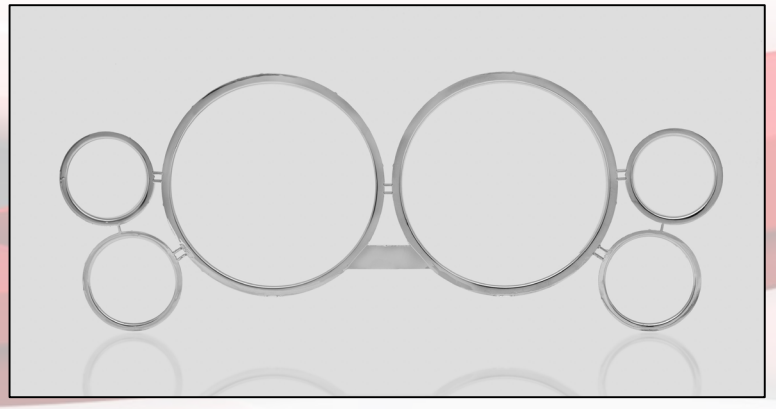
UV Cure - Physical Vapor Deposition (PVD)

- An alternative to chrome plating
  - Tinted topcoats
  - Various gloss levels, high gloss to matte
  - Textured/Brushed surfaces in substrate telegraph through metal

Dark chrome / black chrome



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UV Curable Coating Considerations

- UV Cure is line of sight
  - “A” surface cure requirement and also overspray cure requirement
- UV Coatings are designed to be thin film coatings
  - Sag points will be less than conventional thermal cure coatings
  - Excessive film builds can result in embrittlement of the coating
- Must consider paintability of the part
  - Sharp edges, Deep recesses, Troughs, Parting line location
  - 3D Complexity
  - Size of Part
  - Masking, Part Fixtures

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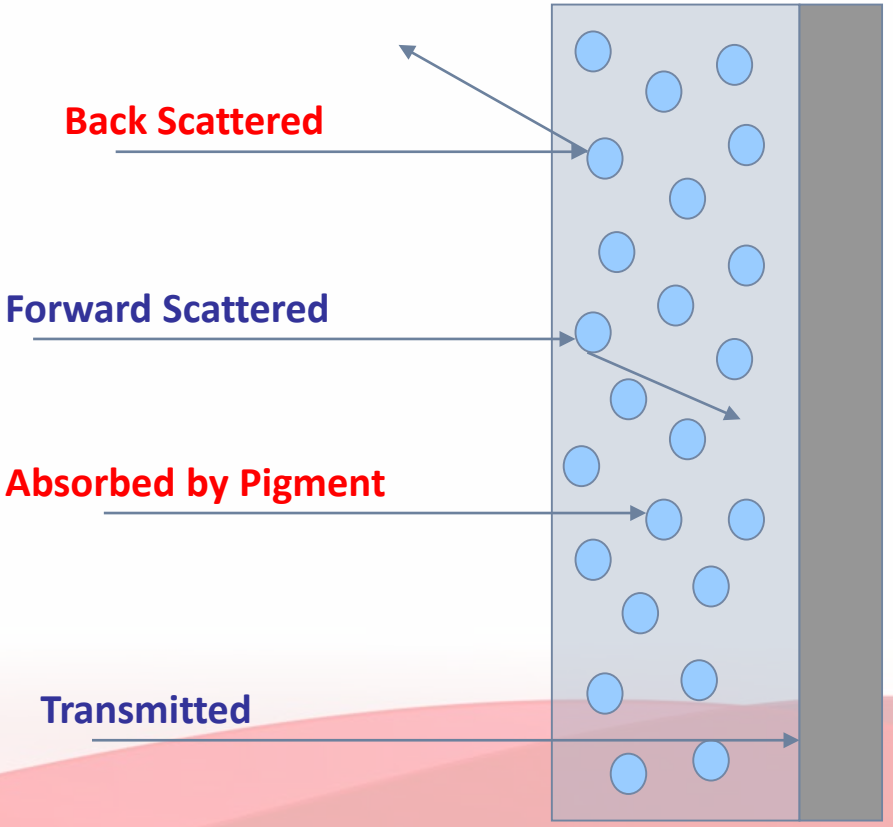
UV Cure and Pigmented Systems

- Pigmented Systems are Possible
  - Coating is more difficult to cure because pigments compete with incoming UV light
  - More consideration for light source and photoinitiator for cure optimization



Thermal Cure Technology

- Low gloss finishes
- Excellent scratch recovery
- Laser etch process for buttons and lighted trim

Recent Approved Thermal Technology

Linear Abrasion

- 10 double rubs using a 500g load over a CS-10 abrasion pad
- Current pass requirement is a Δgloss of less than 1.5

Low Gloss 600R Jet Black								
Sample	**60° gloss**				**85° gloss**			
	Before	**After**	**Δgloss**	**Gloss Retention**	**Before**	**After**	**Δgloss**	**Gloss Rentention**
Red Spot 1	1.7	1.8	0.1	94.4%	10.6	11.7	**1.1**	**90.6%**
Red Spot 2	1.8	1.9	0.1	94.7%	10.6	11.7	**1.1**	**90.6%**
Red Spot 3	1.7	1.8	0.1	94.4%	10.2	11.3	**1.1**	**90.3%**
Red Spot 4	1.8	1.9	0.1	94.7%	10.6	11.7	**1.1**	**90.6%**
Red Spot 5	1.8	1.9	0.1	94.7%	10.9	12.0	**1.1**	**90.8%**
Previous 1	1.8	2.2	0.4	81.8%	5.6	8.7	**3.1**	**64.37%**
Previous 2	1.9	2.2	0.3	86.4%	10.1	13.1	**3.0**	**77.10%**
Previous 3	2.2	2.3	0.1	95.7%	4.7	7.5	**2.8**	**62.67%**

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Scratch and Chemical Resistance

- Traditional thermal systems can be adapted to be self healing but the trade-off in performance can be too severe for visible high traffic surfaces

- UV and Dual Cure systems can be used in some applications where additional chemical and scratch resistance are needed

Dual Cure Technology

- Combination of thermal bake and UV Cure

- Tinted Dual Cure topcoat direct to substrate
  - Part molding quality must be free of visible defects
  - Tinted topcoat is used to influence color

- Clear Dual Cure topcoat over thermal basecoat
  - Basecoat hides some molding issues
  - Color opacity can come from thermal basecoat

Microscratch

- High gloss Piano Black
  - Scratching and visible fingerprints are common complaints
  - New UV and Dual Cure based formulas address microscratching concerns better than more traditional thermal systems

		Scratch			VW Microscratch		Ford Microscratch					Martindale	Linear Abrasion
Basecoat	Topcoat	1mm 5-Finger 6, 8, 10N	7mm 5-Finger 8, 10, 12N	10N Erichsen	20% Gloss Retent.	20% Gloss Retent.	20% Gloss Retent.	Post Gloss 24 hrs	24 Hrs. % Retention	Post Gloss 7 day	7 day % Retention	% Gloss Retent.	Appearance
Thermal BC	Thermal topcoat 1	Fail - 6N	Fail - 8N	Pass	35.66	56.18	35.66	50.10	56.18	47.31	53.06	43.56	Pass
Thermal BC	Thermal topcoat 2	Fail - 6N	Fail - 8N	Pass	41.69	83.38	41.69	73.73	83.38	66.27	74.94	57.18	Pass
Thermal BC	UV topcoat 1	Fail - 6N	Pass	Pass	85.72	91.01	85.72	79.66	91.01	85.46	97.64	91.43	Pass
Thermal BC	UV topcoat 2	Fail - 6N	Pass	Pass	70.21	76.49	70.21	68.23	76.49	71.64	80.32	97.12	Pass
Thermal BC	UV topcoat 3	Fail - 6N	Pass	Pass	81.63	75.76	81.63	66.97	75.76	74.79	84.60	91.51	Pass
Thermal BC	Dual Cure topcoat	Pass	Pass	Pass	93.37	93.04	93.37	82.43	93.04	89.61	100.00	98.54	Pass
none	Dual Cure tinted topcoat	Pass	Pass	Pass	97.36	97.82	97.36	85.10	97.82	84.87	97.67	99.08	Pass

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New Applications, new requirements, new tests…

- The need to address fingerprints and surface cleanliness in general is becoming less about aesthetics and more about functionality
  - Touch screen visibility
  - Camera & sensor lens clarity

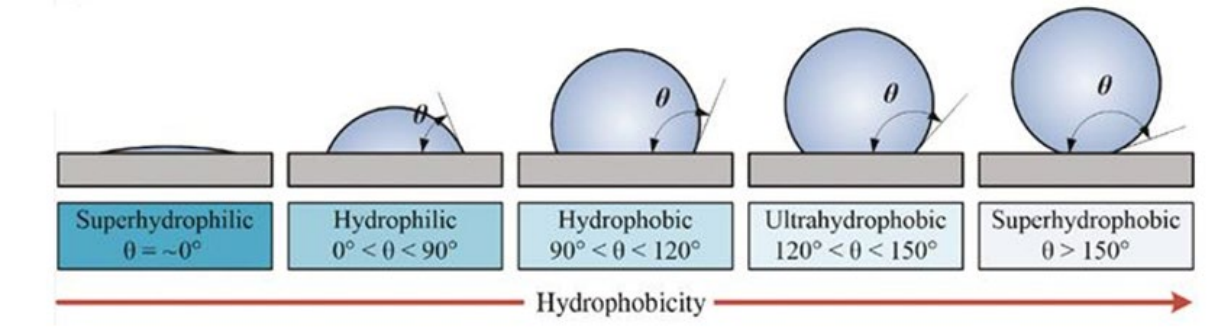
- Tests exist but are not standardized
  - Existing tests are being modified

Anti-Fingerprint

- Defining fingerprints
  - Transfer:
    - What is left on the surface after exposure
  - Visibility:
    - How much of the fingerprint is visible after the transfer
  - Cleanability:
    - How easy is it to remove from the surface

Anti-Fingerprint

- Reduce fingerprint transfer and visibility by changing surface energy and making the surface hydrophobic and/or oleophobic
- Surfaces that repel water are hydrophobic or super hydrophobic, oils (oleophobic) or both (omniphobic)
- Measure contact angle with goniometer
  - Using water, targeting greater than 110°
- Measure contact angle with hexadecane
  - >50° is considered oleophobic



Fingerprint “Cleanability”

- Some test methods evaluate initial transfer and cleanability of fingerprint from surface, or rather, how much is left behind.
  - Synthetic fingerprint solution and rubber stamp used to create fingerprint on surface
  - Using a spectrophotometer, the test evaluates the improvement in optical haze or surface roughness, or apparent visibility of the fingerprints after microfiber cloth wipe

Easy Clean

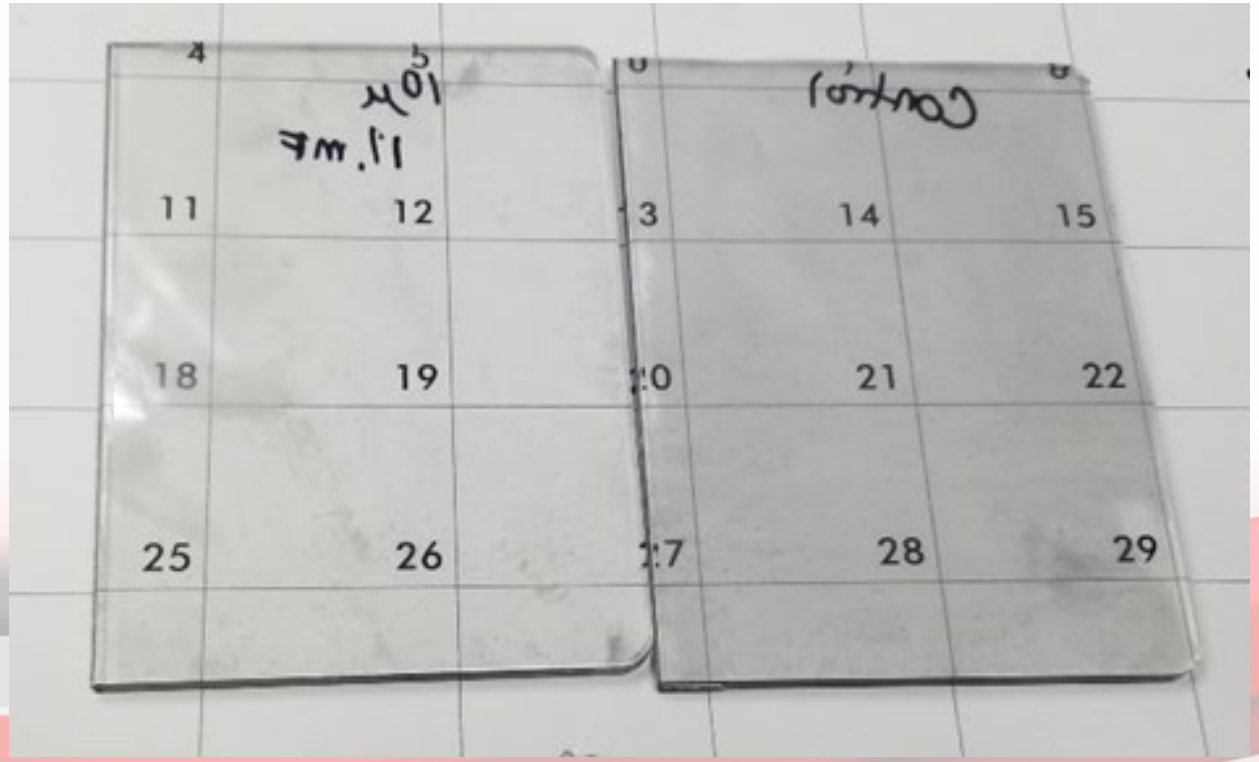
- Today the definition of dirt repelling surface means contaminants are easily removed with normal methods
- Added consideration for sensors and cameras should include ways to prevent initial surface contamination:
  - Dust/Dirt repellence
  - Ice repellence
  - Anti-fogging
  - Many more!

Dust/Dirt Surface Contamination

- How well does the surface repel dust/dirt build-up?
- How easily does it come off? Using what method?
  - Cloth wipe, rinse, squeegee, air
- Methods for post dust/dirt exposure evaluation vary:
  - Light Transmission
  - Change in haze
  - Reading change in image clarity or signal strength

Dust/Dirt Surface Contamination

- Dust/Dirt Repellence Example:
  - Dry solution on coated and uncoated polycarbonate with no rinse



Review - Decorating Considerations

- What are the performance requirements?
  - OEM defined tests
  - Extended testing to failure
- Who will be applying the coating and what equipment do they have?
- Is there a visual target already established?
  - Color, gloss
- Has the substrate been confirmed?
- Will there be any post decoration or assembly?
  - Inks, foils, adhesives, welding, etc.

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Thank you!

Diane E. Marret

Business Development Manager

Red Spot Paint & Varnish, Co., Inc.

demarret@redspot.com

812-428-9174