

BASF Coatings



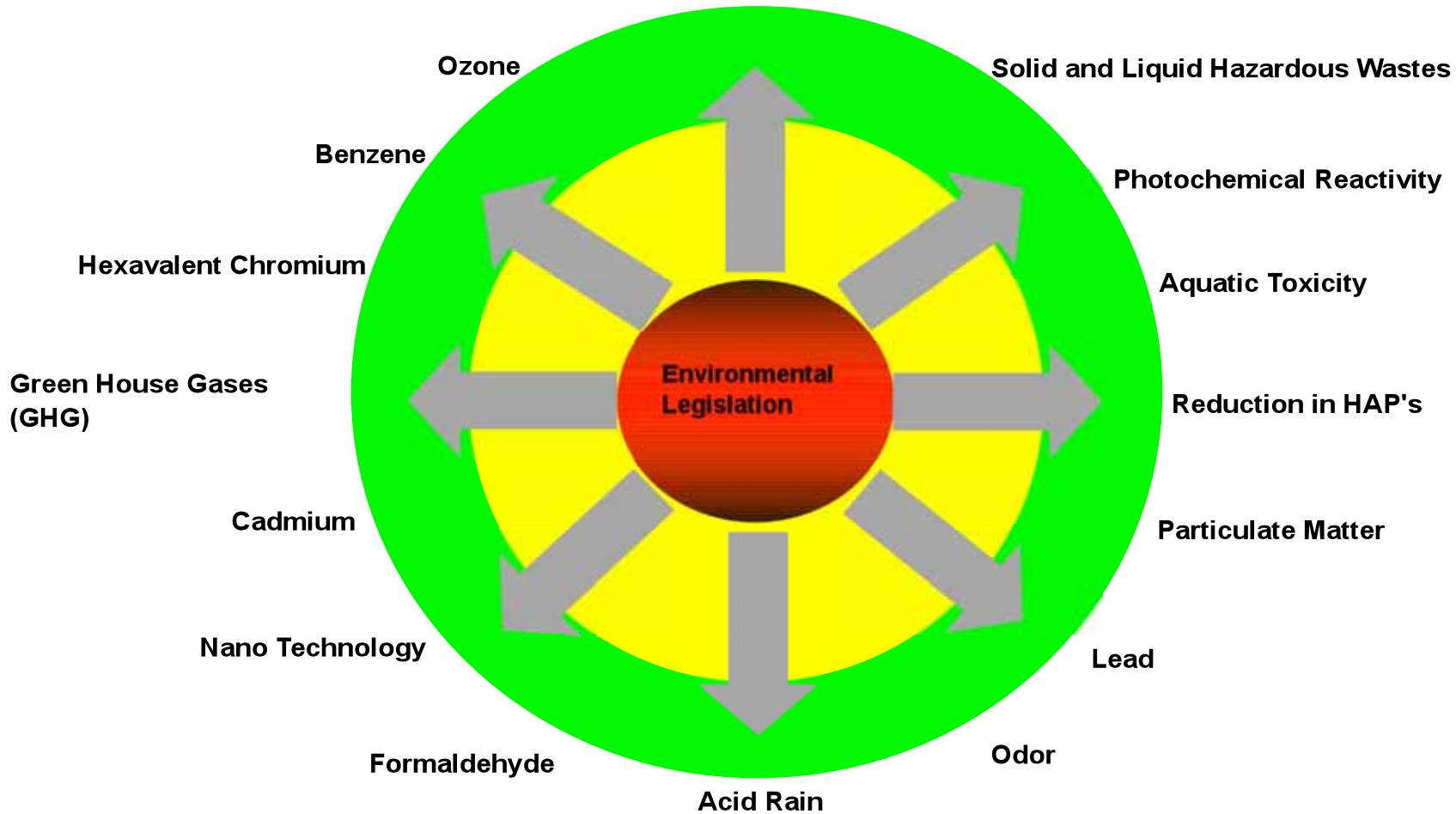
Advances in Automotive Coatings Technology

**Trace Evidence Symposium
Clearwater, Florida
August 4, 2009**



Environmental Legislation; *Drivers*

CAAA Clean Air Act Amendments
Volatile Organic Compounds (VOC's)



- Trends / Drivers

 - Pigments
 - Synthetic
 - Interference
 - Infrared Reflecting

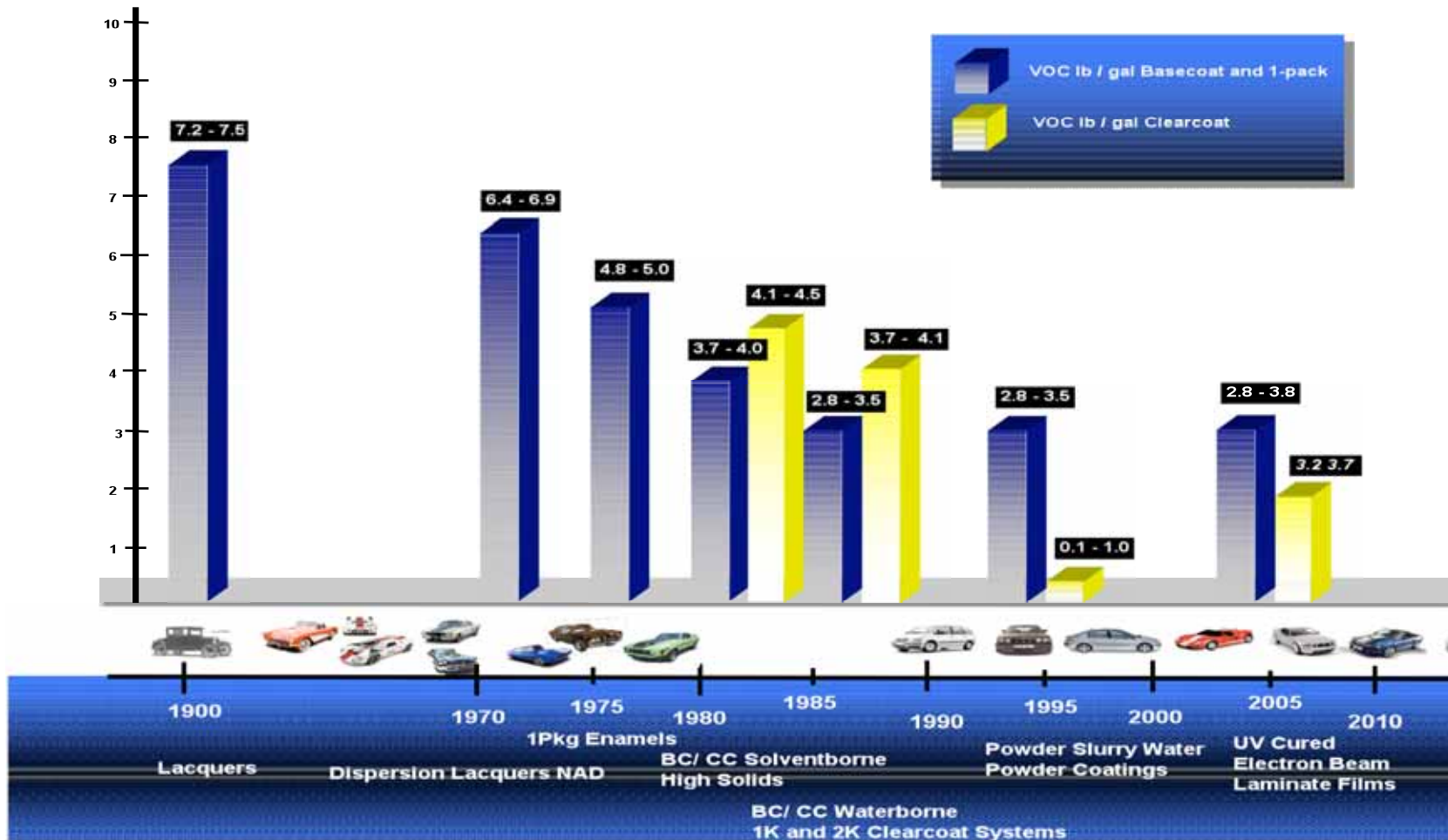
 - Integrated Processes

 - Film Laminates
-

Trends & Drivers



Technology and VOC; *Historical Review*






Technology; *Historical Review*

Technologies Introduced



1900	Lacquer
1960	Alkyd-, Nitrocombi-paint
1970	1K AC/ MF-paint
1980	2K AC/ NCO-paint
1990	Powder/ Powderslurry, WBBC
2000	Carbamate, UV-Cure
2010	3-WET Integrated Systems

Main Development Focus

Weathering, Film Erosion
Gloss, Non-Yellowing
Cracking, Durability
Chemical Resistance
Lower Emission
Scratch, Mar, Etch, Resistance
Stream  :uring



Industry Trends

Technical Advancement in VOC Reduction

○ Energy Minimization

- Integrated systems (reduce carbon footprint)
- Low energy cure systems
 - ❖ UV and electron beam
- New chemical approaches
- Application improvements
 - ❖ one & two coat bell application



○ Renewable and Re-cyclable Resources

- Bio-based material (renewable feed stock)
- Bio-degradable
- Use of microbes, bacteria, enzymes as catalysts



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Cool Cars are Timeless!

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All Markets are Connected by Color

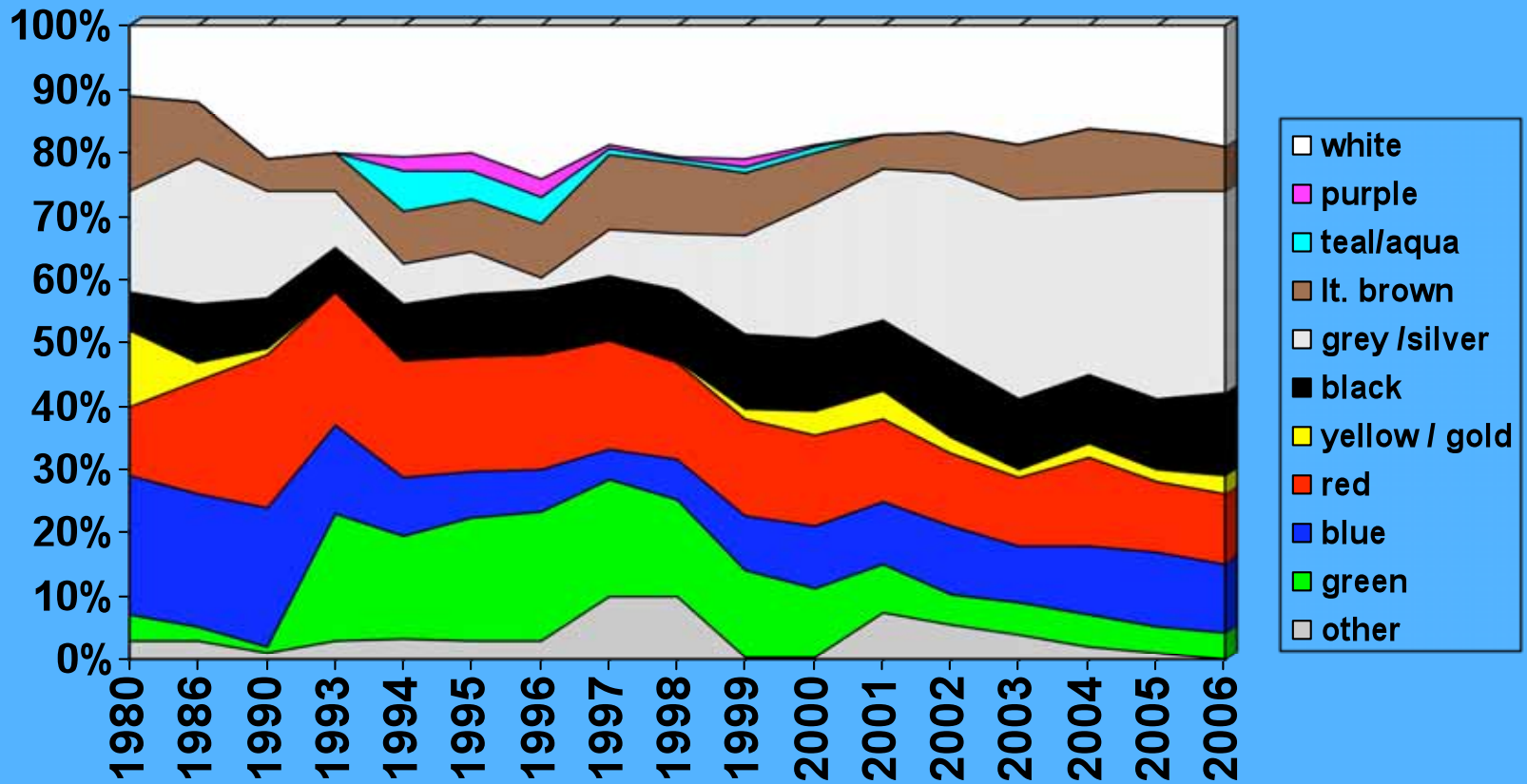
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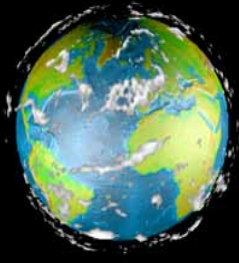
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Automotive Color Popularity

North America



Integrated Processes



○ Benefits of Integrated Coating Systems

- **Elimination of a Bake Oven**
 - ❖ Total energy reduction
 - ❖ Lower emissions of CO₂

- **Reduce the Paint Shop Footprint**
 - ❖ Less materials for construction
 - ❖ Lower heating/ cooling costs

- **Elimination of Waste**
 - ❖ Less material usage
 - ❖ Less paint sludge



Integrated Processes

Standard Process



Integrated Process 1 (WBBC)



Integrated Process 2 (WBBC)



Integrated Process SB (HSBC)



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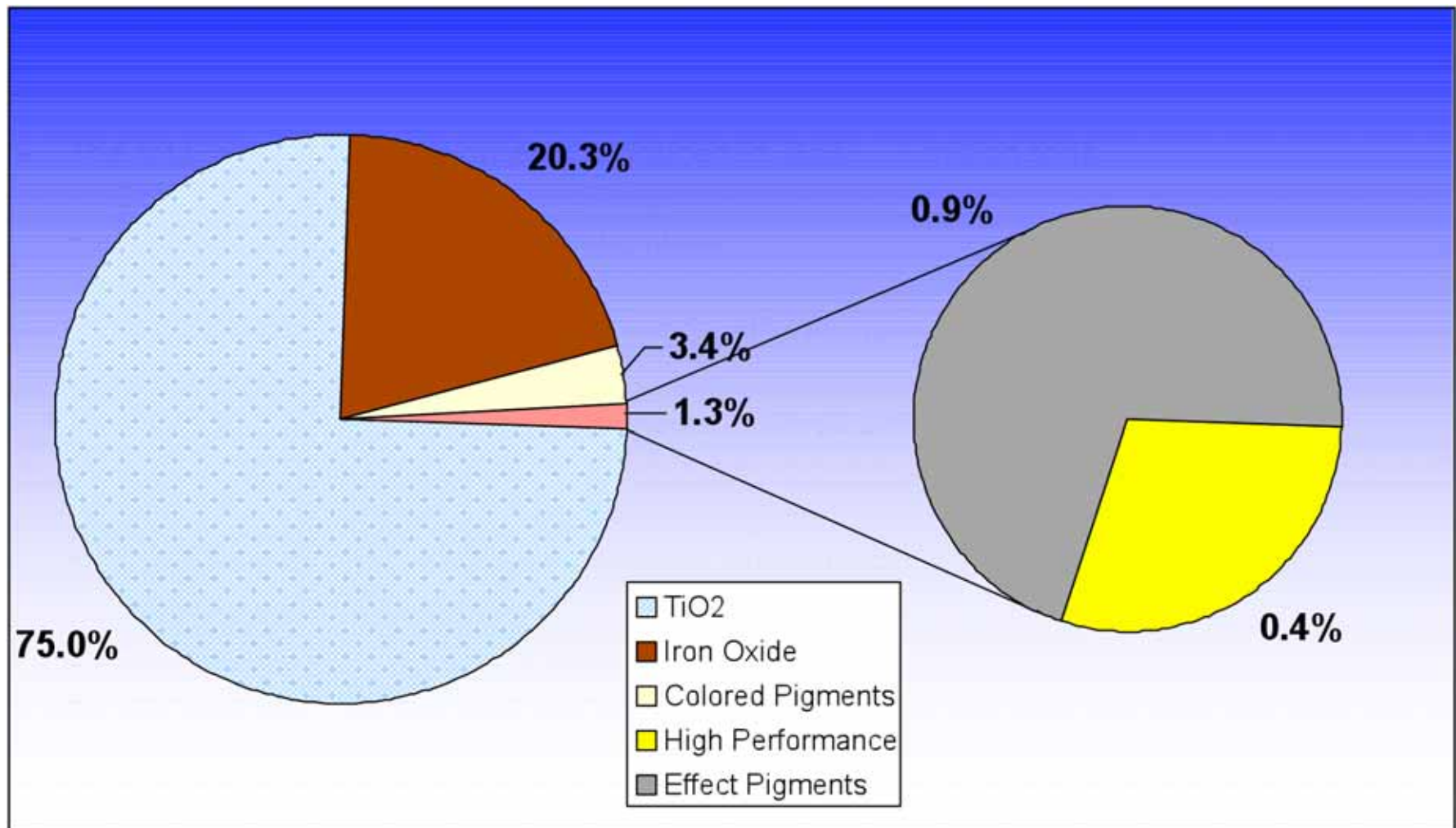
Color & Appearance are More Difficult to Control

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Pigments
Synthetic
Interference
Infrared Reflecting

The Market for Effect Pigments



Anatomy of an Effect Pigment

Weather Treatment (optional):
Outermost layer

Substrate (Core)

Coating Layer: thickness determines the color

High index of refraction

Absorption + Interference color

OR

Low index of refraction

Absorption color

Coated platelets

- Aluminum
- Natural and Synthetic Mica
- Glass Flakes
- Alumina
- Silica
- Varies smooth to rough
- Varies opaque to transparent

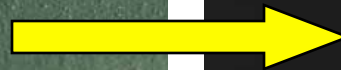
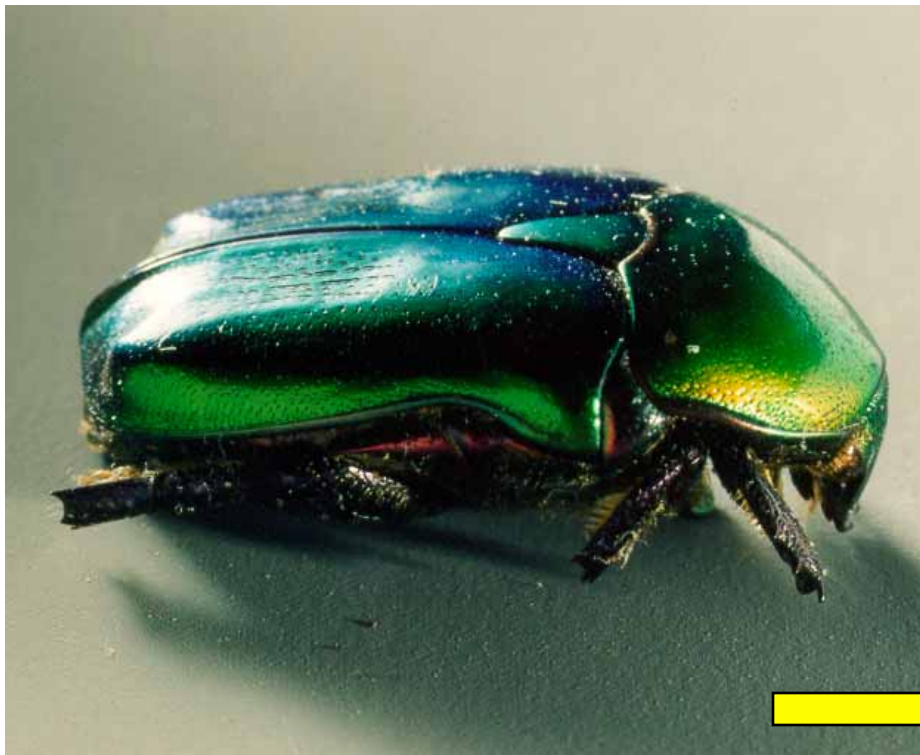
Color and Function

- Increased chroma and luster
- Reflection + Interference
- Absorption
- Improved orientation
- Decreased opacity
- Appearance more critical
- Durability protection

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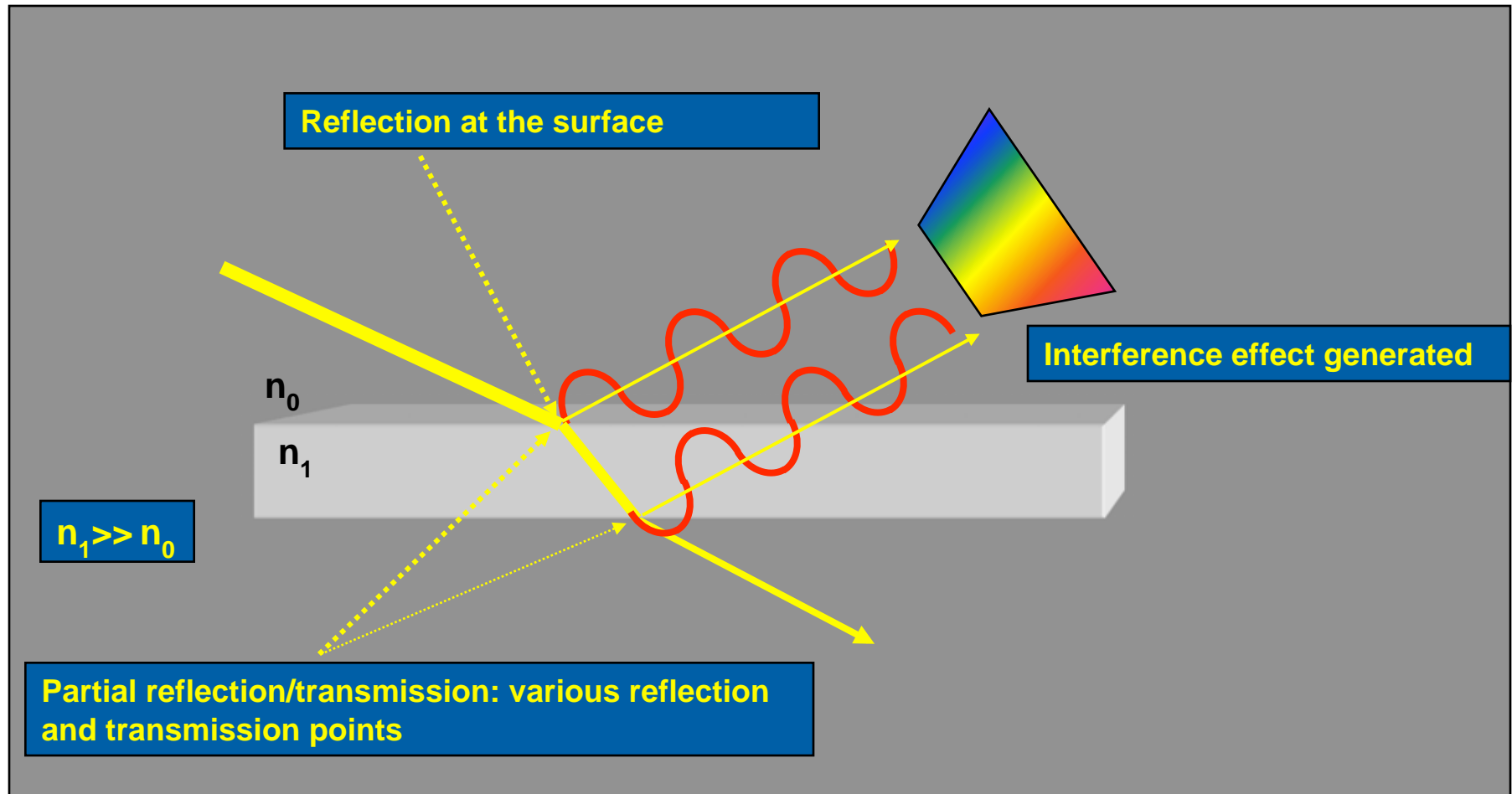
Target: Mimic Nature

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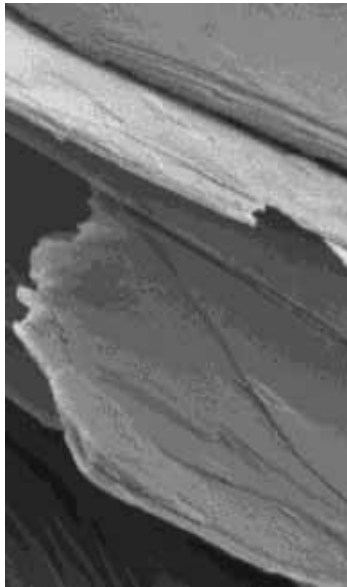


Principle of Light Interference

Color Flop and Goniochromaticity

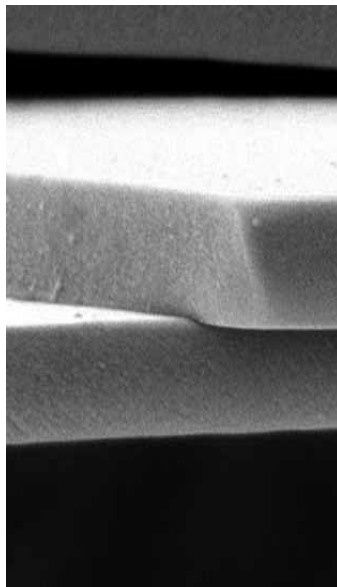


Changing the Substrate



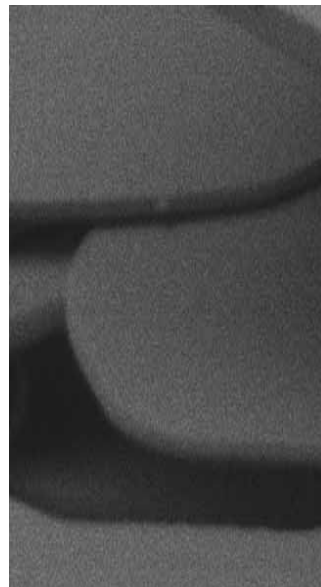
Mica

Hiding power



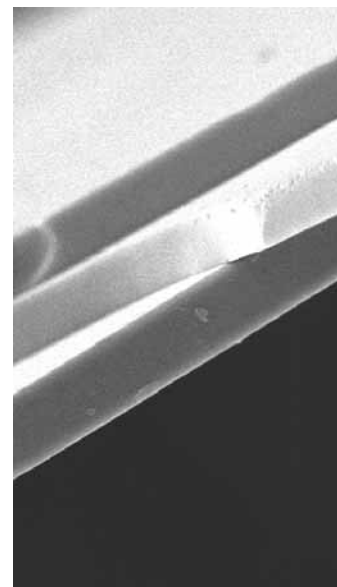
Silica

Color
travel



Alumina

Sparkle
Performance



Borosilicate

Transparency
Gloss



**Diffraction
Aluminum**

Holographic

Color Dependent on Coating Thickness

- **Interference:**
TiO₂ Coated
- **Absorption:**
Fe₂O₃ Coated
- **Combination:**
TiO₂ + Fe₂O₃ Coated



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Colorstream



Silica Flake coated with a layer of iron oxide

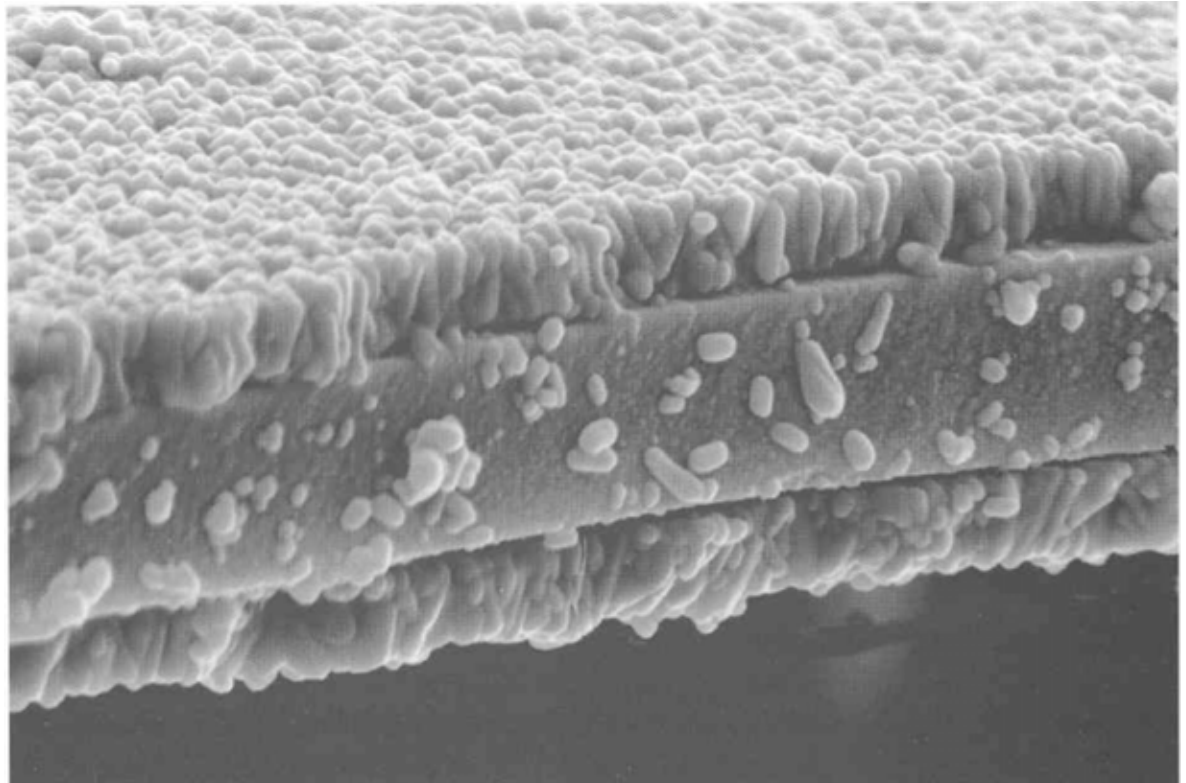


Photo courtesy EMD Chemical

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Color Enhances Shape

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Overview Cool Pigments

- Heat build up is caused by solar radiation
 - Major component for increase in temperature is IR region
 - “heat island” effect
- Pigments can reduce the reflectivity of solar radiation
- All pigments absorb, reflect, and transmit solar radiation to different degrees
- Substrate plays a major effect on solar reflectance
 - Visual hiding versus solar hiding

BASF has excellent market success in “ULTRA-Cool” colors for building materials

“Cool” Pigments

- IR transparent
 - Organic Perylene Pigment Black 32

- Some IR reflective pigment chemistries
 - Inorganic Pigment Green 17 (FeCr)
 - Inorganic Brown 29 (FeCr)
 - Inorganic Yellow 164 (MnSbTi)

Many pigments, e.g. aluminum flake or titanium dioxide, are very efficient at reflecting infrared light

Spectral Radiation of Sunlight

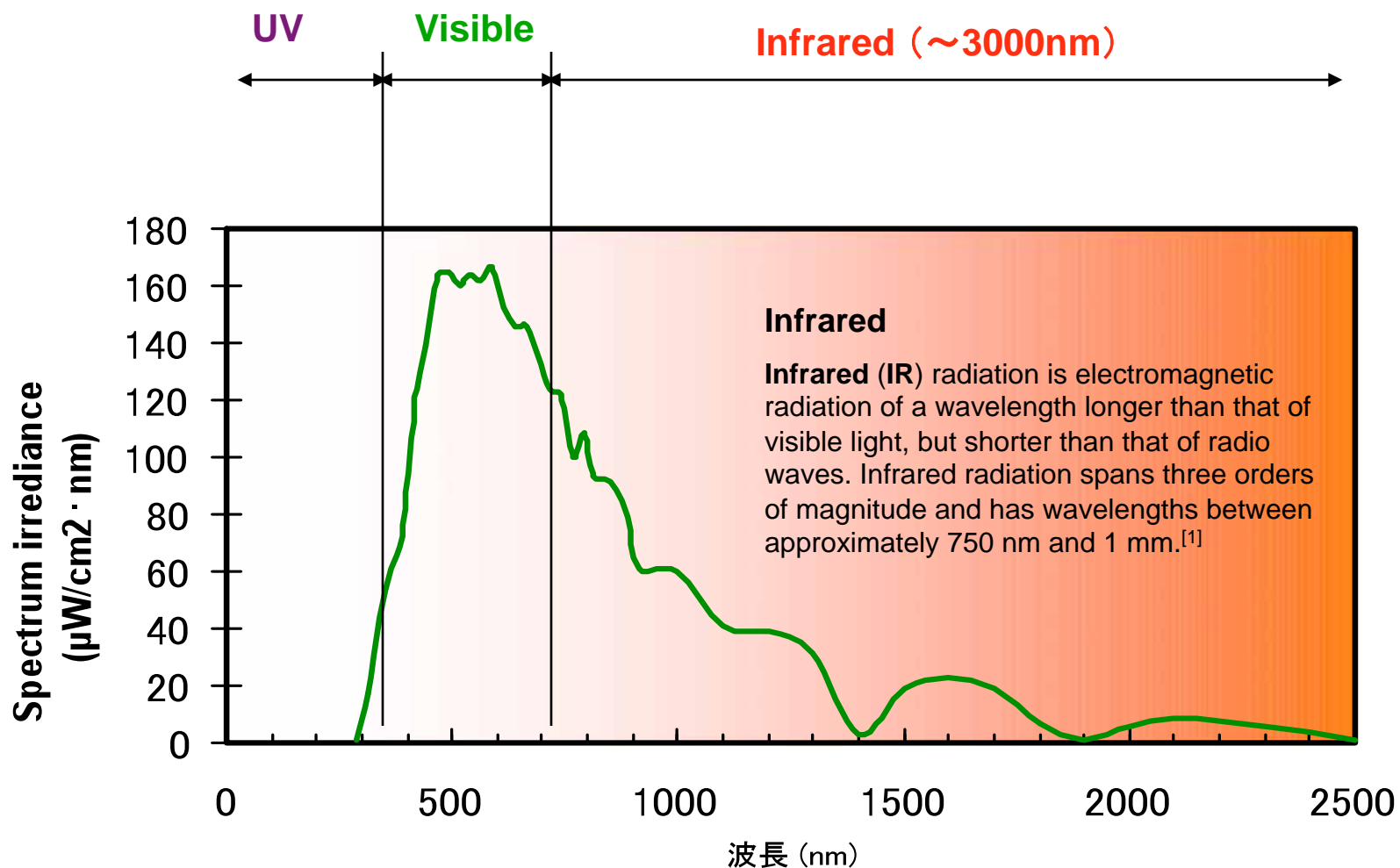
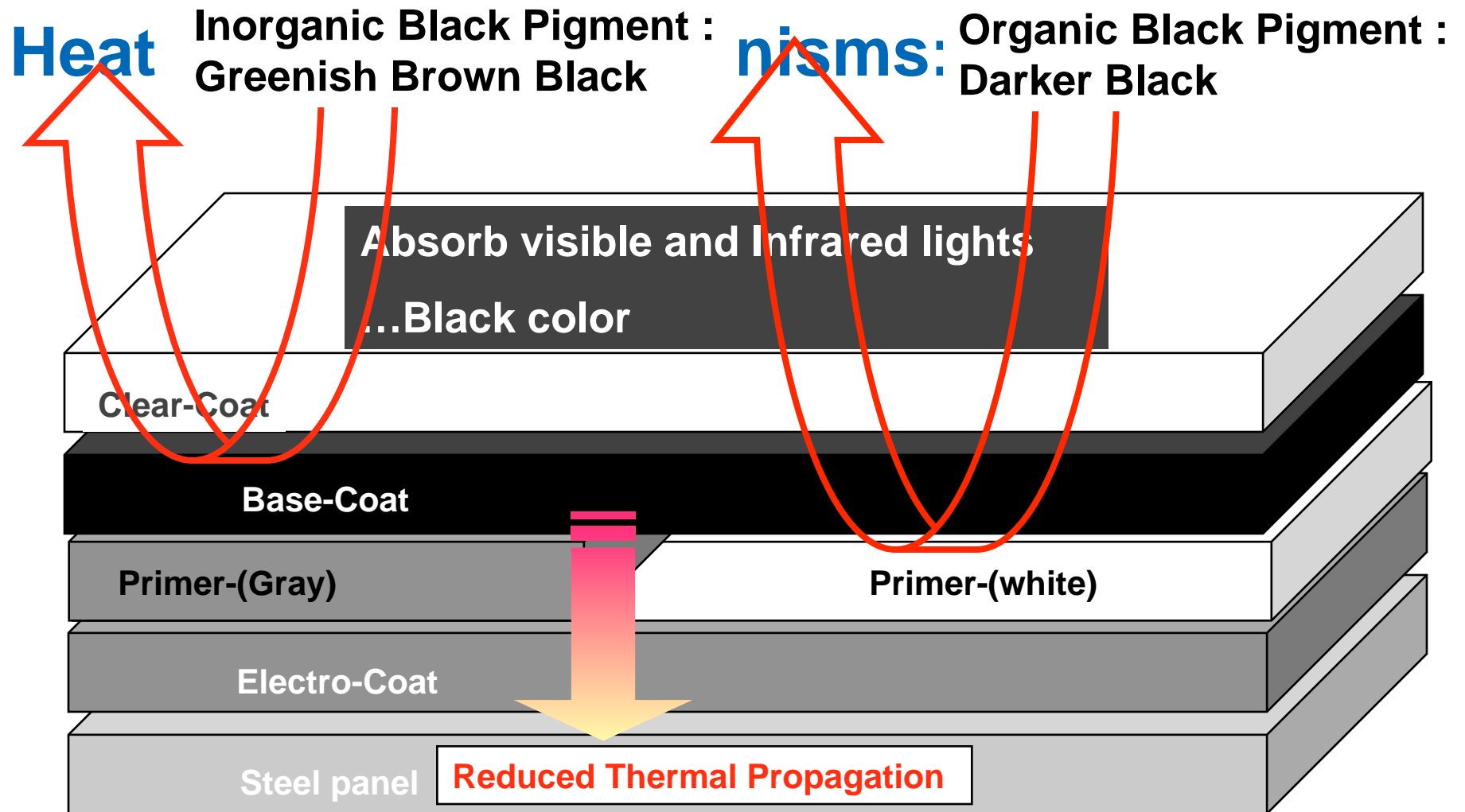


Image exposure to visible spectral range



Image exposure to near-infrared spectral range, 700–1000 nm





The Road Ahead to Cool

- Understand the benefits of coating an automobile with solar reflective pigments
 - Limitations of the color palette
 - Heat Island Effect
 - Impact on HVAC mass reduction
 - Passenger comfort and convection cooling
 - Contribution of the window glazing
 - Thorough studies needed to quantify the relative portion the coating makes on heat build up
 - Continue to work with CARB to ensure good approach to cool
-

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It Can Get Complicated

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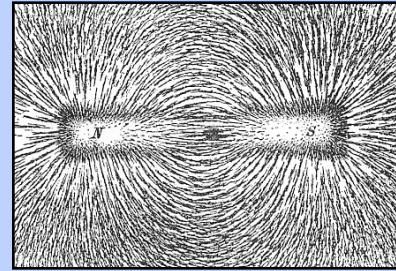


Functional Pigments

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Magnetic Imager Effect

Oriented Towards Color



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- Magnetically oriented lamellar effect pigments
- Badging/branding, contour lines, etc
- Mass reduction

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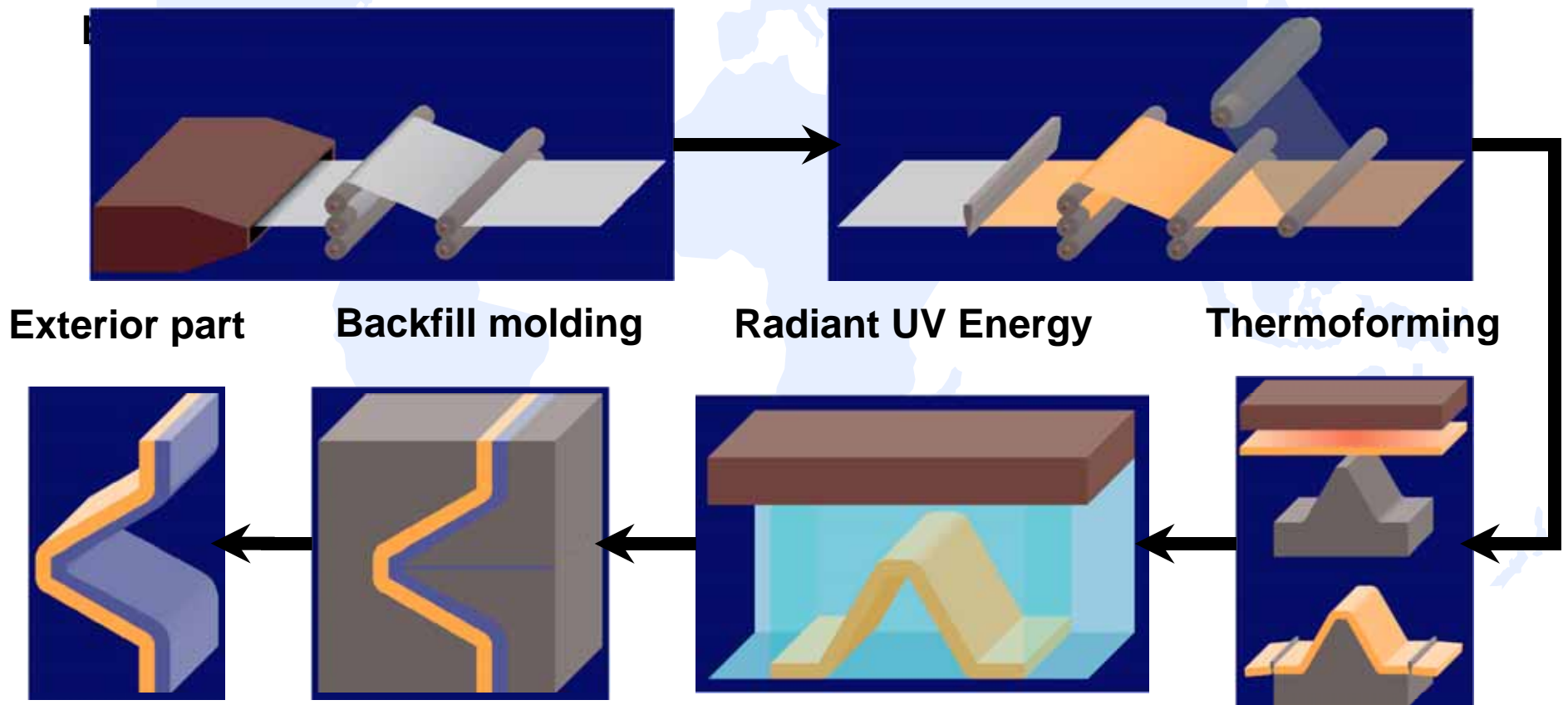
UV Film & Composite Substrates

- ✓ Class A finish on plastic surfaces
 - ✓ Improved scratch and mar resistance
 - ✓ No spray equipment required for application
 - ✓ Less complex
 - ✓ No VOC issues
 - ✓ Less energy
 - ✓ Smaller footprint for application
-



Laminate Film/ Painted Foil and In-Mold Color

○ After applying laminate film, parts may be post-processed to enhance properties



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E7 Concept design intent

- Aluminum space frame
 - All exterior body panels are composite
 - Doors TPO with Kevlar mesh inserts – Bullet Proof
 - Door structure – Rigid Composite
 - Fenders & Quarter panels – TPO
 - Hood, Roof and Deck – Reinforced TPO and other composites
 - All exterior surfaces utilize advanced UV cure paint film
 - Print on demand graphics for turn-key manufacturing
 - Performance specifications: www.carbonmotors.com
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Carbon Motors Corporation – E7 Police Interceptor

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Still, Cool Cars are Timeless!

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Acknowledgements

- Trace Evidence Symposium Organizers
 - Lee Brun-Conti
 - Everyone @ BASF
-