UV & EB Curing of Coatings – The Power of Light

Chicago Society for Coatings Technology

Dr. Mike J. Idacavage
Esstech Inc.

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Energy Curable Industrial Coatings

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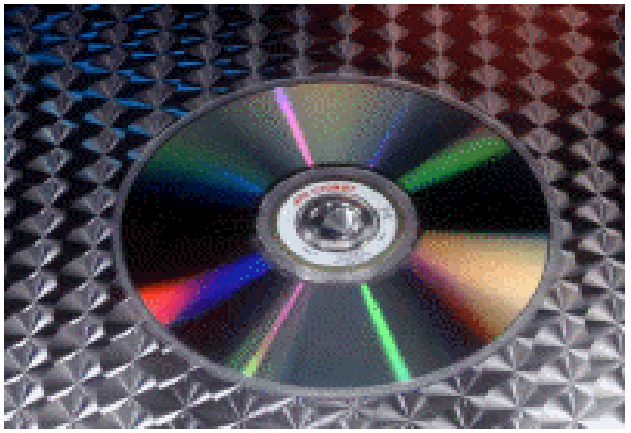
Energy Curable Graphic Arts Applications



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What is UV/EB Curing?

- Using UV energy, visible light, or high energy electrons as opposed to thermal, evaporative, or oxidative (air-dry) cure to form a coating, film or ink
- Types of energy used for energy curing:
  - Ultra Violet (UV): 200 – 400 nm
  - Visible light: typically 380 - 450 nm
  - Electron beam: high energy electrons

While I will frequently use the term "UV/EB curable", please note that the terms "radiation curable or "energy curable" may be used interchangeably.

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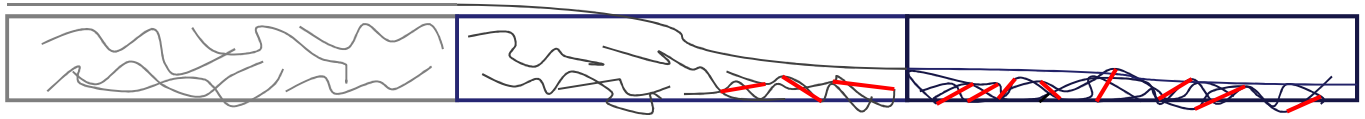
What is the UV Curing Process?

Conventional Cure

Drying Stage
Solvent Removal
Coalescence
Heat/Forced Air

Wet Application

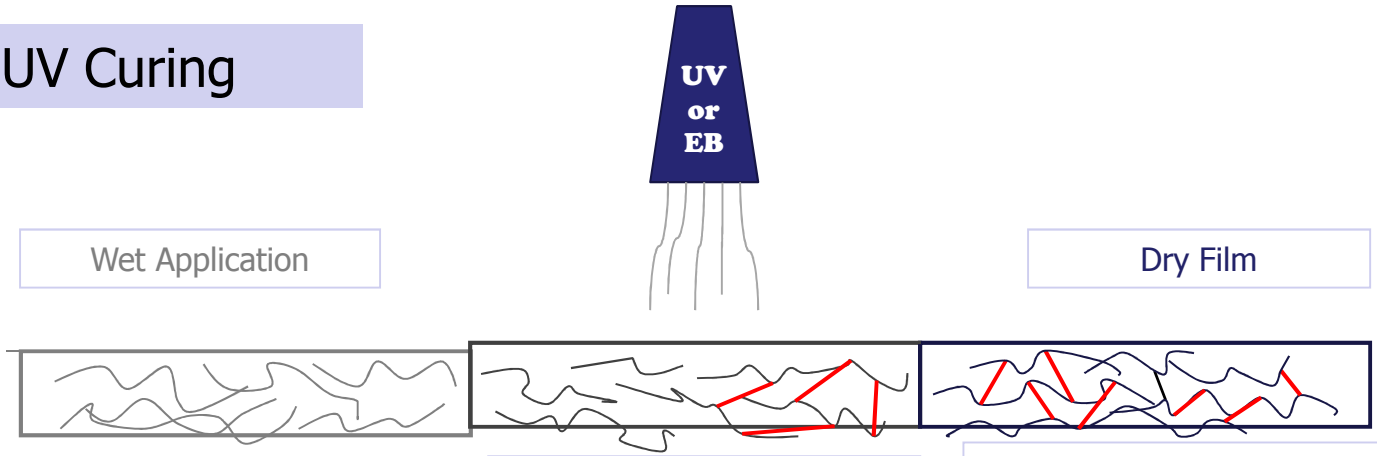
Dry Film



Dry Time in
Seconds or Minutes

- Property Development over Time

UV Curing



Wet Application

Dry Film

Instantaneous Cure
milliseconds

- Immediate Property Development
- High Cross Link Density
- Retains Shape

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Why Use Energy Curing?

- Productivity, Productivity, Productivity
  - Seconds to cure vs. minutes or hours
- Lower Overall Cost (per cured part)
  - 100% solids, cure speed, recycling of coating, etc
- Single component formulas
  - Eliminates mixing errors found in 2 component systems
- Regulatory Concerns (VOC emission)
  - Avoid solvent use in most cases
- Smaller equipment footprint
  - Less floor space needed
- Energy costs (esp. now with high oil prices)
- Did I mention Productivity?

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Property Strengths

- UV/EB Curing can generate a high crosslink density network
  - High gloss
  - High hardness
  - Scratch and stain resistance
  - Fast cure
- Works best with flat substrates

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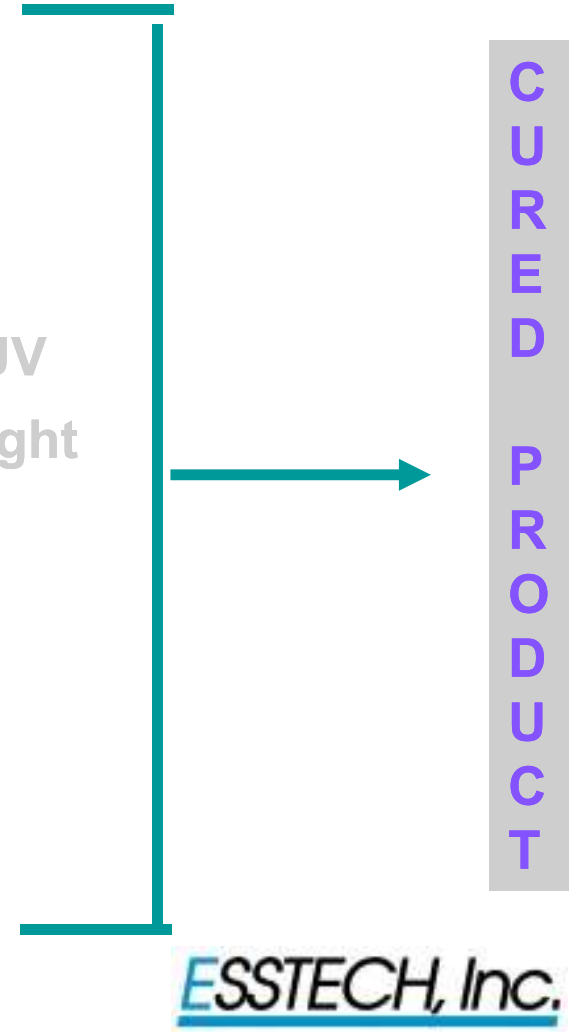
Areas for Improvement

- Adhesion to metal, esp. during post-forming
- Adhesion to some plastics
- Tear resistance
- Low gloss in 100 % solid systems
- Low film weight for 100% solids
- Overall cure of 3-D parts

EC coatings can have high shrinkage, which adversely affects adhesion to non-porous substrates. Lack of solvent coupled with a fast cure reduces the formulator's ability to meet low gloss, low film build requirements. Additional lamps are needed to cure 3D parts since EC is a line of sight cure method.

UV Curing

- Acrylated Resin(s)
  basic coating properties
- Monofunctional Monomer(s)
  viscosity reduction, flexibility
- Multifunctional Monomer(s)
  viscosity reduction, crosslinking
- Additives
  performance fine tuning
- Photoinitiator Package
  free radical generation



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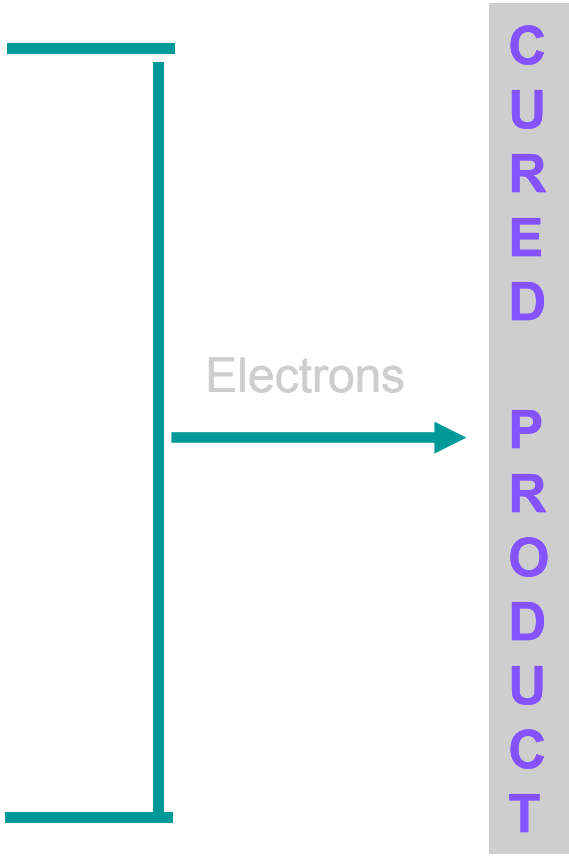

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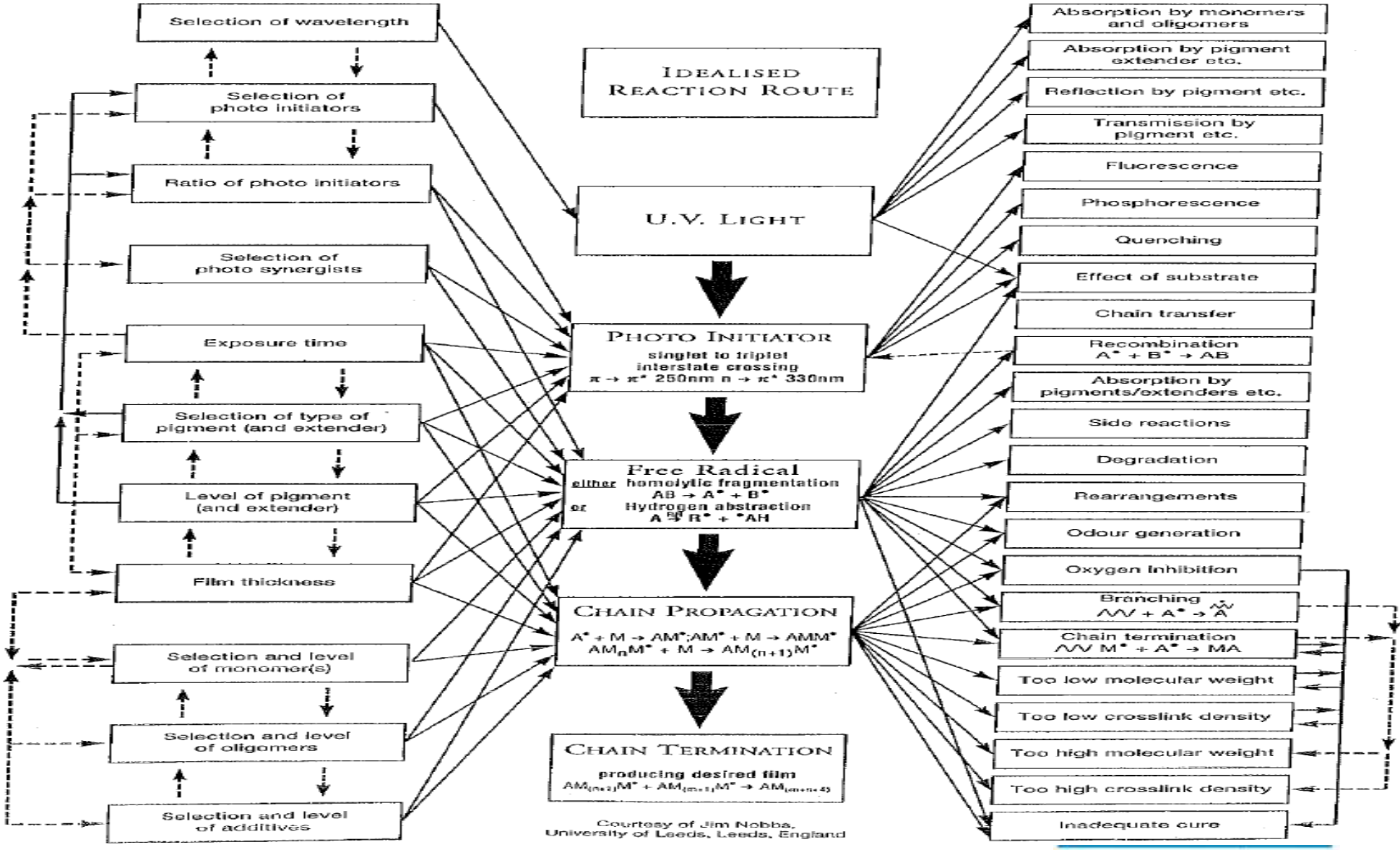
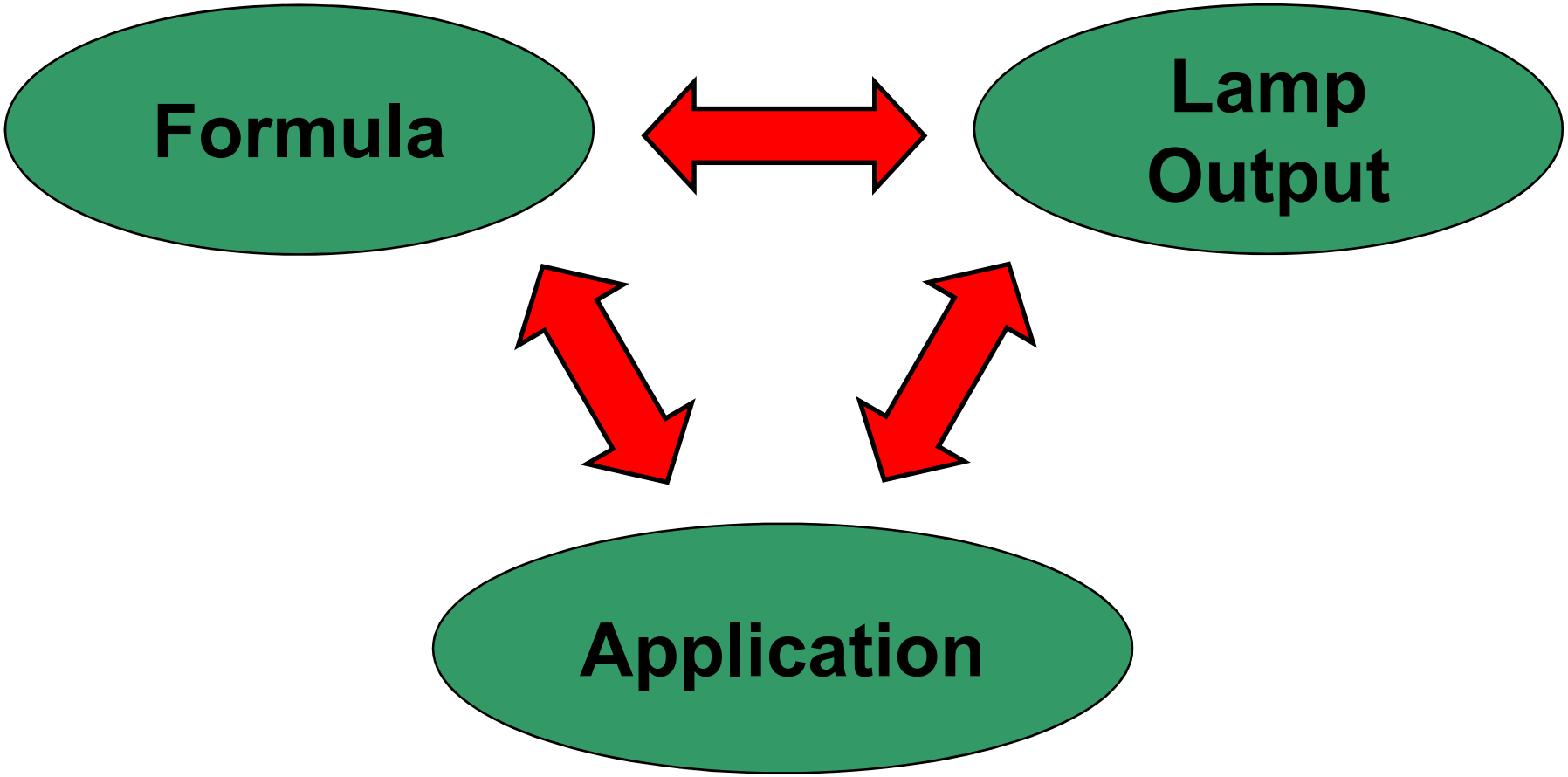
Everything You Always Wanted to Know About UV Formulating



Formulation of EC Products



All three aspects are interrelated

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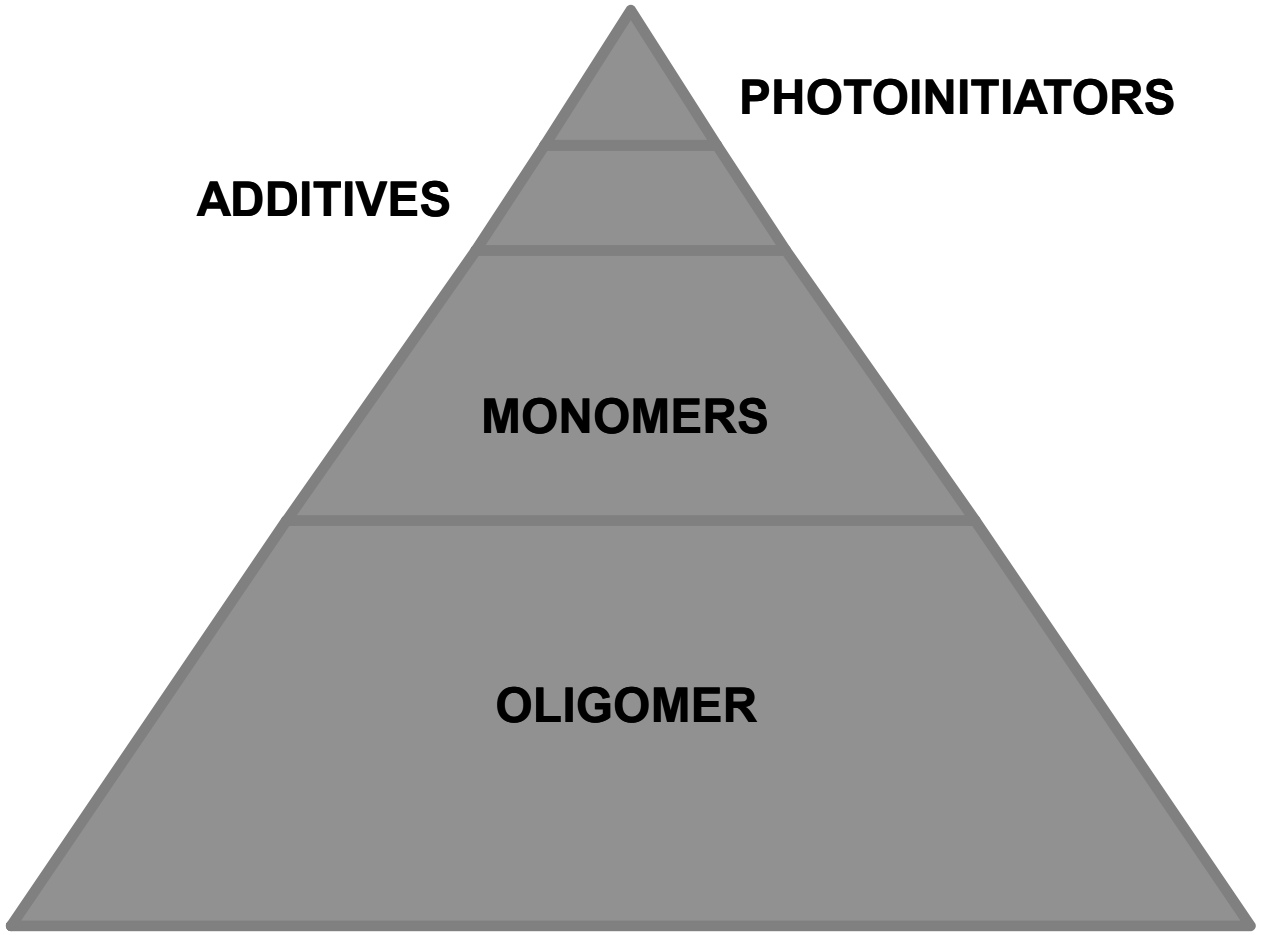
Formulating a UV Curable System



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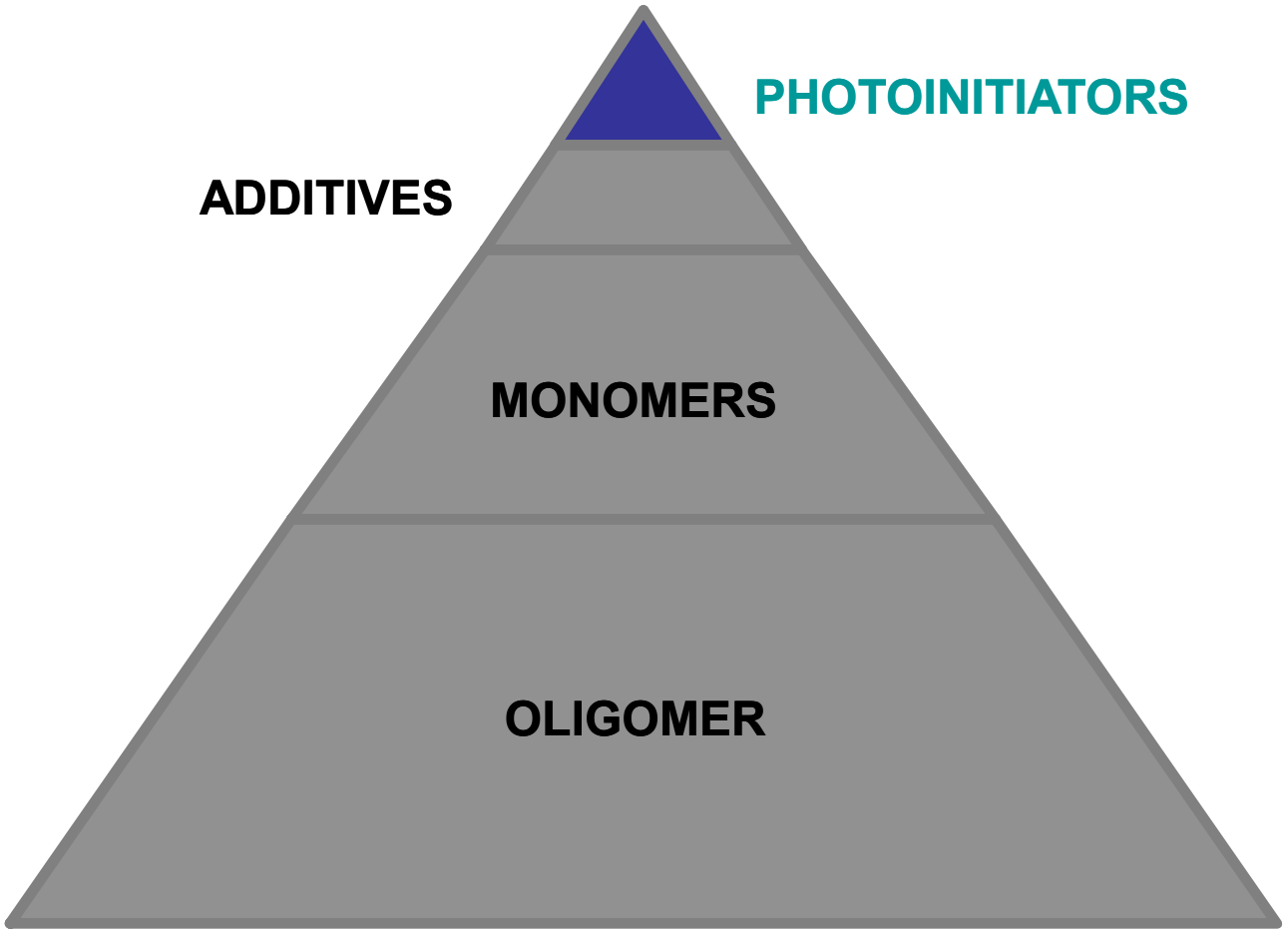
Formulating a UV Curable System



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Applications of UV/EB Curable Coatings

Industrial coatings and graphic arts market segments:

- Coatings for wood furniture and flooring
- Coatings for plastic, metal and paper
- Fiber optic coatings
- Coatings for electronic components
- Coatings used on automotive components
- Overprint varnishes
- Flexographic inks
- Screen Print inks
- Lithographic inks
- Laminating and pressure sensitive adhesives

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Formulating for Properties

Some desirable properties for coatings that can be achieved through UV or EB cured coatings:

- Adhesion
- Cure speed
- SARC (scratch & abrasion resistant coatings)
- Weatherability
- Pigmented systems

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Applications

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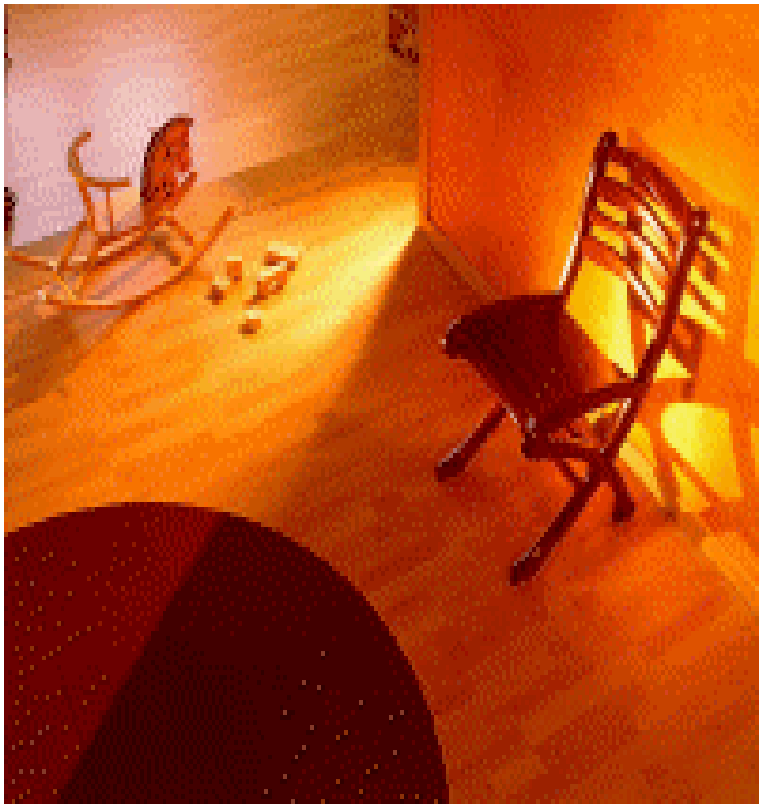
Energy Curable Coatings for Wood

- Fillers for plywood, MDF, particle board
- Top coats on furniture
- Kitchen cabinets
- Coatings on hardwood or parquet flooring
- Wood molding
- Ready to assemble (RTA) furniture



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Plastics Market

- Plastics: Very large and varied market, but two main sub-segments for UV/EB
- Automotive:
  - Headlamp lenses – hardcoats
  - Basecoats for Reflectors
  - Interior "soft touch" coatings
  - Interior hardcoats
  - Exterior side panels – hardcoats, sealers for SMC
- Non-Automotive: (rigid and flexible)
  - Rigid:
    - CD-DVD
    - Flooring – PVC
    - Containers
    - Hardcoats on plastics (e.g. cellphones)
  - Flexible:
    - Films (e.g. window films)

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Some Typical Application Methods

- Automotive:
  - Spray: usually out of solvent, some 100% solids
    - Air-assisted atomization
    - Airless hydraulic atomization
    - Rotary atomization (best for 100% solids)
  - Dip coating
  - Spin coating

- Window Films
  - Roll coater
  - Gravure
  - Reverse Gravure

- CD/DVD
  - Spin coater
- Vinyl Flooring
  - Roll coater
  - Slot die

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Challenges with UV/EB on Plastics

- Adhesion to Plastics
  - Getting "bite" in 100% solids system
  - High shrinkage with free radical cure – related to functionality
  - See recommendations
- 3-D curing, shadow cure (some plastic parts are intricate)
- Use of pigments (issue on any type of substrate)
  - Block some UV light
  - Need to use right PI combinations
  - Thick pigmented coatings difficult
- Getting low enough application viscosity
  - increase diluent concentration
  - lower viscosity oligomers
- Matting Agents – the right diluents
- Costs – need to look at the whole process benefits, and the overall performance benefits

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Metal Market Segments Using UV/EB

- Pipe, tube and conduit
  - Clear and colored on tube
- Specialty coil
  - Fasteners
  -
- Metal Deco
  - Inks and coatings on can bodies
  - Coatings on can ends
  - Inks and coatings caps & closures

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Tube Coating

UV clear coating on galvanized tub

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UV/EB Coatings for Metal

Challenges

- Adhesion to difficult substrates
- Spray application for coating post-formed items
- Corrosion (salt spray) resistance
- Pigmentation (UV at higher coating thickness)

Advantages

- Low/no VOC
- Reduced energy costs
- Shorter cure time
- Space savings
- Hardness, scratch resistance, chemical resistance

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Why UV/EB ?

- Open pot life
  - consistent printing and color
  - reduced time for clean-up & fewer wash-up
  - low make-ready waste
- Instant drying
  - reduced floor space needed for drying
  - ability to "convert" in-line
- Improved properties for inks and coatings
  - improved film weight control (100% solids)
  - higher gloss
  - reduced dot gain
  - better solvent resistance
  - improved adhesion
- Environmentally friendly
  - very low volatiles e.g. VOC -- safer work environment

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Why Not UV/EB ?

- Additional capital cost
  - retrofitting can sometimes be difficult
  - EB is expensive, but is becoming more cost competitive
- Inks and coatings are can be more expensive
  - but offset by improvements in productivity, superior appearance
- Re-training of operators
  - UV/EB inks perform differently compared to conventional inks & coatings

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RadTech International NA

- RadTech is a non-profit trade association
- Over 700 Members
- Just celebrated our 25th Anniversary
- Our members are across the supply change
- Members support over 20 application areas for UV and EB
- Coatings community is the strength of our group
- http://www.radtech.org/

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RadTech 2012

- Our Biennial Conference and Exhibition
- Over 80 exhibitors and 100 papers—all UV and EB
- Sessions include: Sustainabilty, Field Applied UV, UV Curing for 3-D, Graphic Arts, Barrier Coatings & Conductive Films for Flexible Electronics, Harsh environments--corrosion, weathering & exterior, Nanomaterials, Photovoltaics, LEDs
- Special short courses if you are new to UV/EB
- As a member of CSCT—RadTech offers you our special member rate to attend
- www.radtech2012.com

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Thank You!

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