A Versatile Binder for Ultra-Matte Effect Coatings

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Allnex

All About Resins

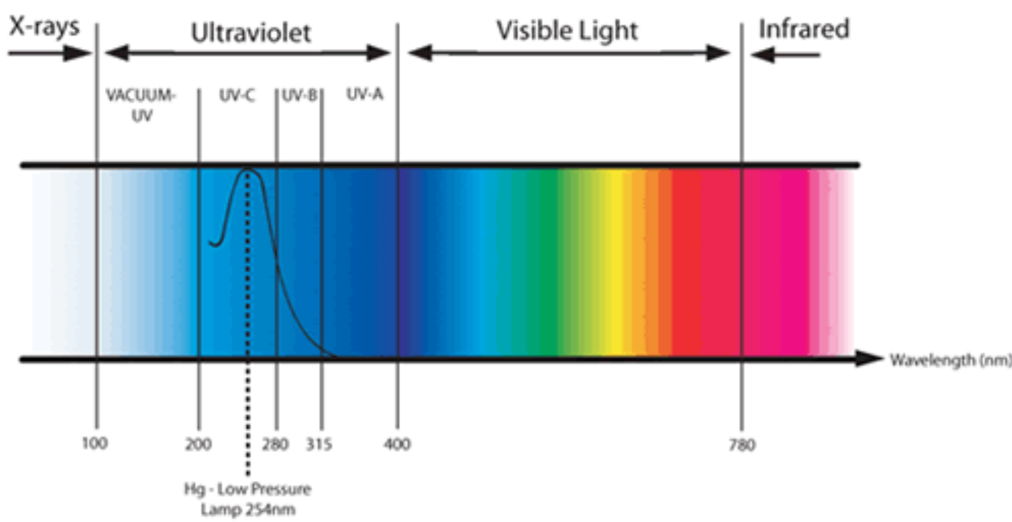
Agenda

- Energy Curing
  - Definitions and benefits
- Matte Effect
  - Challenge with Matting 100% UV Formulations vs. SB, WB
- Performance
  - Wood
  - Flexible Flooring
  - Exterior Coatings
  - Plastic Substrate
- Conclusions

What is Ultra-Violet (UV) curing?

- Using UV energy or visible light, as opposed to heat, solvent evaporation, or oxidation (air-drying), to convert a liquid formulation into a solid material
- Types of energy used:
  Ultra Violet (UV): 200 – 400 nm
  Visible light: typically 380 - 450 nm

ELECTROMAGNETIC SPECTRUM



Productivity, Productivity, Productivity

Seconds to cure vs. minutes or hours

No reaction until exposure to UV energy

"Cure on Demand", long pot life and reduced waste

Single component formulas

Eliminates mixing errors found in 2 component systems

Lower Overall Cost (per cured part)

100% solids, cure speed, recycling of coating, etc.

Regulatory concerns (VOC emissions)

Low to no VOC

Energy Costs

Line of sight curing

- All areas of the part must be exposed to UV energy
- Lamp placement critical, but not difficult

Absorbance of system

- Components that absorb/block UV may interfere with cure
- Select components that don't absorb UV or select PI that absorbs in another region of the UV spectrum

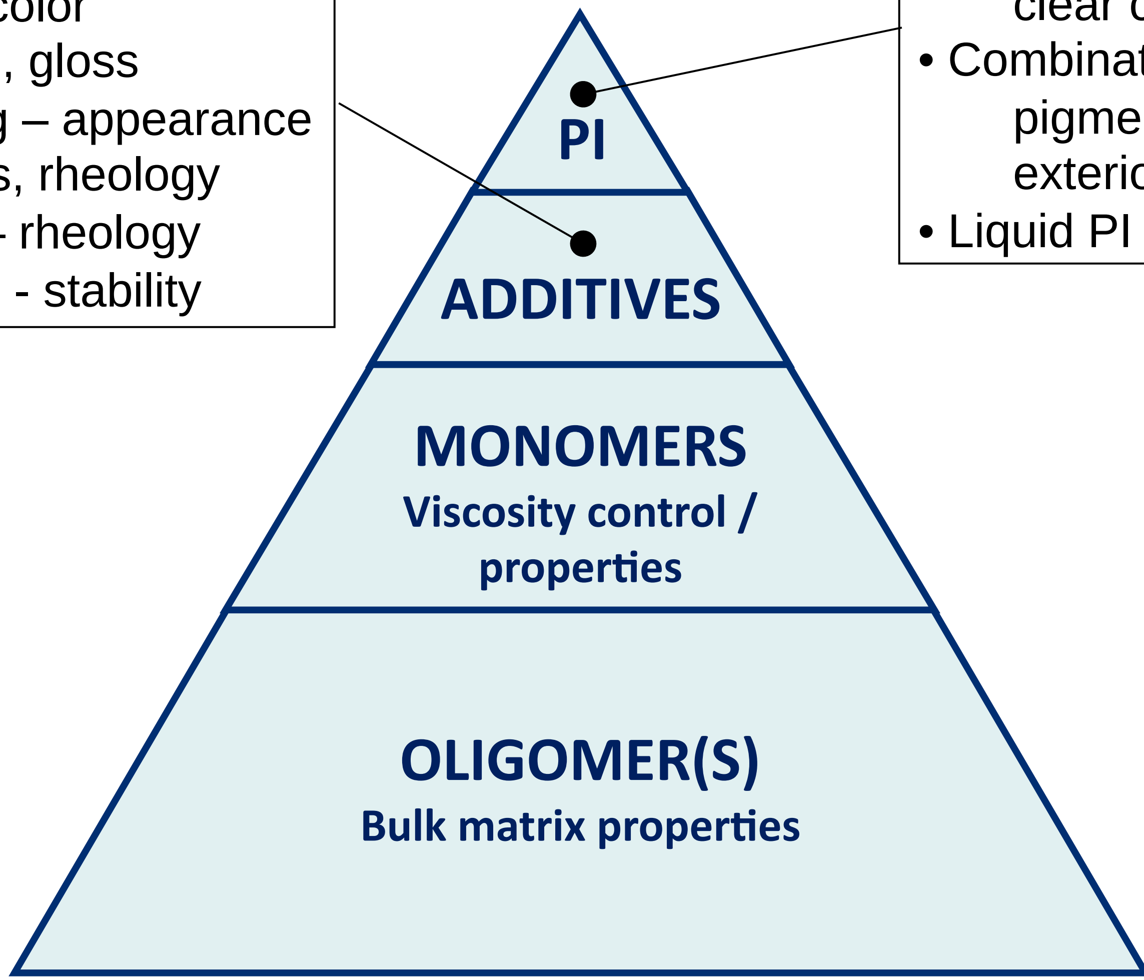
Shrinkage

- All reactions generate shrinkage, which may lead to poorer adhesion
- Mitigate with selection of diluents, oligomers
- Use of WB systems can reduce shrinkage (no monomers needed to reduce viscosity)

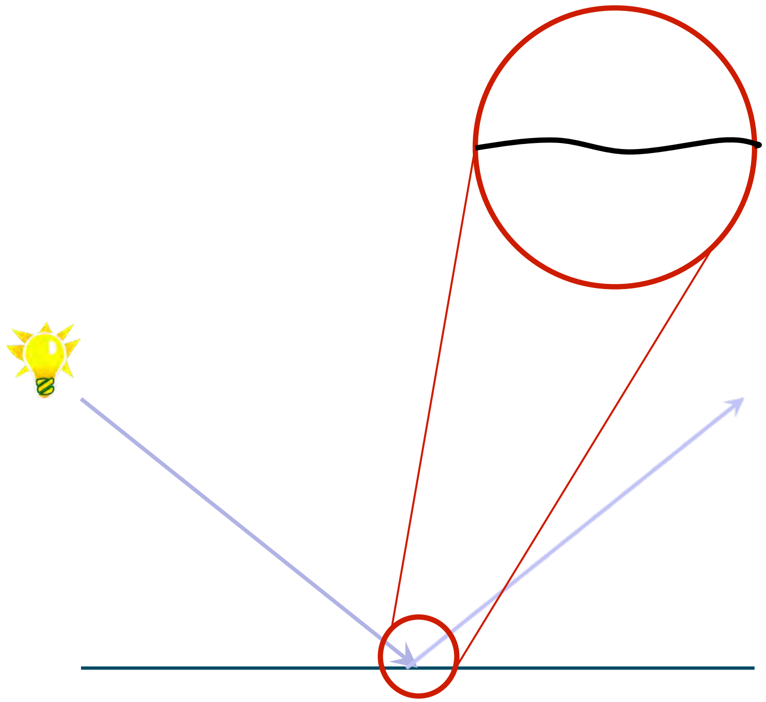
Energy Curing
100% Solids Formulation

- Matting agents – gloss
- Pigments – color
- Waxes – slip, gloss
- Flow/leveling – appearance
- Silica – gloss, rheology
- Thickeners – rheology
- pH adjusters - stability

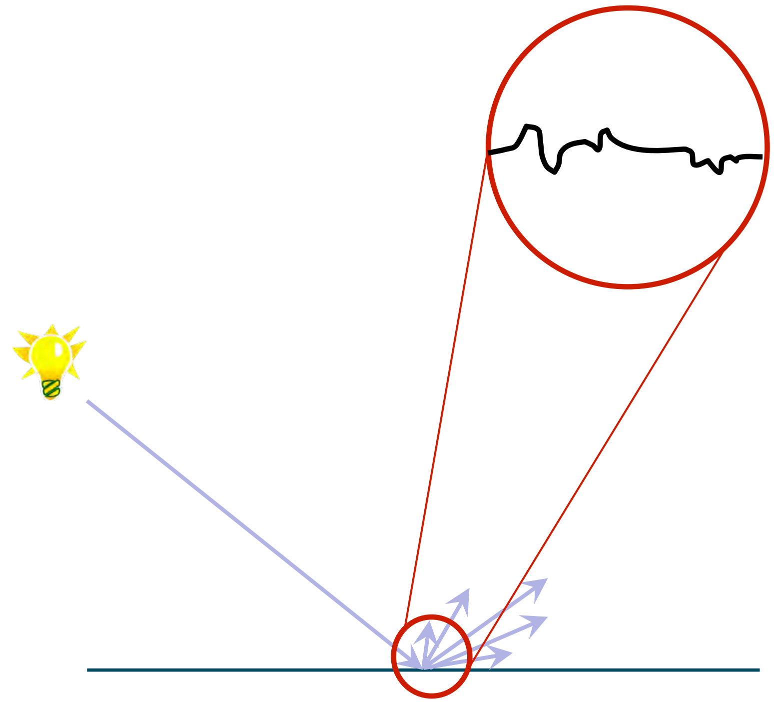
- Single PI –
  clear coatings
- Combination PI -
  pigmented, highly filled, exterior durable
- Liquid PI preferred



Gloss vs. Matte Surface



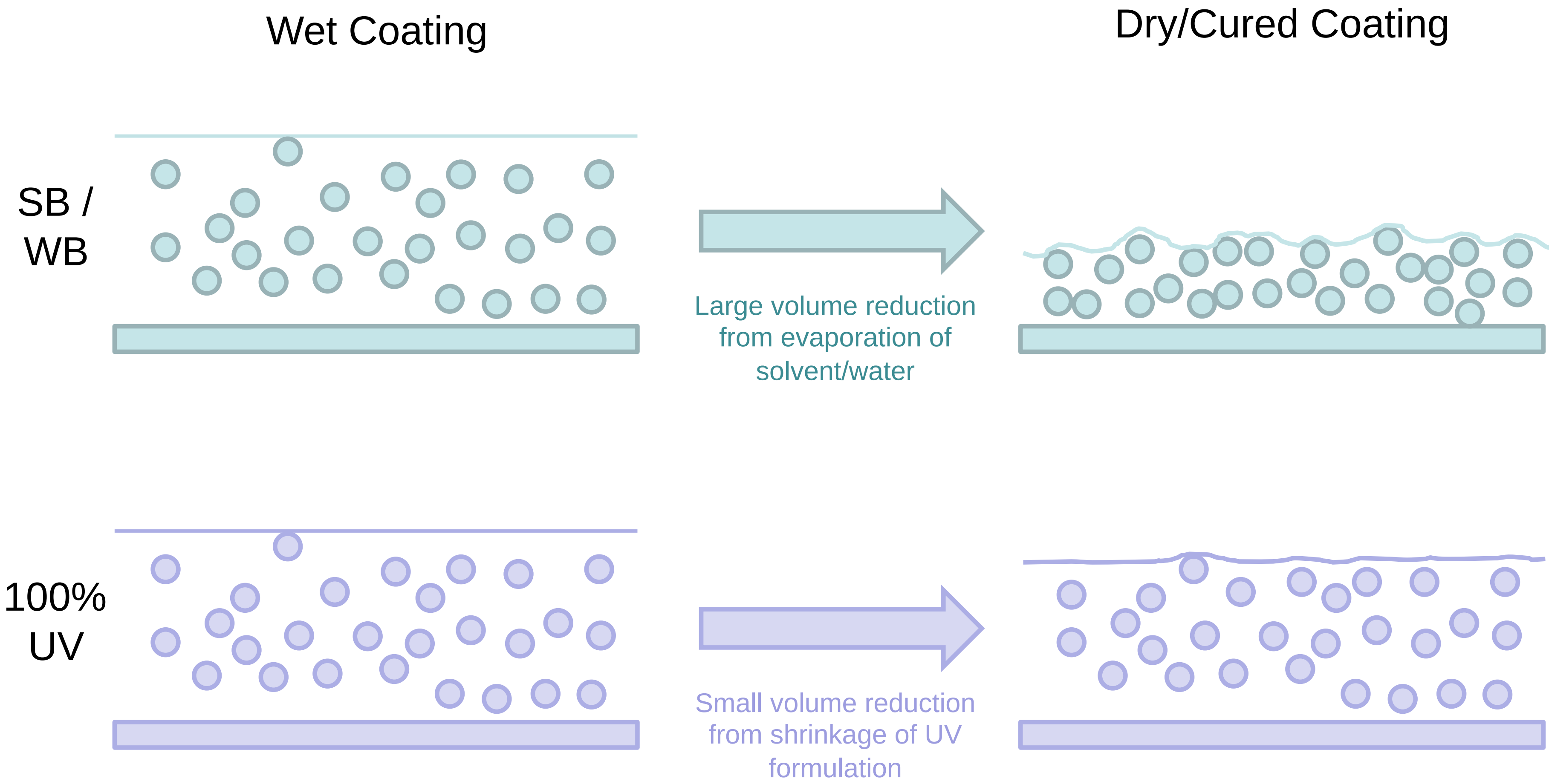
High Gloss Coating



Matte Coating

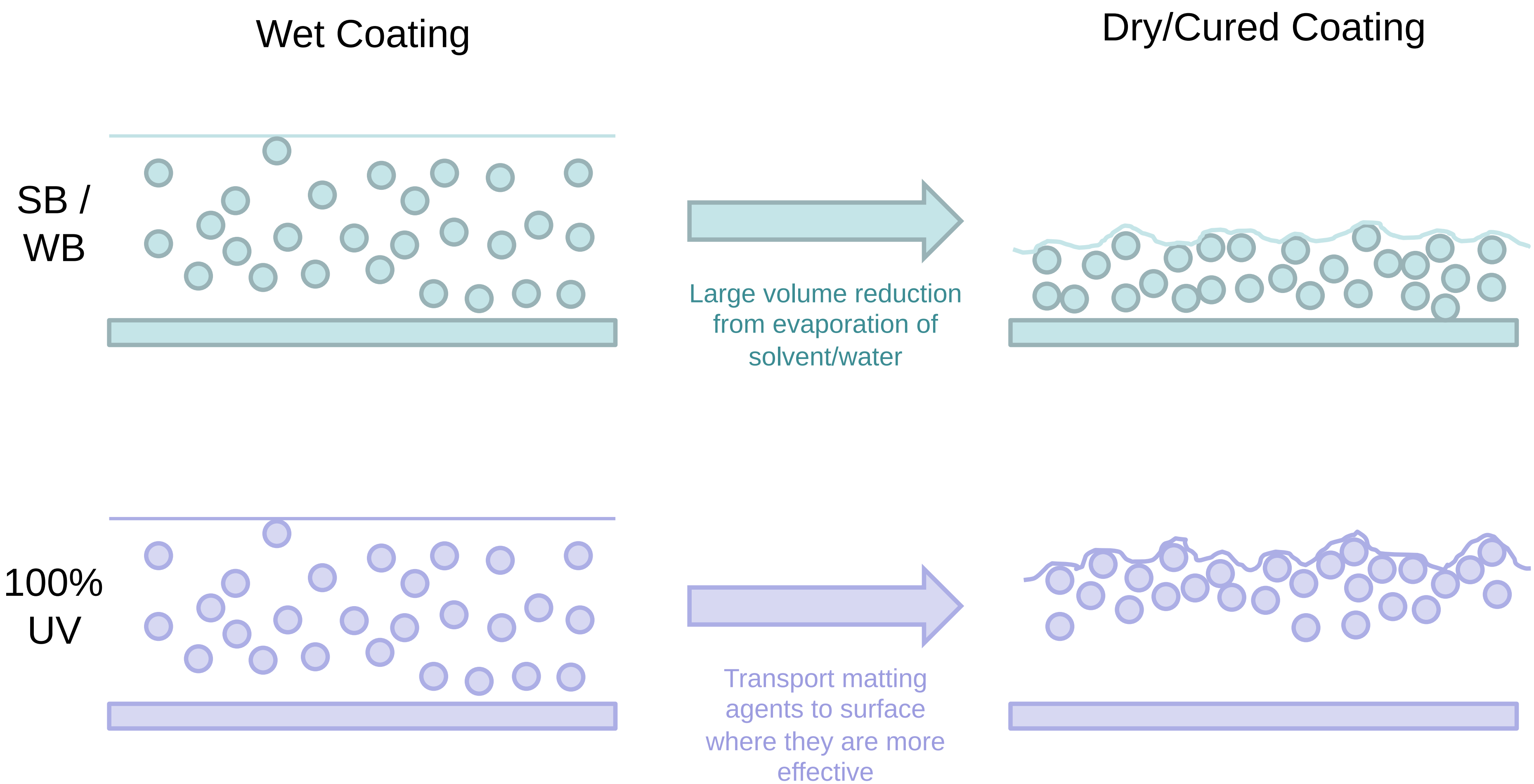
Matting

SB/WB vs. 100% Solids Formulation



Matting

SB/WB vs. 100% Solids Formulation



Challenges with Low Gloss 100% Solids UV

- No evaporation of solvent or water (limited volume reduction)
- 2x amount of matting agents versus SB/WB systems
- Control of viscosity/rheology is more difficult
- Dead Matte with compromises, eg. use of solvents or monofunctional diluents

Target Properties for a Solution

- Not self matting, but co-resin to help matting agent efficiency
- Reach desired gloss levels with LESS matting agents –or- lower gloss with same amount of matting agents
- "Dead Matt" (Gloss < 5, 60°) without solvents / monofunctional diluents

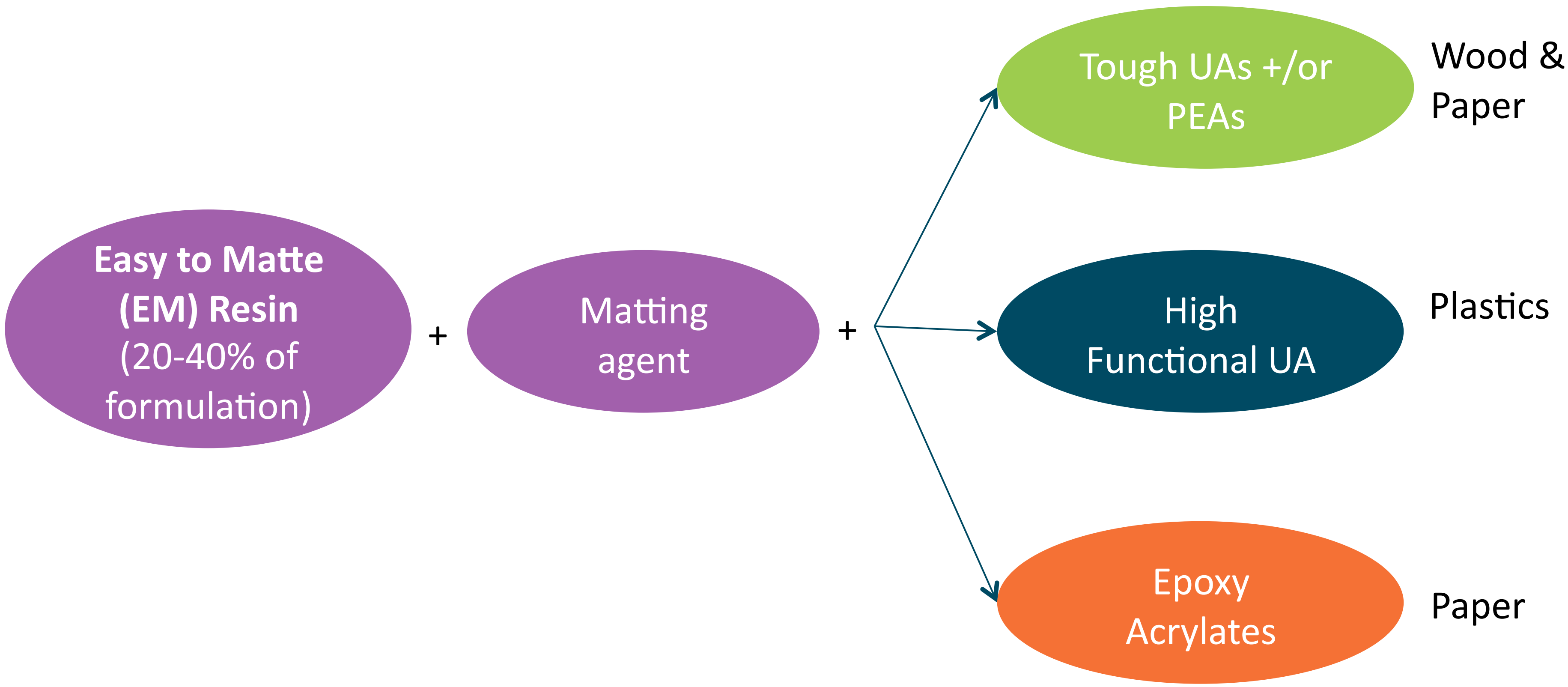
Easy to Matt (EM) Binder
Typical Properties

Typical Values	
Viscosity (cP, 20 rpm, 25°C)	± 3500
Color, Gardner	white milky
Density (g/mL)	0.8
Functionality, theoretical	4

Typical Cured Properties	
Young modulus (MPa / psi)	842 (122,000)
Tensile strength (MPa / psi)	8.6 (1250)
Tensile elongation (%)	1.4
Glass transition temperature (°C)	65

Easy to Matt (EM) Binder

How to Use



Combining matting & formulation efficiency & flexibility !

Reference Starting Point Formulation
Parquet Topcoat

	pbw	Features
Tough Urethane Acrylate **Hard Polyester Acrylate** DPGDA	30 **20** 42	3f aliphatic urethane acrylate 4f polyester acrylate
Photoinitiator 1 Photoinitiator 2	3 2	PI blend
Silica 1 Silica 2 Wax	8 2 2	Gloss control

- **25µm wet coat applied on UV-PUD primer – 3 coats 100% UV sealer**
- **UV** cure**: 10m/min 2x 200 WPI Hg lamps**

Gloss wood panel	Length	Cross direction
60°	17	14
85°	45	23

EM Resin Starting Point Formulation

Parquet Topcoat

	pbw	Features
Tough Urethane Acrylate **EM Resin** DPGDA	30 **20** 42	3f aliphatic urethane acrylate Easy to Matte resin
Photoinitiator 1 Photoinitiator 2	3 2	PI blend
Silica 1 Silica 2 Wax	8 2 2	Gloss control

- **25µm wet coat applied on UV-PUD primer – 3 coats 100% UV sealer**
- **UV cure: 10m/min 2x 200 WPI Hg lamps**

Gloss wood panel	Length	Cross direction
60°	5	4
85°	25	5

EM Resin Starting Point Formulation
Gloss vs. Monofunctional Diluent

Raw Material		SPF	+ 1f diluent	+ 1f diluent	+ EM resin
Reference SPF		100	100	100	100
+ Monofunctional Diluent			10	20	
+ EM Resin					20
Gloss at 60/ 85° angle					
Line Speed 7m/min	100 WPI Hg lamp	11.1/51.1	4.0/23.5	3.8/17.2	5.4/51.7
	200 WPI Hg lamp	12.9/57.4	4.6/34.1	3.3/22.0	6.7/57.3
	300 WPI Hg lamp	11.0/54.0	4.7/32.2	3.1/20.0	6.0/55.3
Line Speed 15m/min	100 WPI Hg lamp	Poor surface cure			
	200 WPI Hg lamp	15.8/72.3	Poor surface cure		7.7/50.9
	300 WPI Hg lamp	18.5/80.3	8.6/60.7	5.9/44.5	9.4/69.4

EM Resin Starting Point Formulation
Gloss vs. Film Build

- 6 -120 µm on black Leneta paper
- UV cure: 10m/min 2x 200 WPI Hg lamps

Gloss	Film Thickness	20°	60°	85°
New SPF with EM Resin	120	0.2	**3.2**	25.5
	80	0.3	**4.0**	27.7
	24	0.4	**4.4**	33.8
	6	0.4	**5.1**	45.5

Limited gloss variations from 6 till 120 µ

EM Resin Starting Point Formulation
Gloss vs. Coating Haze

30 µm wet coat applied on glass plate and Leneta paper
cured 7m/min 200 WPI Hg lamp
Haze measured with XL-211 Hazegard system

	Haze Gardner	Gloss 60° coat on Leneta
Glass plate	0	-
Standard topcoat	24	12
New topcoat with EM resin	**28**	**4**
Standard topcoat + 20pbw monofunctional diluent	36	3

Low gloss with good transparency

Stain Resistance on Leneta paper

- 25 µm wet coat applied on white Leneta paper
- UV cure: 10m/min 2x 80W Hg lamps

18 hours spot test	Reference SPF Gloss 60° : 17	EM resin SPF Gloss 60° : 5
2% Eosine	2	2
Coffee	5	5
Mustard	2	2
Red wine	5	5
EtOH/ water (1/1)	5	5
Bleach water (7%)	5	5

Low gloss without compromising on stain resistance

EM Resin Starting Point Formulation
Gloss vs. Cure Conditions

- The EM resin formulation can be used in different curing conditions (lamps, distance to substrate, speed) and has positive effects to lower gloss. **The higher the light intensity, the lower the gloss.**

- The **distance of the lamp to the substrate has a minor impact on the gloss** level

- Line speed has an influence on the gloss level. **A slower line speed gives more time for the formulation to cure** (= more time for gel/ full-cure) **and lower gloss.**

Electron Beam curing (EB)

- EB cured finish: 250Kvolt – 50kGy

	g/m^2	Gloss 60°
Ref. benchmark	40	30
New SPF with EM resin	40	5

EM resin shows same performance in EB curing

EM Resin Starting Point Formulation

Resilient Flooring

Component (*)	Ultra-Matt	Reference
Biobased Polyester Diacrylate	23	37
EM Resin	**13**	**0**
Monomer(s)	50	50
Silica matting agents	7	7
Wax	2	2
Photoinitiator	4	4

	Gloss and stain level	
Gloss 60° angle (**)	8-9	40
Average 6 domestic stains (max = 5/5)	4.0	4.0

EM resin is an ideal blending partner for PEAs for flexible flooring

(*) Reactivity / Curing conditions: 7m/minute 300 WPI Hg

EM Resin Starting Point Formulation

Exterior Durable Coating

Component (*)	Reference SPF	EM resin SPF
Weatherable Urethane Acrylate	36	30
EM Resin	-	**20**
Monomer(s)	52	38
Photoinitiator	4	4
Silica matting agent	8	8

	Gloss and stain level	
Gloss 60° angle	12-15	5
Average 6 domestic stains (max = 5/5)	4-5	4-5

In combination with weatherable UA, gloss levels <5 can be obtained with EM resin

(*) Reactivity / Curing conditions: 7m/minute 300 WPI Hg

EM Resin Starting Point Formulation
PET Film Coating

Component (*)	Ultra-Matt	Reference
EM Resin	**28**	**0**
Polymer/diluent blend	10	29
Monomer(s)	54	63
Photoinitiator	4	4
Silica Matting Agent	4	4
	Gloss level	
Gloss 60° angle	5	35

EM Resin in combination with polymer diluent blend brings significant reduction in gloss

(*) Reactivity / Curing conditions: 20m/minute 300 WPI Hg lamp

Conclusions

- 100% solids Easy to Matte resin created
- Can achieve low gloss with less matting agent
- Can achieve lower gloss with same amount of matting agent
- Gloss levels are relatively independent of film thickness
- Better cure speed vs. monofunctional monomers
- Compatible with variety of other UV resins for use in other markets

Acknowledgements

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Thank you for your attention!

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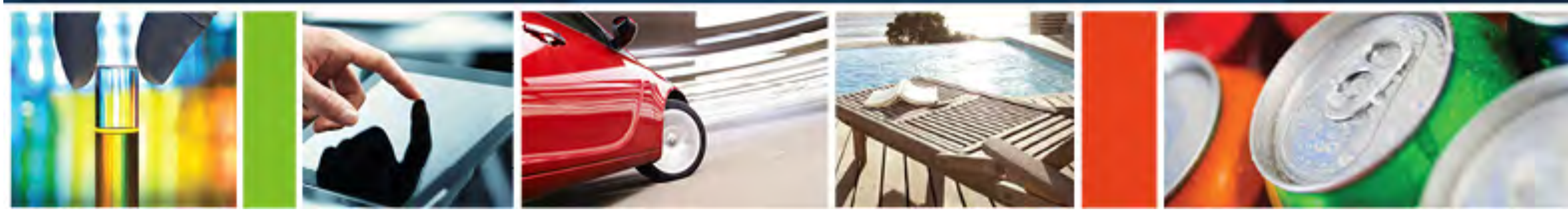

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