Paper Upgrade - A Path to Realistic Looking Substrates

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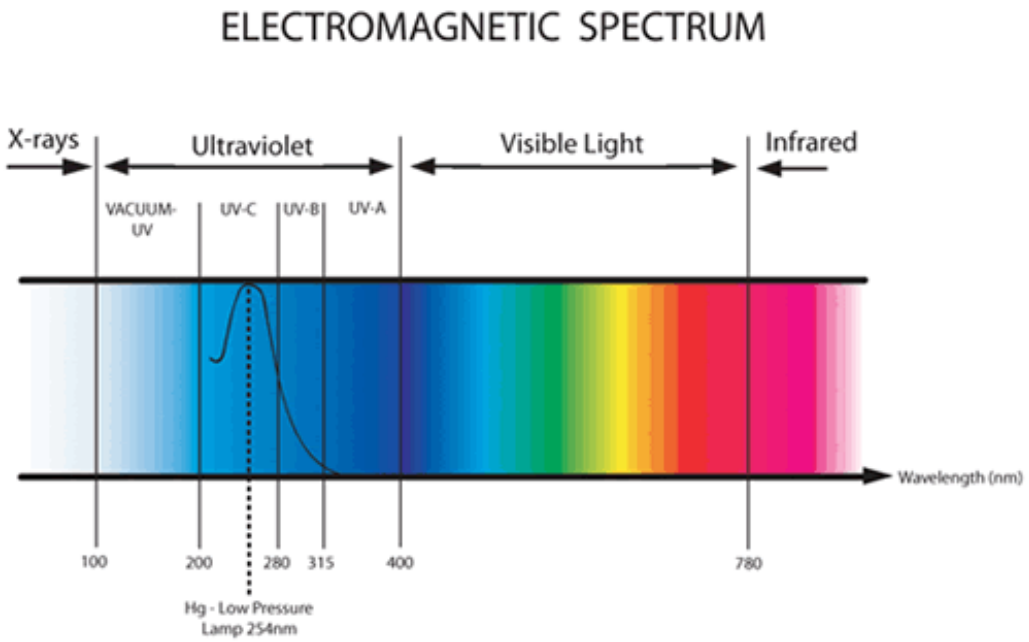
Background

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



Advantages of 100% Solids UV Curable Systems

- 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

Paper Upgrade

- Printed paper and foil are used to upgrade inexpensive substrates.
- It is possible to create very realistic looking substrates using texture, optics (grain pattern, color, low/high gloss), and haptics (feel)
- Texture and grain may be generated by physical means or through digital printing. Inks can generate the color, and help with grain.

Paper Upgrade

- Materials are needed to :

- Prepare the paper to receive high quality prints
- Create matte and gloss coatings for topcoat
- Provide long term protection if used in an exterior application.

Paper Upgrade – Sealer / Basecoat – 100% solids

- Traditionally, 100% solids coatings used as sealers/ basecoats are epoxy acrylates or modified epoxy acrylates.
- Polyester acrylates are generally used for pigmented coatings (better wetting)
- If sustainability is also a target then biobased resin can be used in place of the epoxy acrylate. Polyester acrylate (PEA) 2 contains ~ 55% biobased C

Paper Upgrade – Sealer / Basecoat – 100% solids

Raw Material	A	B	C	D
EA 1	50			
PEA 1		55	30	
PEA 2			40	
PEA 3				57
TPGDA			10	15
OTA-480			20	
TMPTA	50	45		15
Photoinitiator	3-5	3-5		5
Amine Synergist				8
Additives				
Viscosity	950	210	320	655
	Low cost, high reactivity	Low viscosity	Low viscosity with abrasion	Biobased coating

Paper Upgrade – Sealer / Basecoat – WB coatings

- Physically drying UV-PUDs will seal the surface and can be handled prior to UV cure.
- UV-PUDs can be selected for clear or pigmented systems. Recent “fit for use” resins would also be appropriate for this
- One benefit of an all UV PUD system is that is that all coating layers can be applied and then one cure step will suffice for all layers.

Paper Upgrade – Sealer / Basecoat – WB UV

Raw Material	A	B	C
UV-PUD 1	100		
UV-PUD 2		100	
UV-PUD 3			100
Rheology Modifier (1:1 with water)	0.5-2.0	0.5-2.0	0.5-2.0
Photoinitiator	1-2	1-2	1-2
Water (if needed)			
Pigment paste (if desired)			
Viscosity	< 500	< 500	< 500
	High reactivity, hardness, light colors	High reactivity, hardness, darker colors	Fit for use, all colors

Paper Upgrade – Topcoat / OPV – 100% Solids UV

- Epoxy acrylates (or modified EA) are used to make glossy, inexpensive coatings.
- Urethane acrylates may be used if toughness or exterior durability is needed.
- Biobased resins can be used for sustainable coatings.
- Resins for soft feel coatings may be incorporated to enhance the haptic aspect of the final part.
- Matte coatings (sometimes a challenge for 100% UV) can be made using PEA 4 without loss of reactivity.

Paper Upgrade – Topcoat / OPV – 100% UV – Matte Coating

Raw Material	A	B	C
ALUA 1	18	19	20
PEA 1	10	10	10
PEA 4 (for matte finish)	19	19	20
Diluents	39	41	42
Silica	7	4	0
Wax	2	2	2
Photoinitiator	5	5	5
60 gloss	2-4	6-8	15-19
Stain Resistance (6 stains) 5 = best	4.5	4.5	4.6
	Full silica	Half silica	No silica

Paper Upgrade – Topcoat / OPV – 100% UV – Gloss Coating

Raw Material	A
ALUA 1	28
PEA 1	20
Diluents	38
Silica	7
Wax	2
Photoinitiator	5
60 gloss	2-4
Stain Resistance (6 stains) 5 = best	4.5
	Good abrasion resistance, toughness

Paper Upgrade – Topcoat / OPV – WB UV

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- Resins for soft feel coatings may be incorporated to enhance the haptic aspect of the final part.
- Matte coatings (sometimes a challenge for 100% UV) can be made using PEA 4 without loss of reactivity.

Paper Upgrade – Topcoat / OPV – WB UV – Matte Coating

Raw Material	A
UV-PUD 3	100.0
UV-PUD 5	
Rheology Modifier (1:1 with water)	2.0
Silica	2.0
Wax	3.0
Photoinitiator	1.5
Water (if needed)	
Viscosity	< 500
60 gloss	10-15
	Fit for use, great intercoat adhesion (no surface prep)

Paper Upgrade – Topcoat / OPV – WB UV – Gloss Coating

Raw Material	A
UV-PUD 5	100.0
Rheology Modifier (1:1 with water)	2.0
Flow and Levelling agent	0.3
Wetting agent	1.0
Photoinitiator	2.0
Water (if needed)	
Viscosity	< 500
60 Gloss	> 85 (substrate dependent)
	Fit for use, low color on cure, excellent hardness

Paper Upgrade – Topcoat / OPV – WB UV – Exterior Coating

Raw Material	A
UV-PUD 4	100.0
Rheology Modifier (1:1 with water)	1.5
Flow and Levelling agent	0.6
Wetting agent	1.0
Photoinitiator	2.0
Water (if needed)	
Viscosity	< 500
60 Gloss	> 85 (substrate dependent)
	UV resistance and toughness 3000 hours QUV - >90% gloss retention, $\Delta b < 1$ 5 years FL - $\Delta b < 1$

Paper Upgrade – Conclusions

- By controlling texture, color, and gloss, realistic wood grain finishes can be created
- Equipment is key to generate the texture, print, and high/low gloss areas
- Traditional resin systems can be used for many of the coatings
- Newer resins, e.g. PEA 4, can provide very low gloss finishes with excellent flow and reactivity
- WB UV resins fit well into this application as their low viscosity, ease of matting, and overall good film properties allow for quality finishes PLUS physically drying UV-PUDs can be cured in one step at theend.

Thank you

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