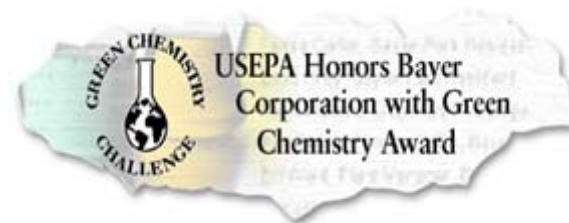




Bayer MaterialScience



Direct To Metal (DTM) UV Curing Systems

Michael Dvorchak

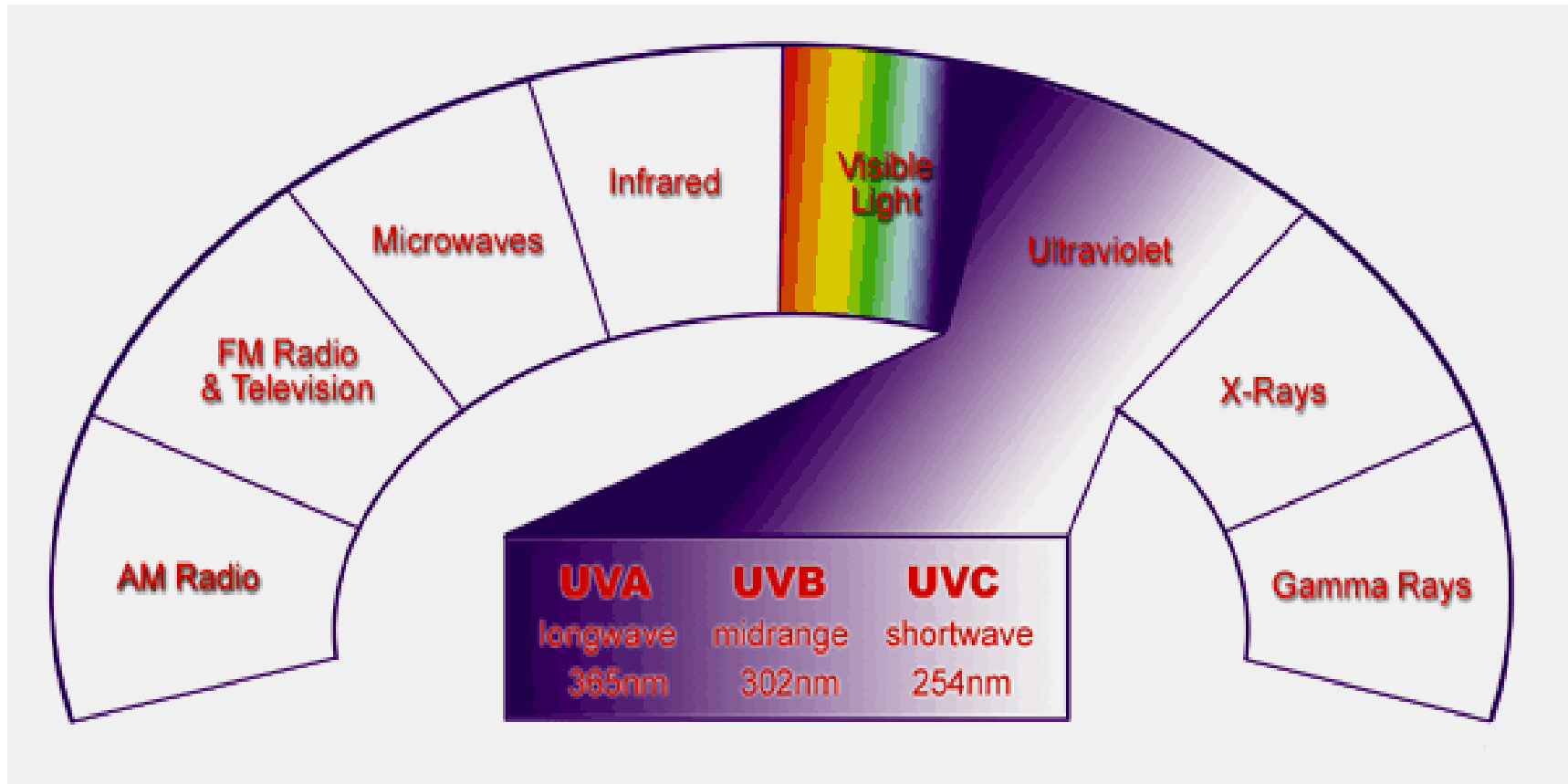
Michael.Dvorchak@BayerBMS.com

Phone: 412-908-1091

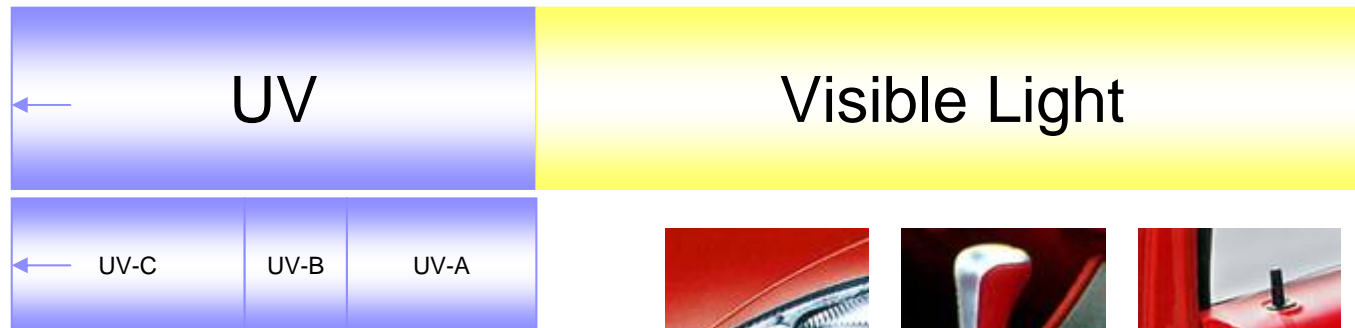
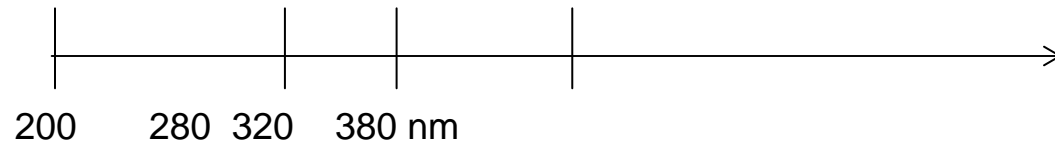


CAS BD NAFTA

Electromagnetic Spectrum



UV Curable Coatings



Direct to Metal UV Curable Pigmented Coating



Key properties:

- Fast cure
- Proper film build
- Good hiding (pigmentation)
- Excellent adhesion to cold rolled steel, e-coat, aged coatings, galvanized iron etc.
- Designed for high volume applications (e.g. General Industrial Widgets, Auto parts etc.)

High throughput formulation screening



Resin/ 50:50 blend Symplex lattice design	Reactive diluent	Photoinitiator/blend	[PI]	Irradiation time [sec]		Distance from lamp
Delta	HDDA	Irgacure 184 #	4%	0	8	
Fox Trot	TPGDA	Irgacure 500 #	1%	20	4	
Echo	TMPTA	Irgacure 500 #/Amine synergist		60		
Hotel		Darocur 1173 #		180		
Charlie		CGI 1870 #				
Delta/Fox Trot		Irgacure 819 #				
Delta/Echo		Irgacure 1850 #				
Delta/Charlie		Darocur 4265 #				
Fox Trot/Echo		Irgacure 184/Darocur 1173				
Fox Trot/Echo		Genacure ITX +				
Fox Trot /Hotel		Irgacure500/Amine synergist/Irgacure 819				
Fox Trot / Charlie		Genacure ITX/ CGI 1870				
Echo / Hotel		Irgacure 1300 #				
Echo / Charlie		Irgacure 1700 #				
Hotel / Charlie		Irgacure 2959 #				

D-optimal design including 2nd order interactions:

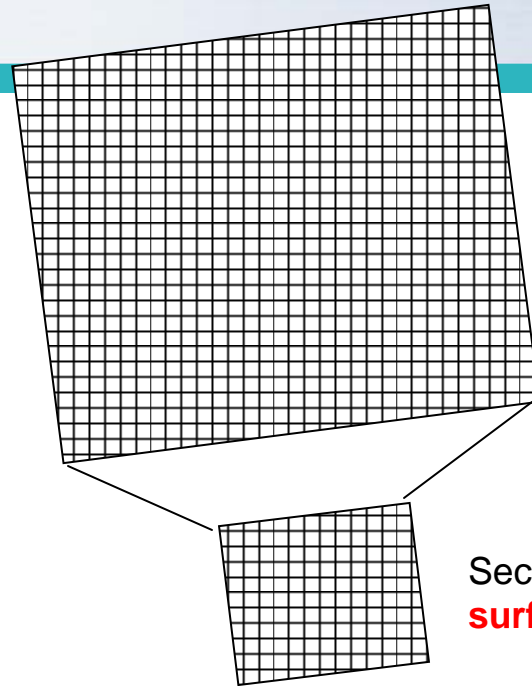
~ 500 formulations and ~ 24,000 films (5 weeks of experimentation)

Multistage screenings and scale up



5 Resins/blends,
3 RDs, PI, [PI]
lamp distance,
irradiation time
24,000 films

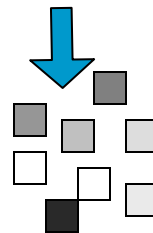
Primary screening: **MAP**
surface and through cure



25 RDs, [RD]
2 pigment packages
100 films

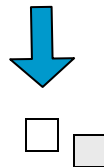
Secondary screening
surface cure, adhesion

6 RDs, P/B ratio
[PI], WFT, irradiation time
Etch primed vs. CRS
48 films



Tertiary screening
surface cure, adhesion

P/B ratio, WFT,
lamp distance
irradiation time



**Adhesion, through cure,
sanding, viscosity, etc.**





Desmolux

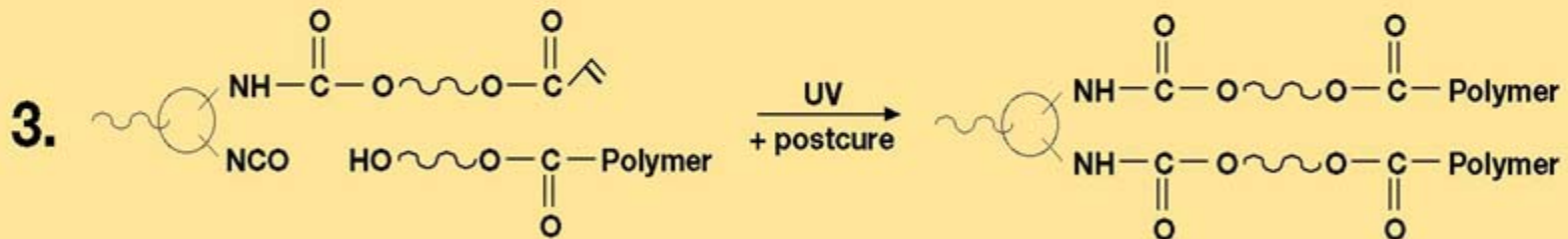
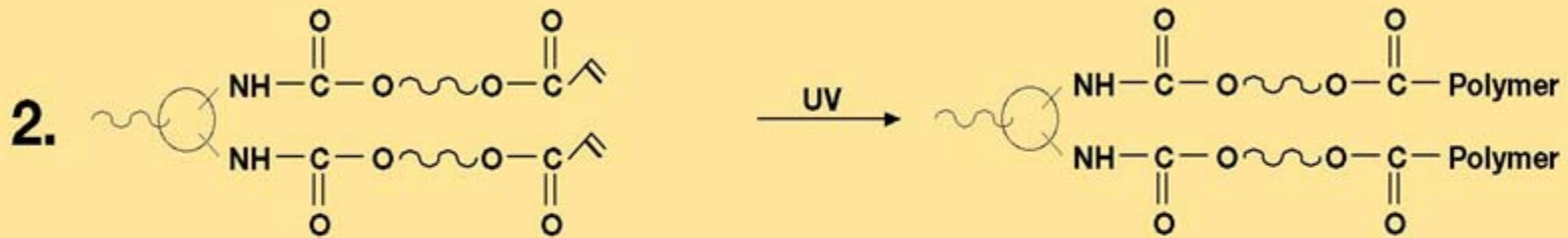
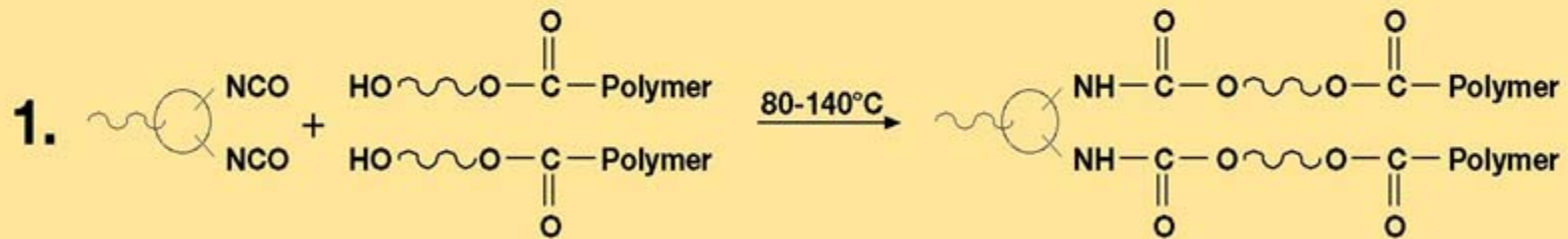
- **Unsaturated acrylates** (resins and oligomers)

- Epoxy ester acrylates
- Polyether acrylates
- Unsaturated polyesters in reactive thinner
- Urethane acrylates
- Dual-cure urethane acrylates

Bayhydrol UV

- **Waterborne UV-curing polyurethane Dispersions**

Comparison: 1. Polyaddition of 2K-PUR-systems 2. Polymerization of urethane acrylates 3. Dualcure with UV and NCO/OH-crosslinking



Reduction of Shrinkage in UV Cure Coatings



Systems	Pendulum Hardness			
	Initial	Day 1	Day 7	14 days
Urethane Acrylate - Hard (A)	72.8	91	110.6	100
Urethane Acrylate - Soft (B)	49	30.8	19.6	19.6
Urethane Acrylate (Hard + Soft) (C)	147	159.6	170.8	163

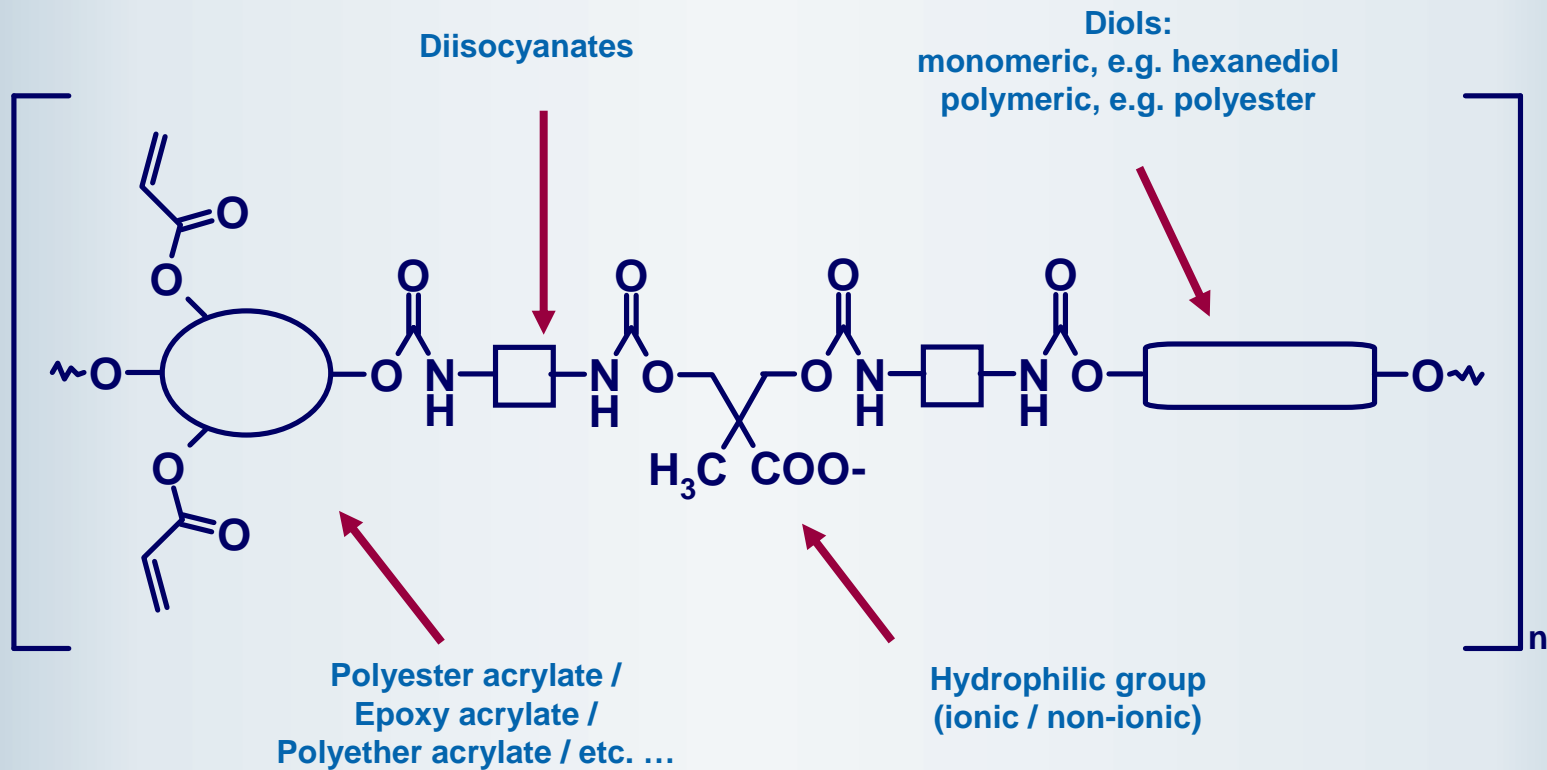
Reduction in shrinkage for UV Cure Systems



Systems	Initial MEK Rubs	Day 1 MEK Rubs	Day 7 MEK Rubs	14 days MEK Rubs
Urethane Acrylate - Hard (A)	100	100	100	100
Urethane Acrylate - Soft (B)	90	70	60	20
Urethane Acrylate (Hard + Soft) (C)	100	100	100	100

Starting Point Pigmented Grey Formulation	Weight, g			
	A	B	C	D
Urethane Acrylate	100	100	100	100
Pigment – TiO ₂	4	4	4	4
Calcium Carbonate Filler	40	40	40	40
Extender pigment – Talc	60	60	60	60
Pigment – Black	0.5	0.5	0.5	0.5
Adhesion promoter	0	30	0	30
Photoinitiator –	8	8	8	8
Solvent – (e.g. Butylacetate, t-butyl acetate {TBAC}, etc)	0	0	30	30
Reactive Diluent - Adjust levels depending on required hardness	20	20	0	0

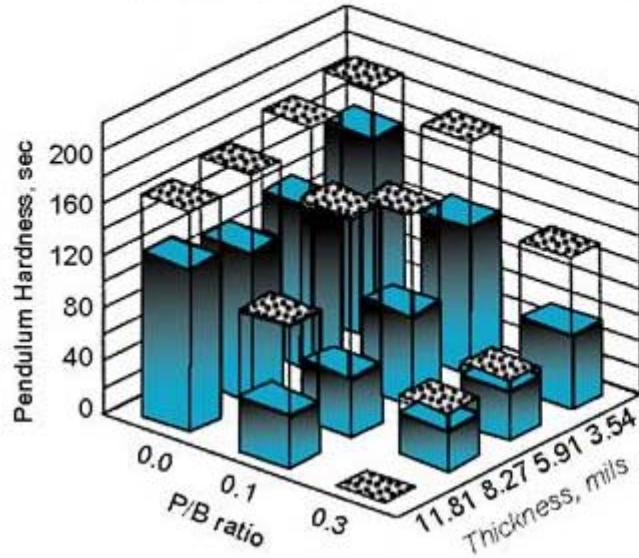
How do the acrylic double bonds get into the polymer?



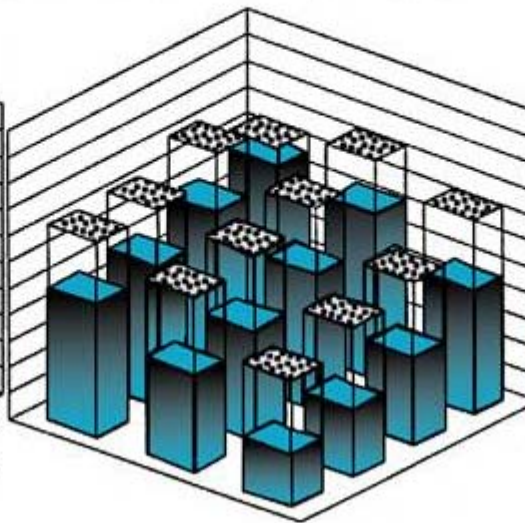
Structure of new high molecular weight
UV Curable polyurethane dispersions

Appendix 2. UV-curing of *Sealer* coating based on non-air-inhibited unsaturated polyester

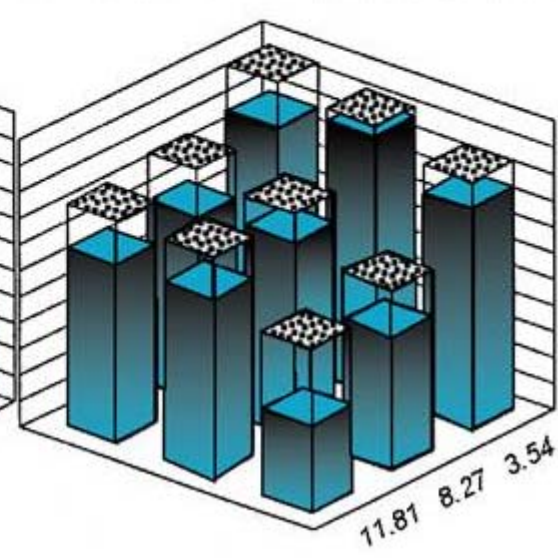
A. Arc Lamp at 200W



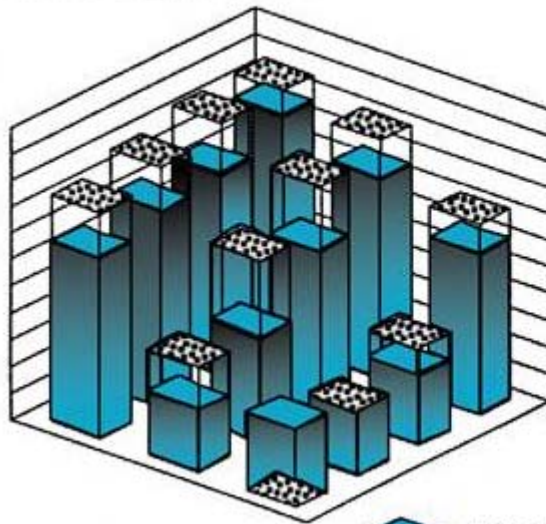
C. TLO3 and arc-lamp at 200W



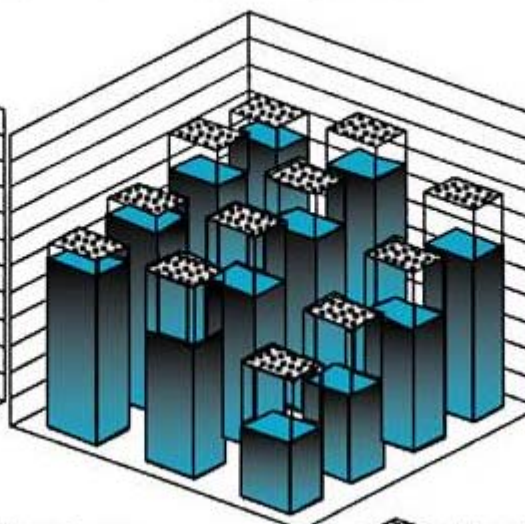
E. Electrodeless V and D Bulbs at 300W



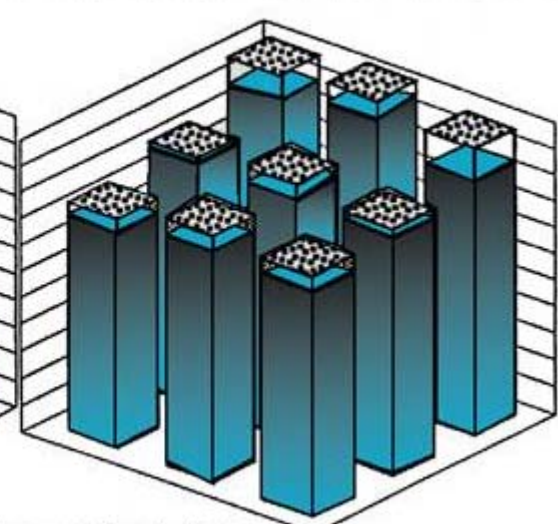
B. Arc Lamp at 300W



D. TLO3 and arc-lamp at 300W



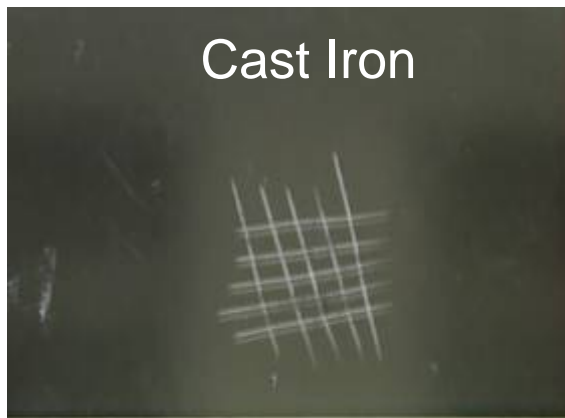
F. Electrodeless V and D Bulbs at 600W



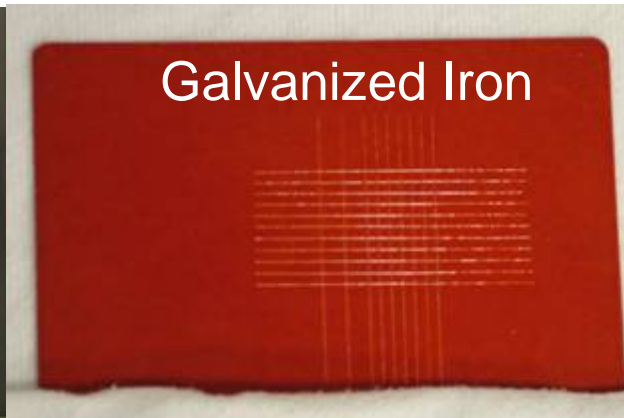
Initial hardness

Hardness after 4 days

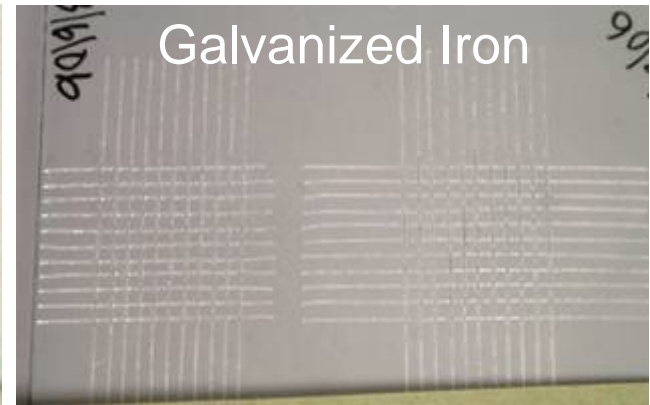
Examples of UV Cure Pigmented Coatings on Metal Substrates



Cast Iron



Galvanized Iron



Galvanized Iron

Examples of UV Cure Clearcoats on Metal Substrates

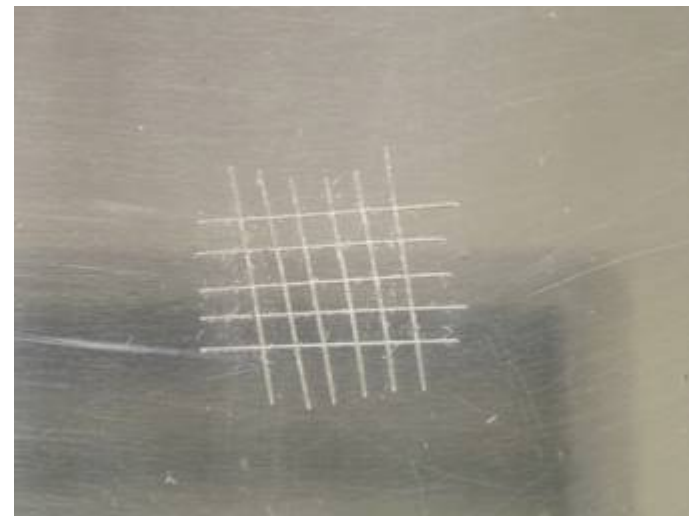
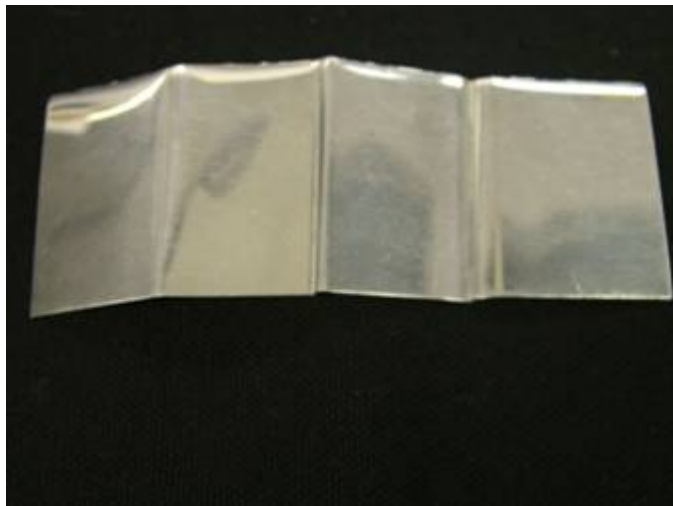
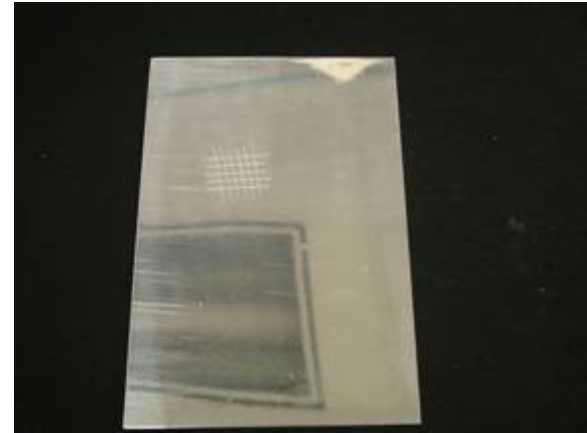


❖ Aliphatic Urethane Acrylate for

Exterior Applications

❖ Excellent adhesion

❖ Good flexibility





Thanks for your attention!

When you think of polyurethanes... think of Bayer!

We invite you to tap into our expertise...





Forward Looking Statements

This presentation contains forward-looking statements based on current assumptions and forecasts made by Bayer Group management.

Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future results, financial situation, development or performance of the company and the estimates given here. These factors include those discussed in our public reports filed with the Frankfurt Stock Exchange and with the U.S. Securities and Exchange Commission (including our Form 20-F). The company assumes no liability whatsoever to update these forward-looking statements or to conform them to future events or developments.