

Dual Cured Silicone Conformal Coatings

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Abstract

Conventional silicone based conformal coatings cure by established thermal or moisture triggered mechanisms. As modern production facilities use thinner materials, at faster line speeds, the thermal stresses, or stand-off time for full cure, start to become problematic. UV cure is a low temperature, rapid process which allows fabricators to produce a large amount of units, in a very small space, i.e very high throughput. This makes UV curing an attractive technique to electronic circuit board manufacturer. However, the complicated architecture of component laden circuit boards makes them less than ideal candidates for UV cure due to the “shadow areas” under the components. In this poster the issues of “shadow” and “dark” cure in complex 3D structures will be discussed. A comparison of the physical properties of UV cured silicone conformal coatings with secondary thermal and moisture curing systems will be highlighted.

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Silicone Conformal Coatings

Product Form	Viscosity, centipoise or mPa.s	Durometer	Cure	Dielectric Strength Volts/mil	Dielectric Constant at 100Hz	Volume Resistivity, ohm-cm
3-1753	385	25A	24hrs @ 25C	380	2.26	1.00E+15
1-4105	830	30A	15mins @ 115 C	530	2.64	5.80E+14
3-1300	350	62A	0.7 sec 600watts	575	2.87	5.40E+13
3-1350	150	57A	0.7 sec 600watts	573	3.08	5.40E+13

Epoxy UV systems capable of providing similar electrical properties to conventional silicone coatings

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UV cured Silicone Conformal Coatings

- **How do you?**

 - **Maintain fast UV cure < 10 sec**

 - **Maintain moderate 2nd cure 8 hrs < > 1 day**

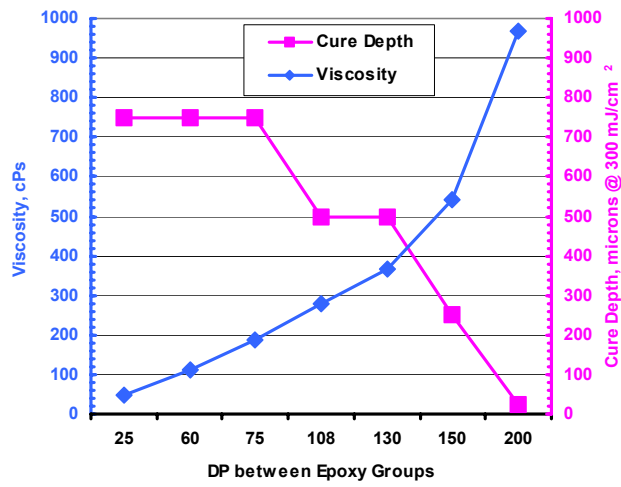
 - **Adhere < 24 hrs (Cu, FR 4, Al,..)**

 - **Control viscosity, Sprayable**

 - **“Tough” silicone mechanical properties**

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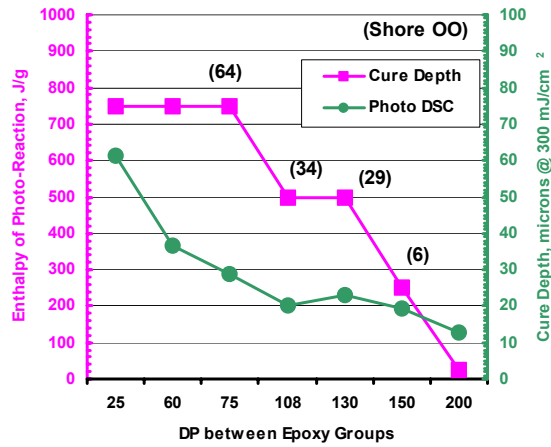
UV Cure



Low DP polymers, low viscosity, fast UV cure, but brittle
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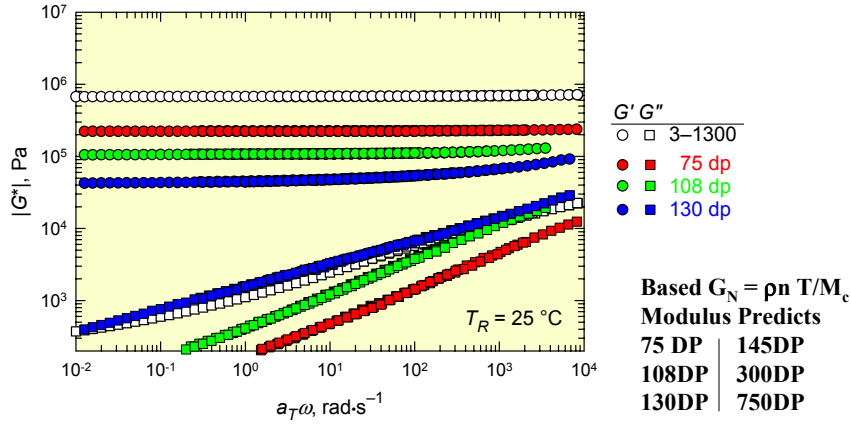
UV cure

Epoxy End blocked PDMS



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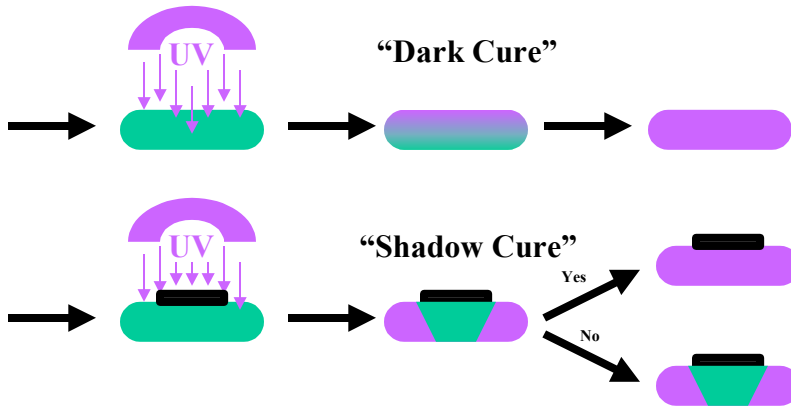
Rheology of Cured Epoxies



Chain Extension In Di-functional Epoxies

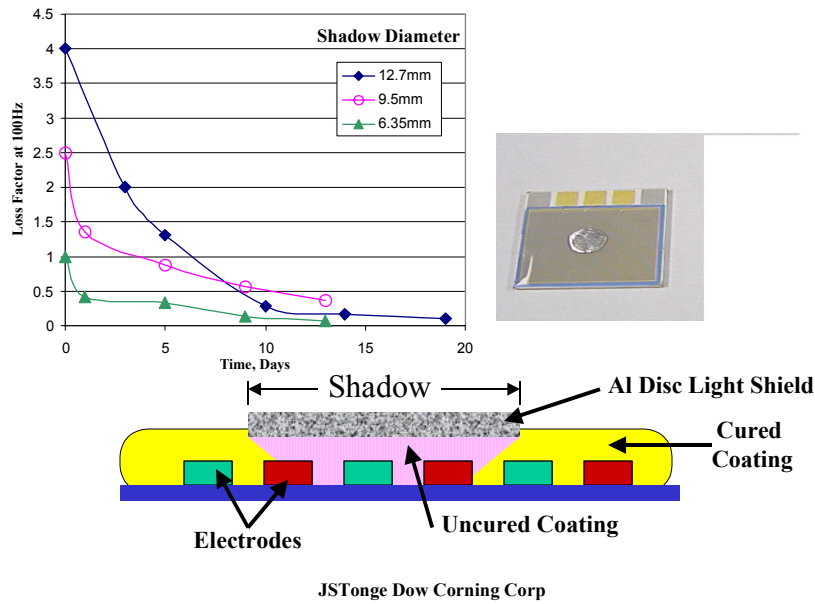
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Dark vs Shadow Cure

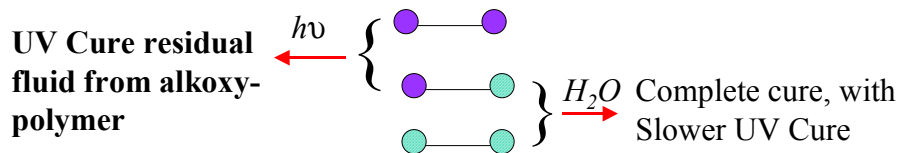


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Inherent Epoxy Shadow Cure



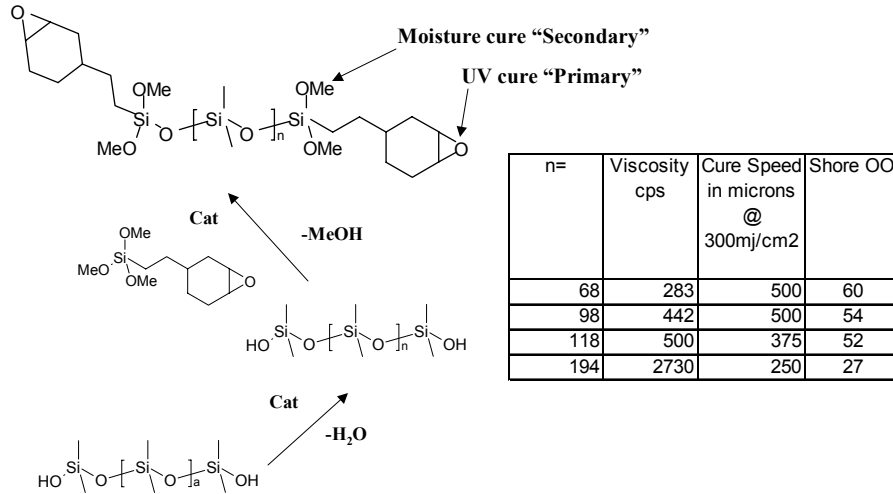
Moisture Secondary Cure



Addition of moisture to UV system
Improves adhesion characteristics

Bimodal Distribution allows fast UV
and moisture cure

Shadow Cure



n=	Viscosity cps	Cure Speed in microns @ 300mj/cm2	Shore OO
68	283	500	60
98	442	500	54
118	500	375	52
194	2730	250	27

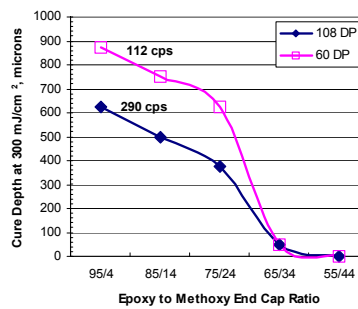
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Secondary Moisture Cure

Epoxy-Methoxy End blocked PDMS

Single Polymer approach

n=	Epoxy/Methoxy End capped	UV Cure depth @300mJ/cm2	Moisture Cure
108	95/4	25 mils	Liquid
108	85/14	20 mils	Liquid
108	75/24	15 mils	2 days cured
108	65/34	<2 mils	1 day snotty/ 2 days cured
108	55/44	0 mils	14 hrs cured
60	95/4	35 mils	Liquid
60	85/14	30 mils	Liquid
60	75/24	25 mils	4days cured
60	65/34	2 mils	2 days cured
60	55/44	0 mils	1 day snotty/ 2 days cured



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Conclusion

- **Cyclo-aliphatic epoxy silicones have inherent RT shadow cure.**
- **Silicon RTV chemistry effective secondary cure.**
- **In simple linear systems UV cure and moisture cure diametrically opposed.**
- **Architectural changes needed to allow for tuning of UV and moisture cure chemistries**