Coatings Trends & Technologies SUMMIT

Low Cure Applications in Powder Coatings

With Emphasis on Formulation

September 2024, Derick A Forcha, End-use Specialist

Agenda


Trends, Opportunities & Challenges
Formulation Strategy
Catalyst Selection
Additive Selection / DSC Analysis
Key Takeaways

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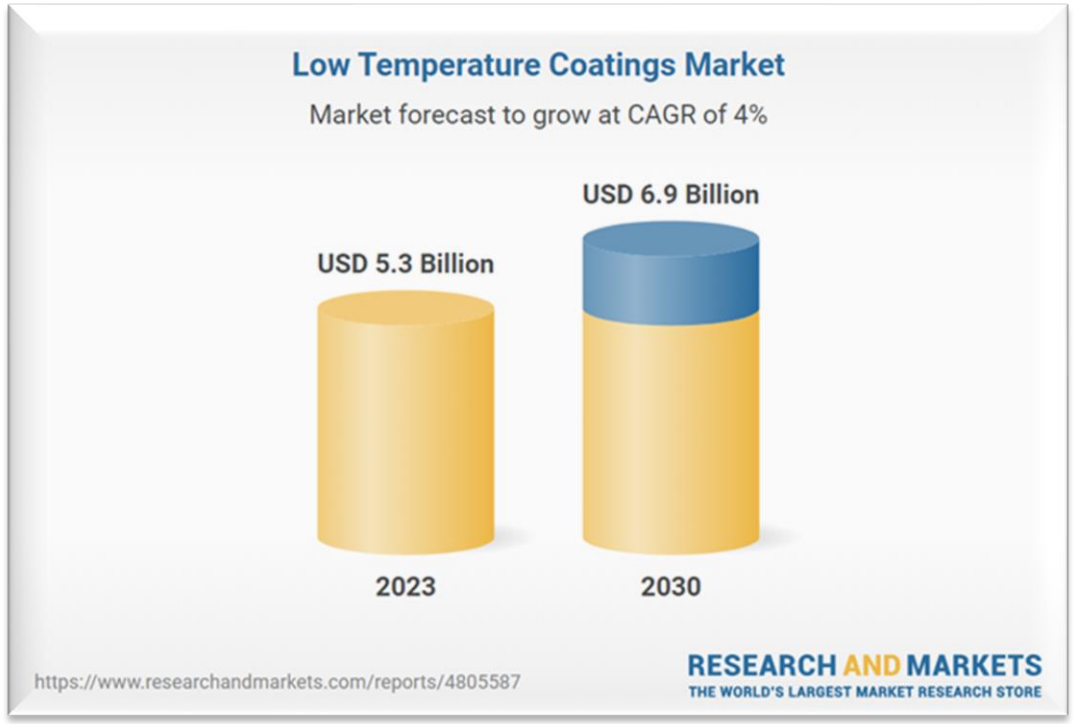
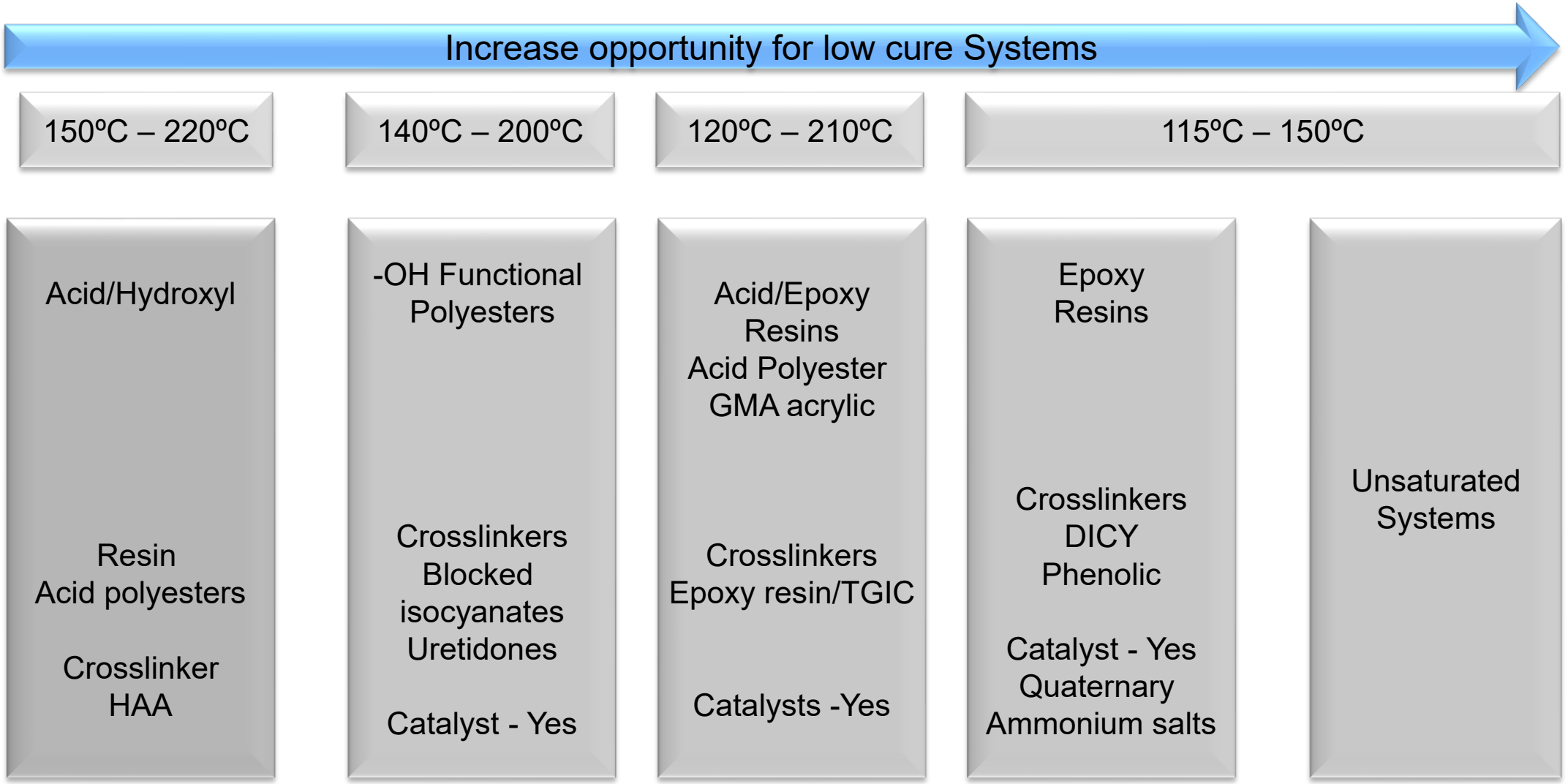
Trends



- In our view the market for low cure applications in powder coatings, will continue grow.

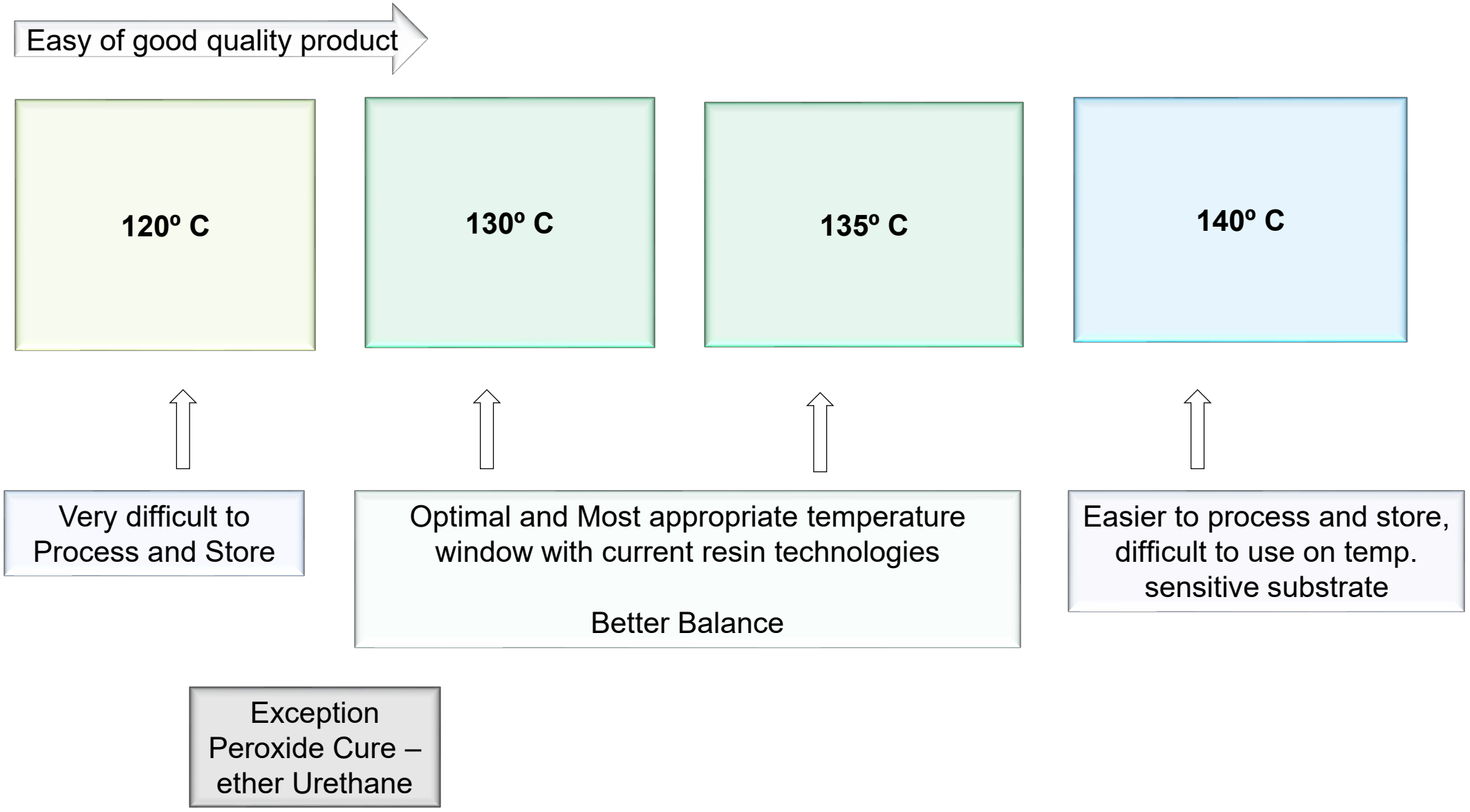
Photo Credit: BYK-USA

Opportunities



Source: (Modified) Merfeld, G. et al. 120C Cure, Durable, corrosion protection for temperature sensitive substrates, 01/28/2005 https://apps.dtic.mil

Challenges of Low Cure Powder Coatings



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Formulation Strategy

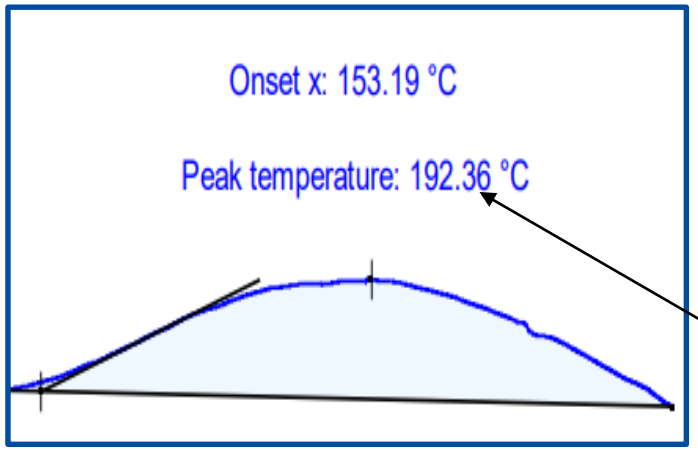
Formulation Strategy

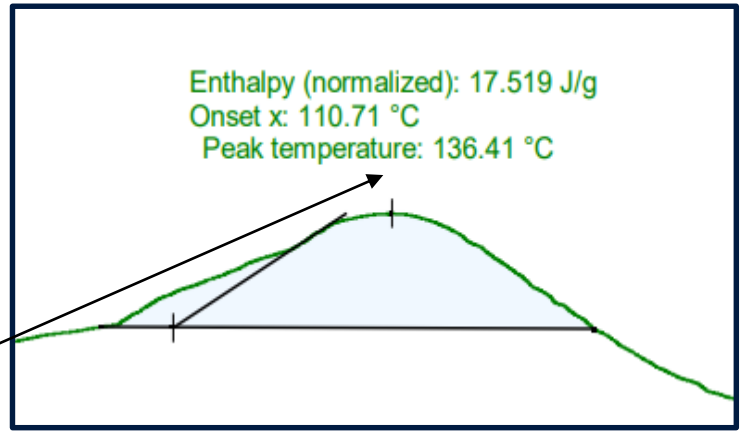
Starting point formulation
Standard additives with
Different melt points
No Catalyst

Formulators introduces
Catalyst to reduce cure
Time & Temperature

Formulator goes back to the
Formula and choose additives
Based on melt behavior
And mechanism

Robust formulation with
greater success in low
Cure application





Pre-catalysis

Cure Window has shifted

~150C for 30 mins
to ~ 136C for 8 mins

Post-catalysis

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Catalyst in Low Cure Formulation

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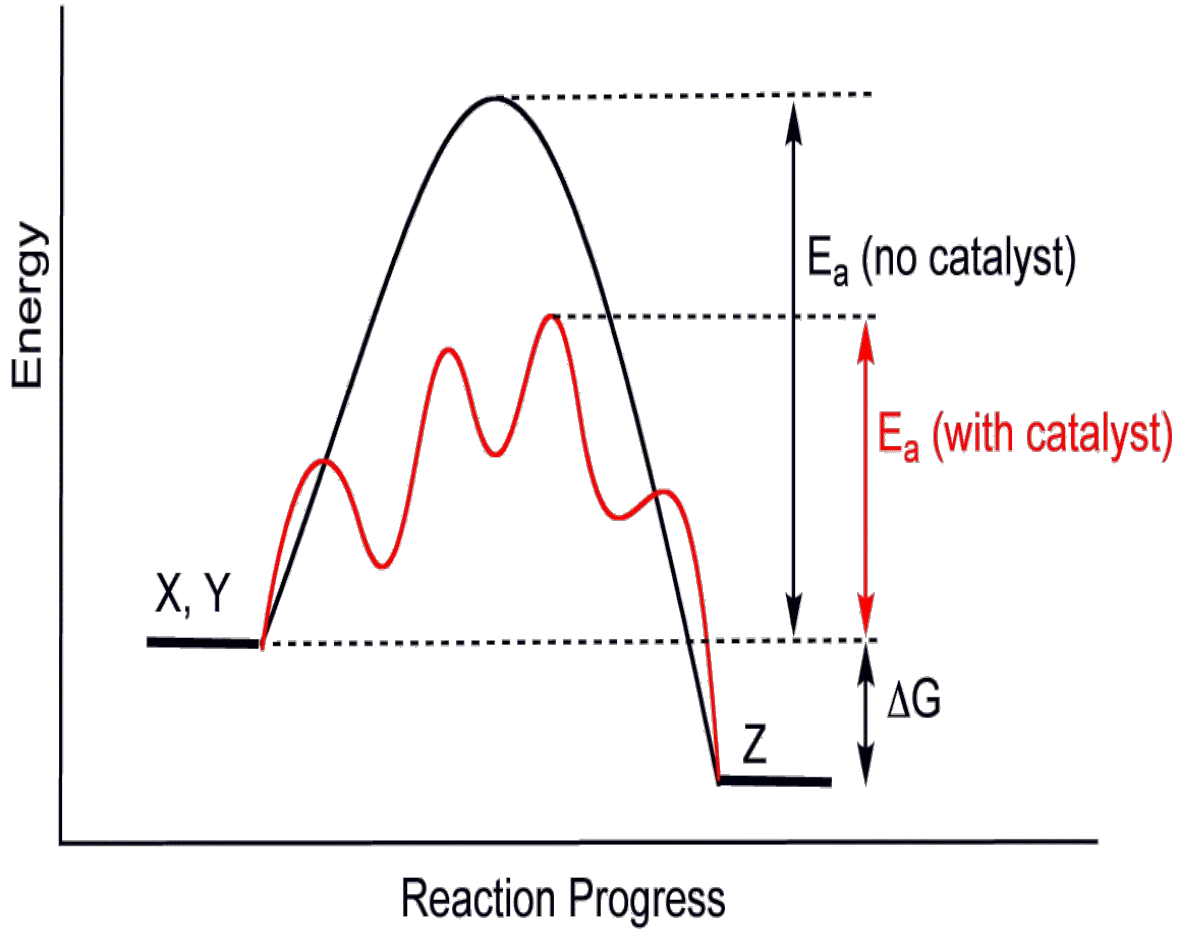
Catalysis in Low Cure Powder Coatings

✓ Lower the activation energy
✓ Shorter reaction time

Catalyst have direct effect on the binder as opposed to the entire Powder coatings formulation

Homogeneous distribution of catalyst in formulation leads to :
- tighter gloss control
- good color development



Model Image credit Source: www.thought.com

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Types of Catalysts

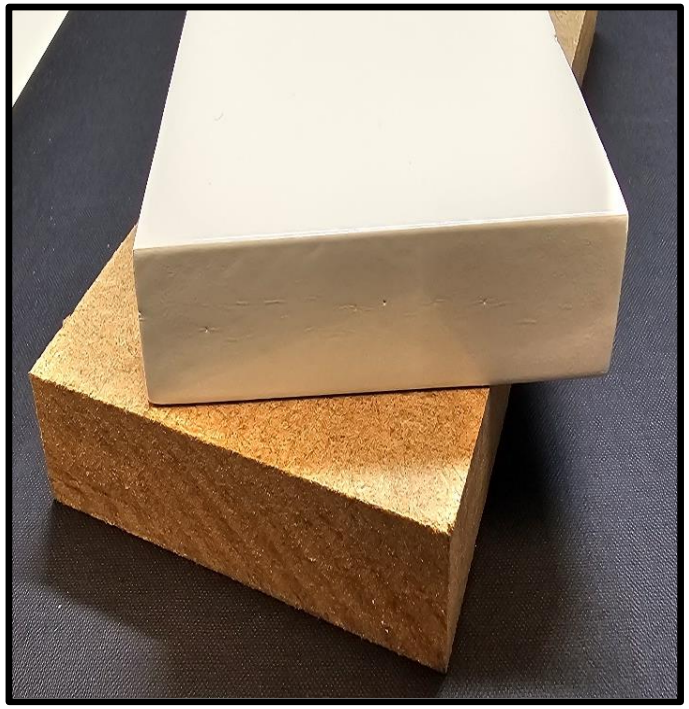
Broad Class of Catalyst

Phase Transfer
Latent Catalyst
Lewis Acid Catalyst
Onium Compounds
Quaternary
Ammonium salts

Common Catalyst Types in powder

Substituted
Imidazole
BTEAC
TBAB
Amine adduct
DBTD (Tin)

Low Cure Lab Samples of
Powder Coatings on MDF
with optimal Catalyst amounts



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Catalyst & Storage Stable Low Cure Powder Coatings

After optimal Catalysis of powder coatings

Qualify for practical storage stability

Traditionally a powder is stored in a glass jar sealed and placed in a water bath
Modified ASTM D 3451 is appropriate

Periodically test for gel time
Fluidization spray ability
Visual Sintering or clumping

Failed test

Go back to review powder formulation
Adjust catalyst appropriately

A more advanced approach
- DSC analysis to see
if there are any premature reactions
with the powder.

Reactivity – Good
Gel Time - Good
Fluidity is NOT good

what do we do?

In principle Hydrophobic behavior desired

Fluidizing additive

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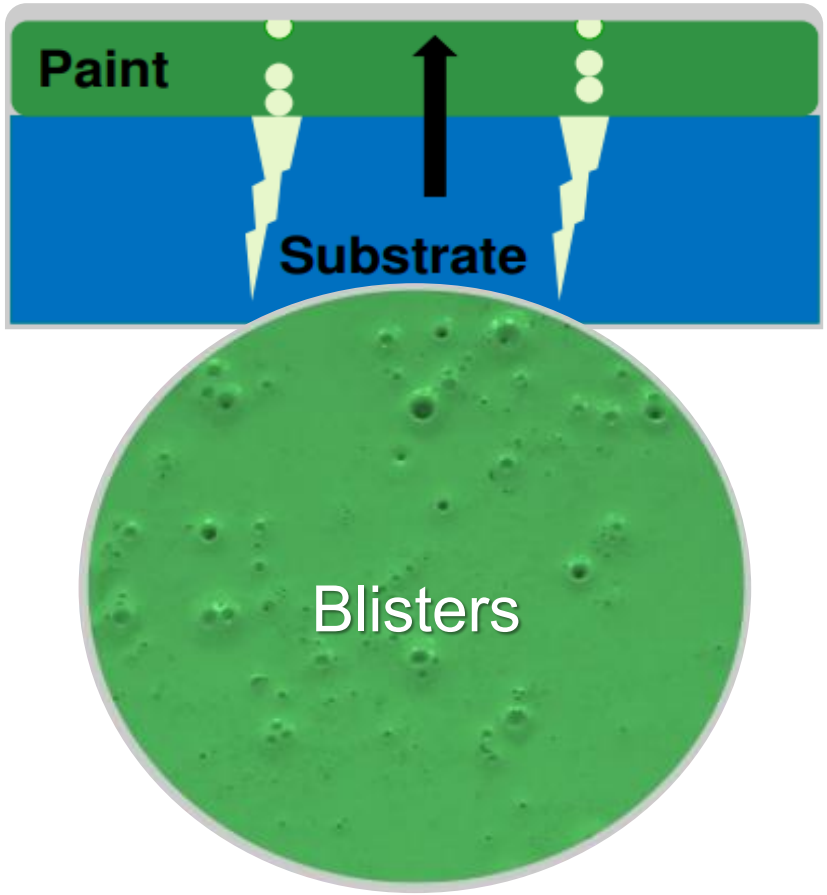
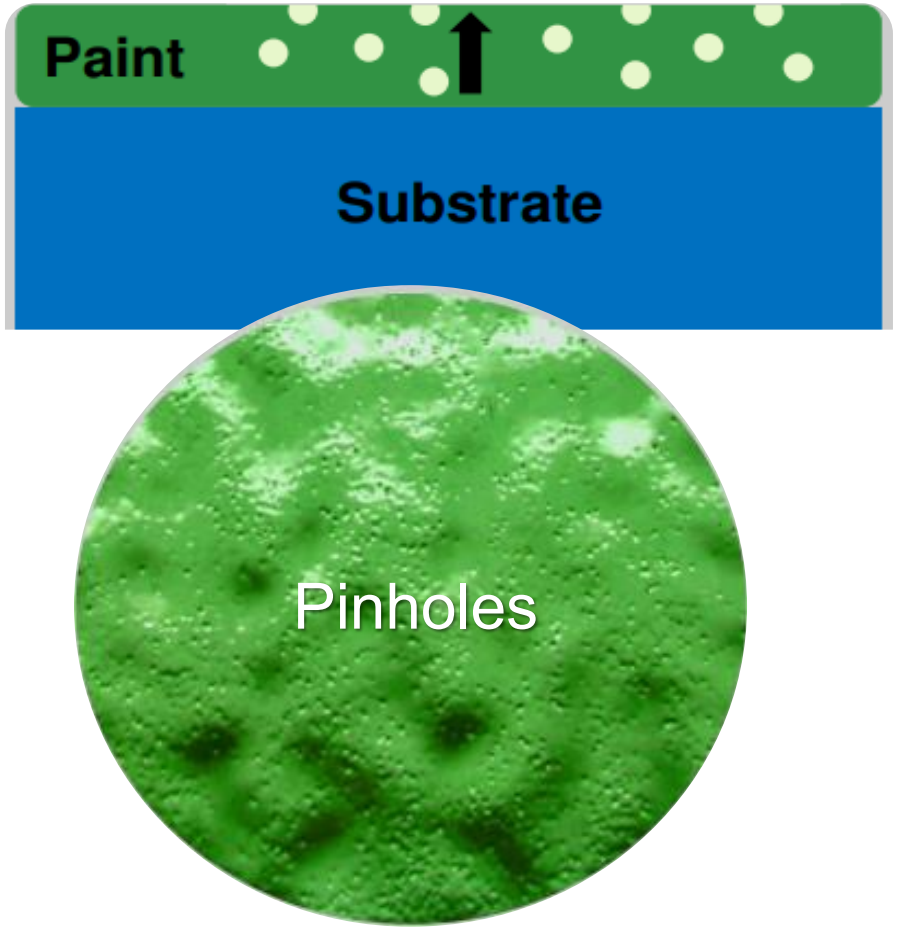
Additive Selection

Outgassing & Degassing

Outgassing



Degassing



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Solving an OUTGASSING Problem

	Raw Material/Purpose	Sample A	Sample B	Sample C	Sample D	Notes
1	Resin/Crosslinker	750	750	750	750	
2	Resin/Crosslinker	75	75	75	75	
3	Leveling	10	10	10	10	
4	Calatyst 1	3	3	3	3	
5	BENZOIN Standard degassing	0	10			Mpt-137C
6	Degassing Additive			15	15	Mpt-75C
7	Outgassing additive				15	Mpt-115C
8	Pigments	100	100	100	100	
9	Filler	62	52	47	32	
	Total (g)	1000	1000	1000	1000	

Formulator chose correct additive Temp. But solving the wrong issue

Melting point of Benzoin Above max cure Peak*

Cure: 135ºC for 8 mins Peak cure temp

Prudent to adjust with Filler

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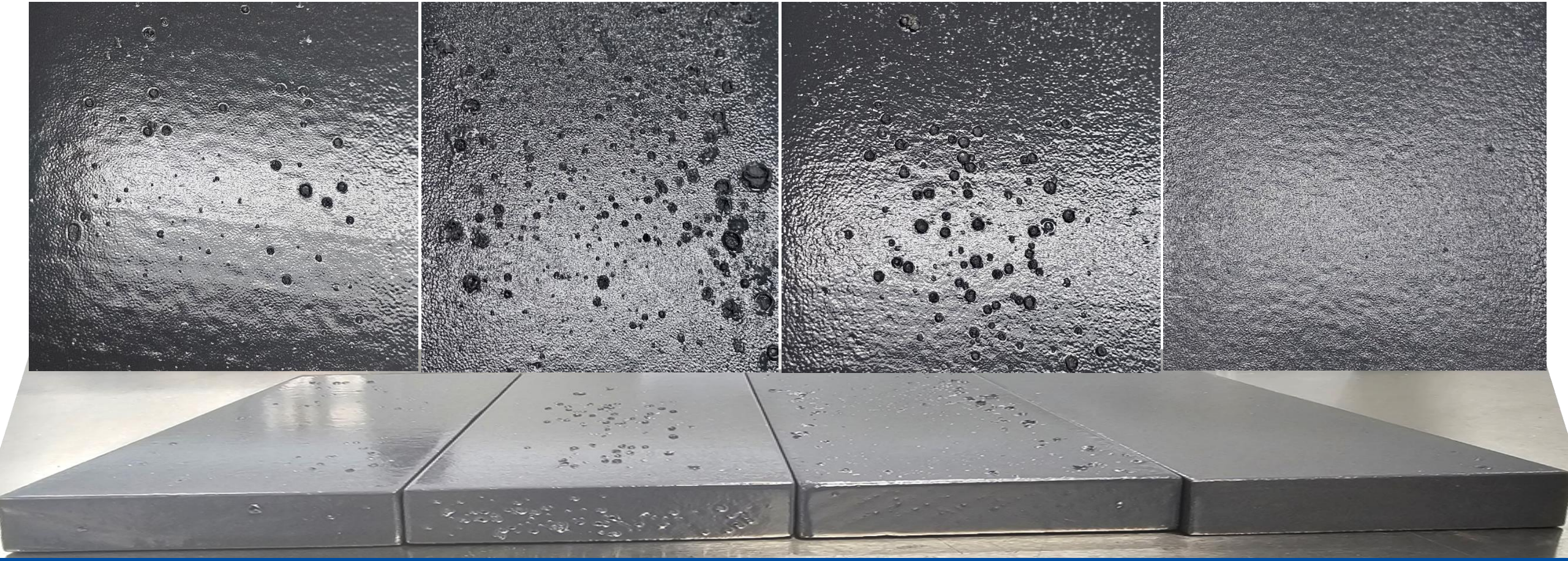
Identifying and rectifying Outgassing & Degassing



Sample A	Sample B	Sample C	Sample D

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Low Cure Off-White Formulation on MDF – Medium Density Fiberboard

Standard MDF
Pre heat & sanding required
Prior to cure

Control low cure Formulation
With Standard Degassing
8 mins @ 138C

Addition of our low cure
Additive package

Sanding/Preheating → Defects/Outgassing/degassing → Defect free Surface

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Leveling Additive & Molecular Weight Consideration

High	Raw Material/Purpose	Sample E	Sample F	Sample G	Notes
1	Resin/Crosslinker	650	650	650	
2	Resin/Crosslinker	65	65	65	
3	Degassing Additive	10	10	10	
4	Outgassing additive	10	10	10	
5	Catalyst	3	3	3	
6	Leveling Additive 1	15			Highest MW
7	Leveling Additive 2		15		Medium MW
8	Leveling Additive 3			15	Lowest MW
9	Pigments	230	230	230	
10	Filler	17	17	17	
	Total (g)	1000	1000	1000	

An inverse relationship seems to Exists between the molecular weight/ viscosity and the degree of leveling

Lower extrusion temperature leads
-To poor dispersion
- Poor melt mixing in Extruder
- Gyration in gloss

Leveling Additive & Molecular Weight Consideration

Sample E High Molecular Weight	Sample F Medium Molecular Weight	Sample G Lowest Molecular Weight

Decrease in MW is associated with an improvement in the flow & leveling

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DSC & Low Cure Powder Coatings Formulation

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DSC Analysis in Low Cure Powder Coatings Formulation

Measures the heat change associated with a chemical reaction giving the thermal signature of polymers against a reference sample

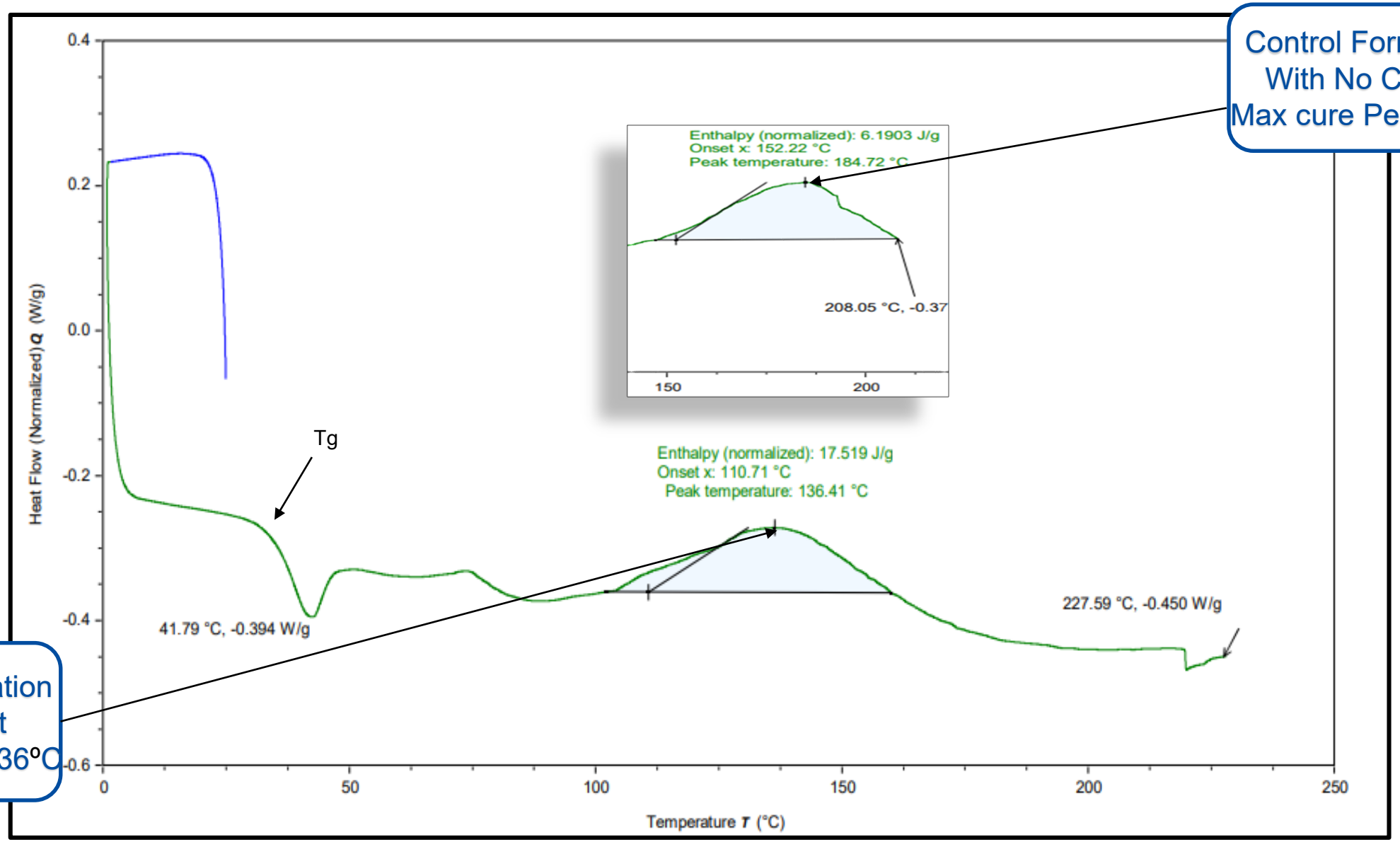
Points to Consider:

How can we use a DSC to determine the Glass transition of low cure powder coatings?

How can we use a DSC to determine the right cure response post catalysis?

How can we determine the effect of catalyst? Using a DSC thermogram

DSC Thermogram for a Low Cure Polyester powder Coatings formulation



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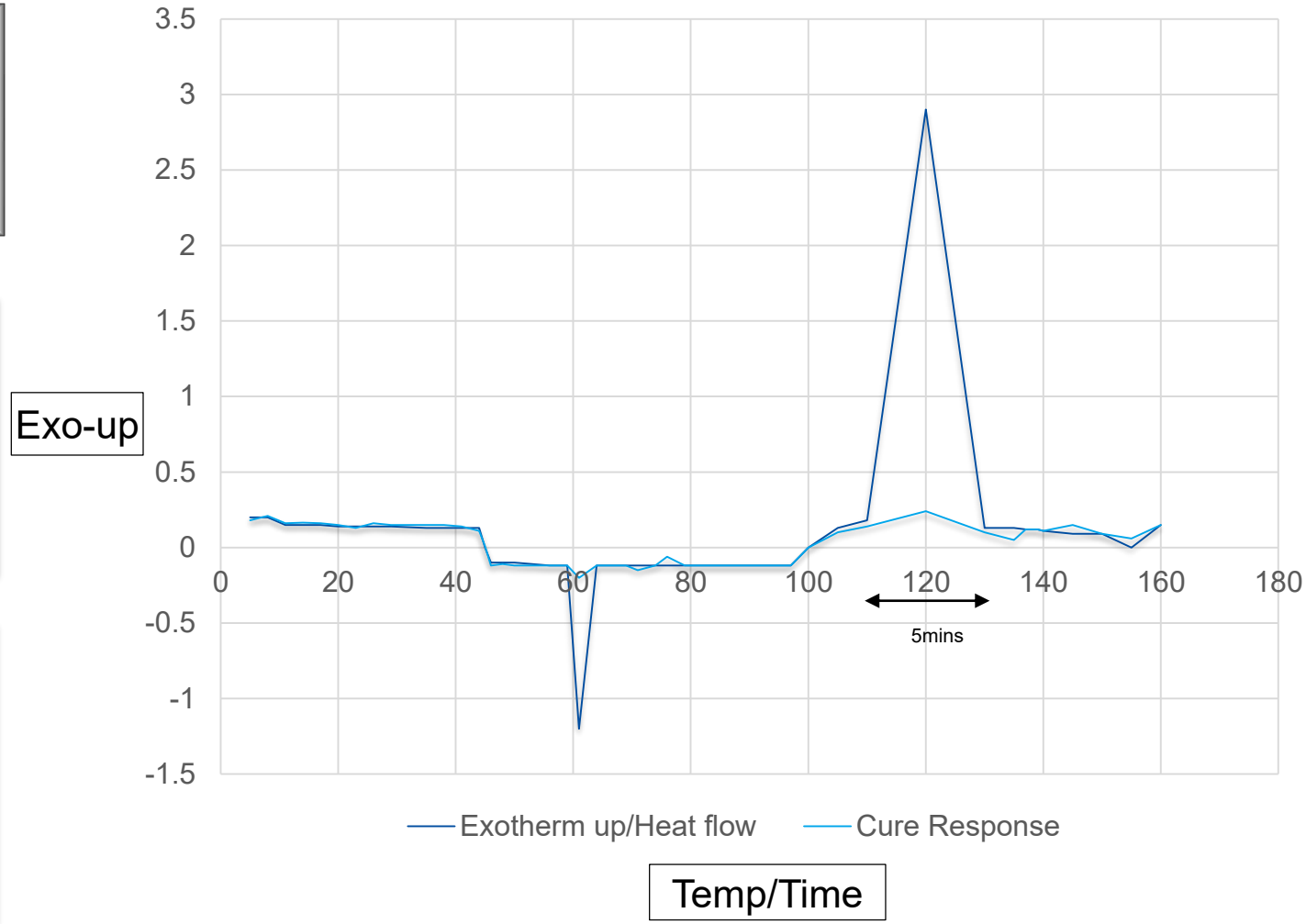
Model Thermogram of an Unsaturated Peroxide Cure System

DSC Thermogram at 10ºC/min is appropriate
Tg of Initial uncured powder > 45ºC preferred

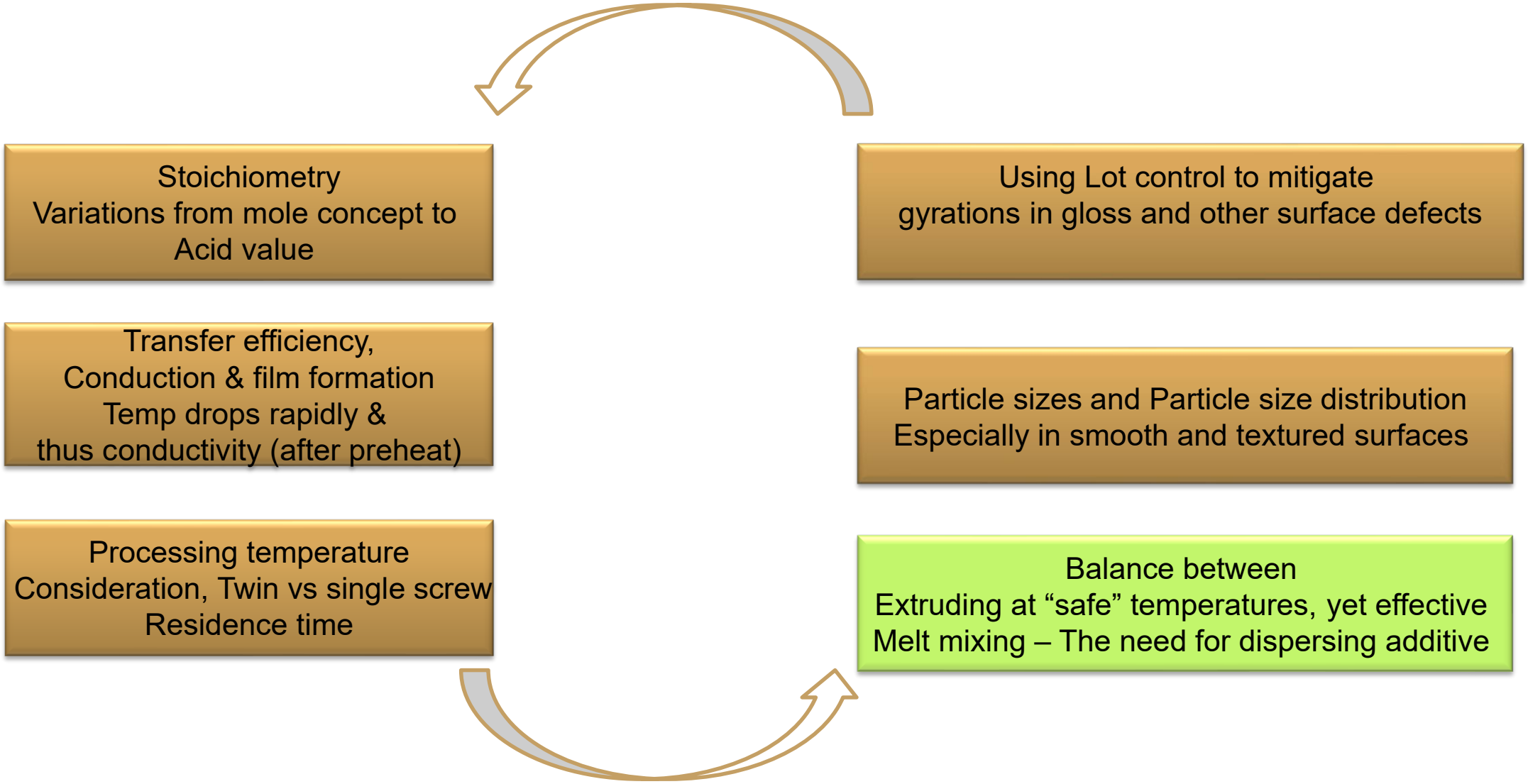
Melting Point - 62ºC
Cure Onset 105-110ºC
Maximum cure peak – 120ºC
Cure is completed at 130ºC

Time measured between cure onset and Completion gives a better indication of cure time it will take for powder to fully cure



Putting things all Together – in Low Cure Powder Formulation

Other Considerations



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Summary
Formulation Strategy

Starting point formulation

Standard additives with
Different melt points
No Catalyst

Select resin chemistry

Introduction Catalyst

Reduce cure
Time & Temperature

Select 130-135°C
curing window
Check DSC

Choose additive package

Based on melt behavior
And mechanism

Outgassing / Degassing
Leveling
Optional Texture

Robust formulation

Great success in
low Cure application

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