ULTRA-LOW TEMPERATURE CURE FOR MDF APPLICATIONS

An advanced chemistry for interior non metallic applications

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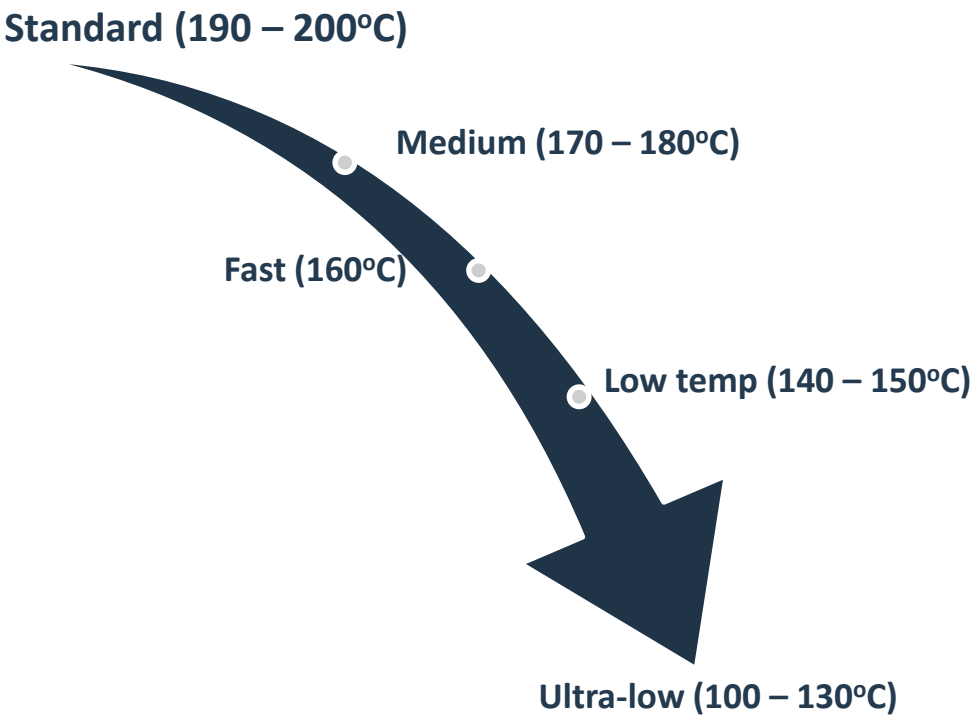
Agenda

1. Introduction
2. Why ULC?
3. Needs/Challenges
4. Advancements
5. Conclusion

Curing Temperatures - Background



Drivers to lower curing Temperatures

- Increase output
- Lower energy cost
- Environmental and regulatory policy
- Heat-sensitive and non-metal substrates

Strong demand for ULC has become more significant for wood and plastic substrates

Why ULC Powder Coating?

Thermally sensitive substrates

- Simplified process for industrial wood
- Design freedom for complex shape components in MDF furniture & cabinetry
- Shifts in regulatory policy are driving technology to switch away from solvent-borne to more environmentally friendly coatings
- Thinner heat sensitive metal sheets

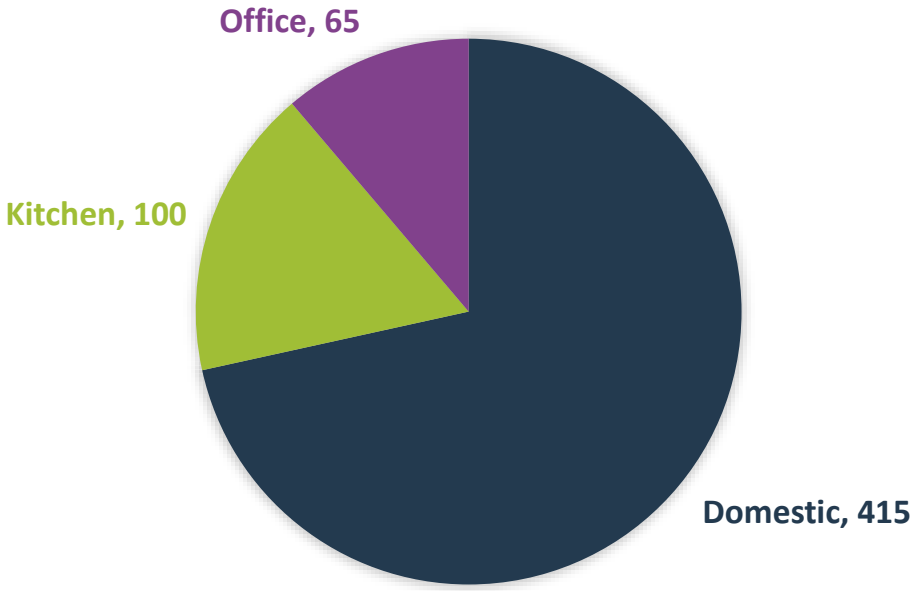
Slow-to-heat components

- Massive metal components are slow to heat, take longer to cure and consuming time & energy
- Lower curing temperatures means massive components can be coated faster increasing throughput & productivity
- Lower cure temperatures increase applicator production efficiency & energy savings

Why ULC Powder Coating?

Global Wood Market

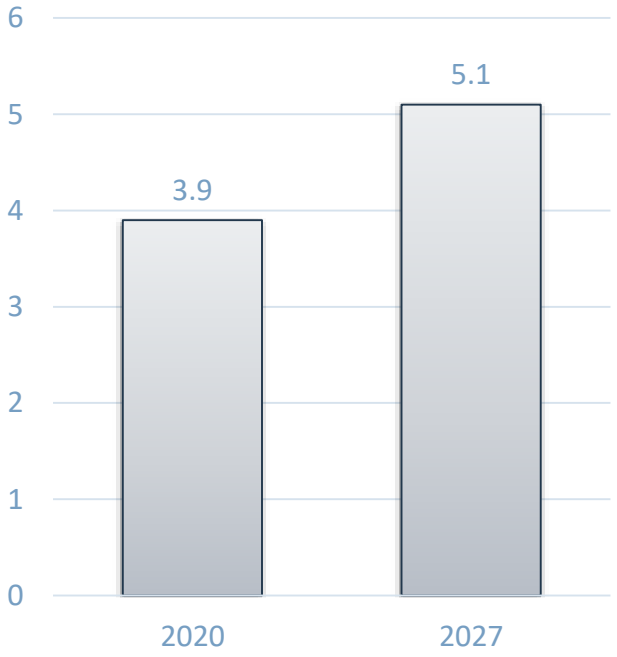
WOOD FURNITURE COATING RESINS (KMT)



Source: Irfab

Total market size ~580 kMT

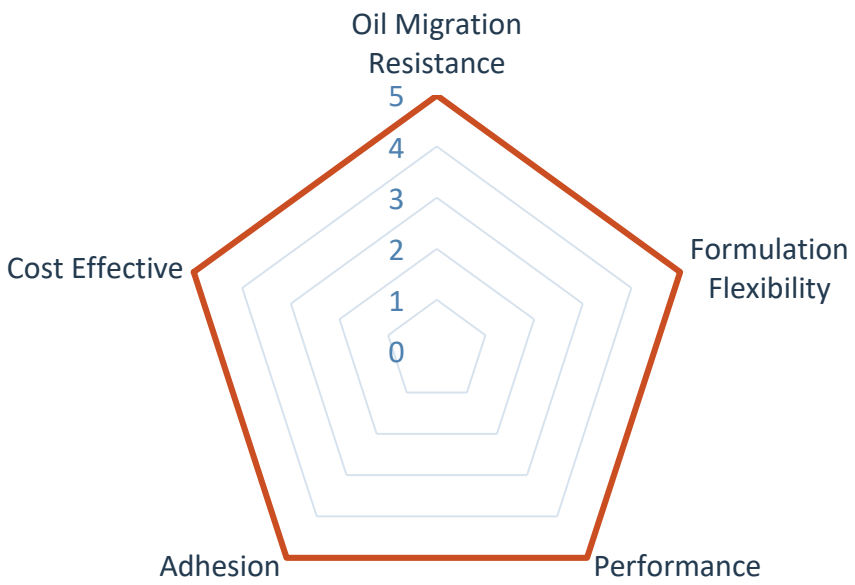
Wood Coating Resins Projection ($billion)



Source: Research and Markets

Unmet Market Needs

A platform technology designed to meet the low bake conditions and appearance requirements for coating MDF



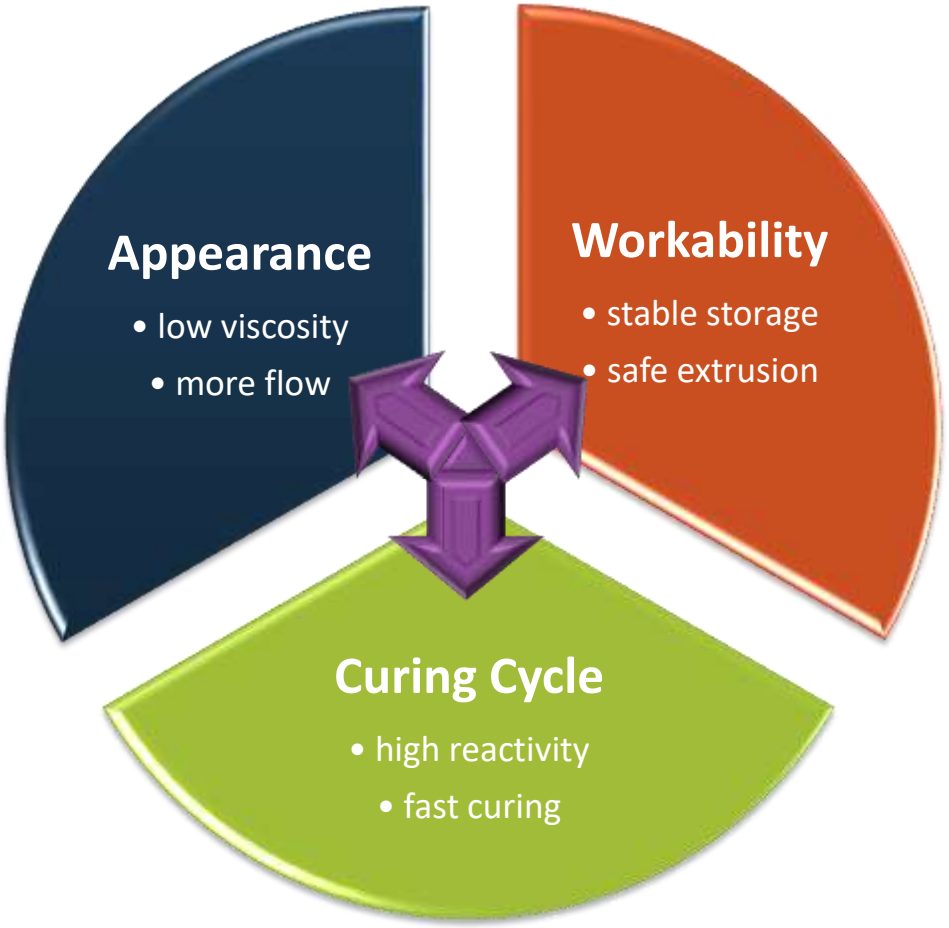
Control of cure.
Control of performance.

Innovation in performance

- Low temperature cure
- Excellent flow
- Ultra smooth appearance
- Stain resistance
- High film build
- Excellent chemical resistance
- Ease of workability

What are the Challenges?

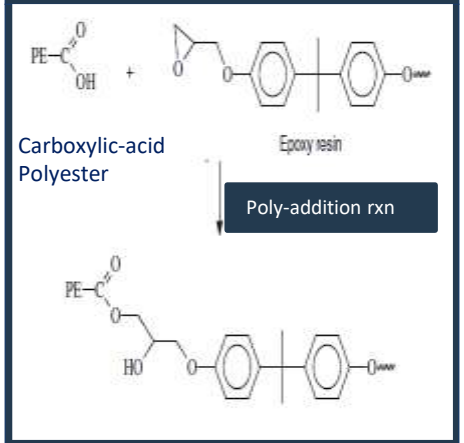
Solving the ‘powder paradigm’ challenge



What are the Challenges?

Low cure by chemistry

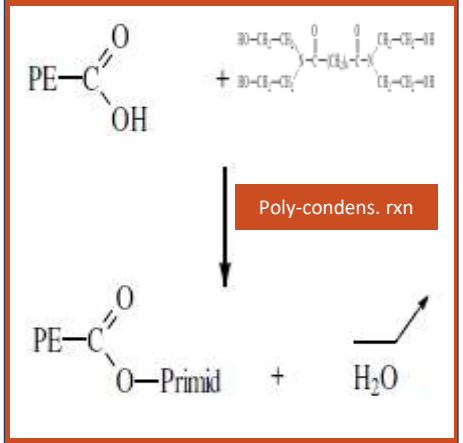
Carboxylic acid terminated Polyester & Epoxy resin for indoor



Addition-reaction can be accelerated with catalysts. It is possible to achieve cure at 125°C.

- Tg – Storage stability of the powder coating must be guaranteed.
- Chemical stability – Powder-coating should not pre-react during processing /storage.
- Viscosity – bad flow aspect due to high viscosity at low temperature

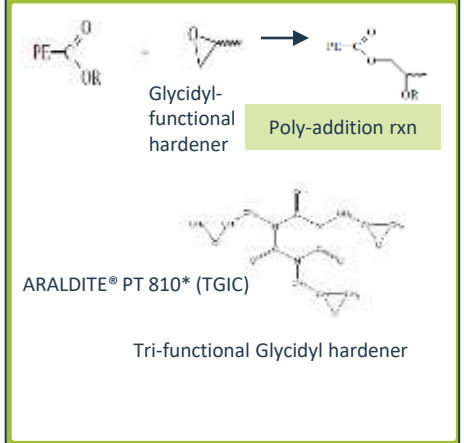
Carboxylic acid terminated Polyester & Hydroxyalkylamide (HAA) for outdoor



Possible to achieve as low as 150°C cure with special high-reactive polyester.

- No suitable catalyst available
- Low Tg: Storage stability concern
- Viscosity: bad flow and degassing at low temperature
- Reactivity: too short resulting to degassing
- Water-spot resistance: limited results with low bake cure

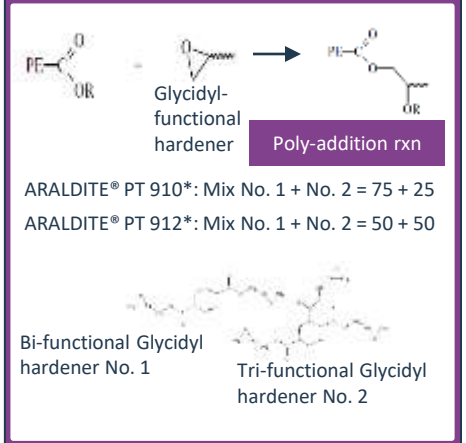
Carboxylic acid terminated Polyester & Glycidyl (TGIC) hardener for outdoor



Addition reaction can be accelerated with catalysts. Possible to achieve cure as low as 140°C.

- Tg: Storage stability must be guaranteed
- Chemical stability: Powder ctg. advancement during storage
- Viscosity: Bad flow aspect due to high viscosity
- Gloss reduction capability concern

Carboxylic acid terminated Polyester & Glycidyl (PT 910/912) hardener for outdoor



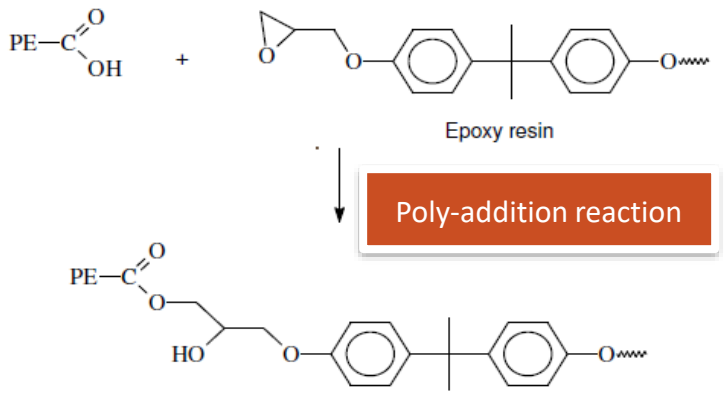
Addition reaction can be accelerated with catalysts. Possible to achieve cure as low as 150°C.

- Tg: Storage stability must be guaranteed
- Chemical stability: Powder ctg. advancement during storage
- Viscosity: Bad flow aspect due to high viscosity
- Gloss reduction capability concern

New Development in the Low Cure

Featuring advanced chemistry for MDF coating

Unconventional Polyester-Epoxy hybrid technology



Designed to meet the delicate balance of the low bake conditions

Performance attributes

- Excellent flow and smoothness
- Outstanding chemical and stain resistance
- OSM at low temperatures

Synergistic binder package

Components	Viscosity mPa.s	Acid Value Mg KOH/g	EEW*	Tg °C
Polyester sample				
CC E (200°C)	2050	100	-----	44
Epoxy sample				
BP E (125°C)	4600	------	430	38

New Development in the Low Cure

Composition	Quantity
CC E	365
BP E	365
Flow Modifier	13
Outgassing	7
TiO2 - pigment	250
Total	1000

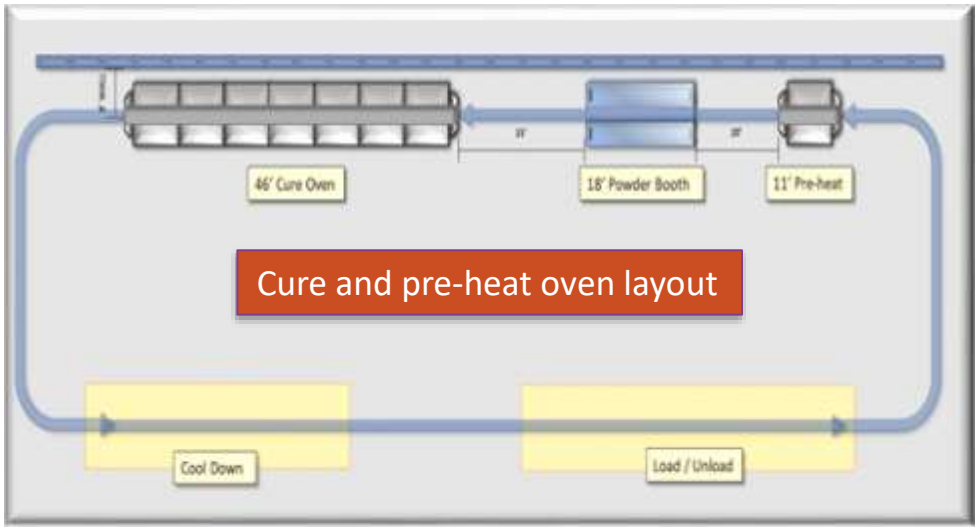
Extrusion Conditions	
Premixing	Bag blend
Extruder Type	ZSK-30MM
Screw	Twin
Temp setpoint (°C)	80/90/90
Extruder speed (rpm)	350
Torque (%)	65 - 75
Feeder speed (rpm)	20

Application Conditions	
Grinding	Strand grinder
Sieving	Russel
Mesh	200
Spray gun	GEMA Optiflex
Substrate	MDF
Cure temp	10 @ 130°C
Oven type	Gas catalytic IR
DFT (µm)	50 – 125

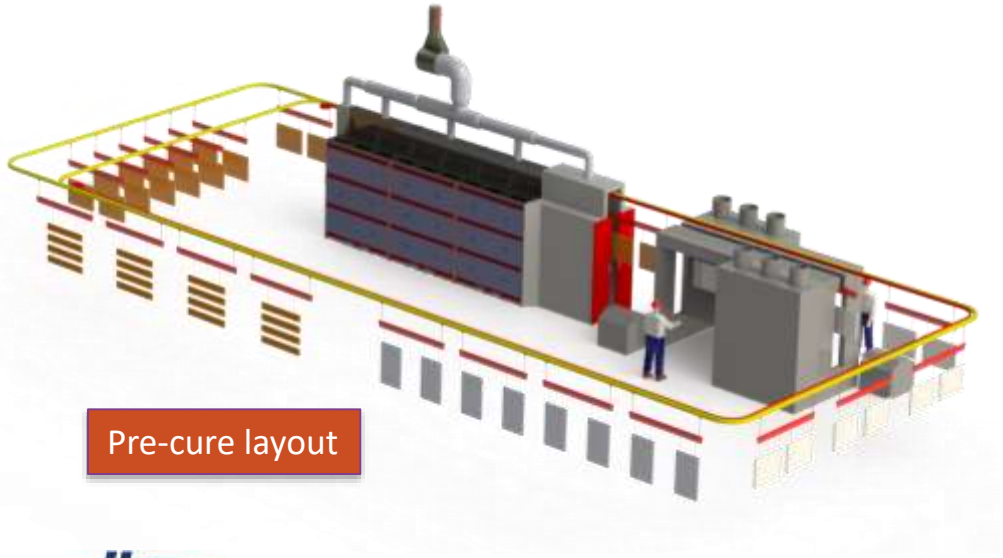
- Compatible with conventional powder manufacturing process
- Optimum performance using gas catalytic IR oven
- Can build 125 microns DFT on single pass

MDF Processing & Application Conditions

Extrusion & Processing Lab Conditions	
Premixing	Bag blend
Extruder Type	ZSK – 30 MM
Temp Setpoint (°C)	100
Extruder Speed (rpm)	350
Grinding	Strand grinder
Sieving	200 mesh
Film Thickness	50 - 125 mm

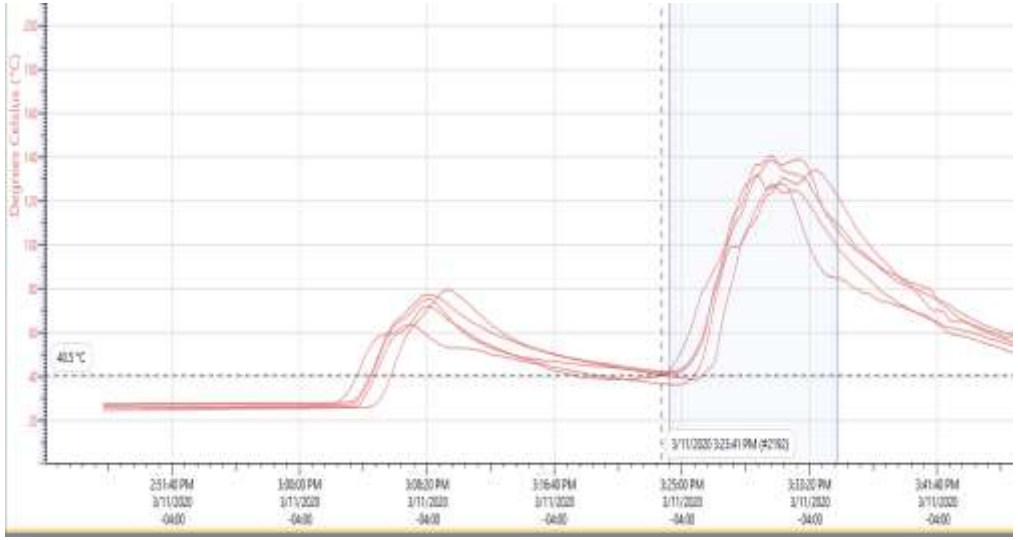


Cure and pre-heat oven layout


Pre-cure layout

Application Lab Conditions [8” X 8” MDF Board]	
MDF Moisture Content	Average 5%
Pre-heat	2min @ 90°C
Surface Temperature	61°C
Environmental Relative Humidity	45% @ 25°C

Recommended IR Gas Catalytic Oven Thermal Profile



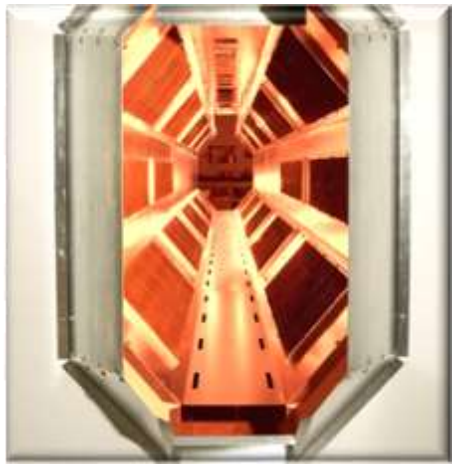
Statistics

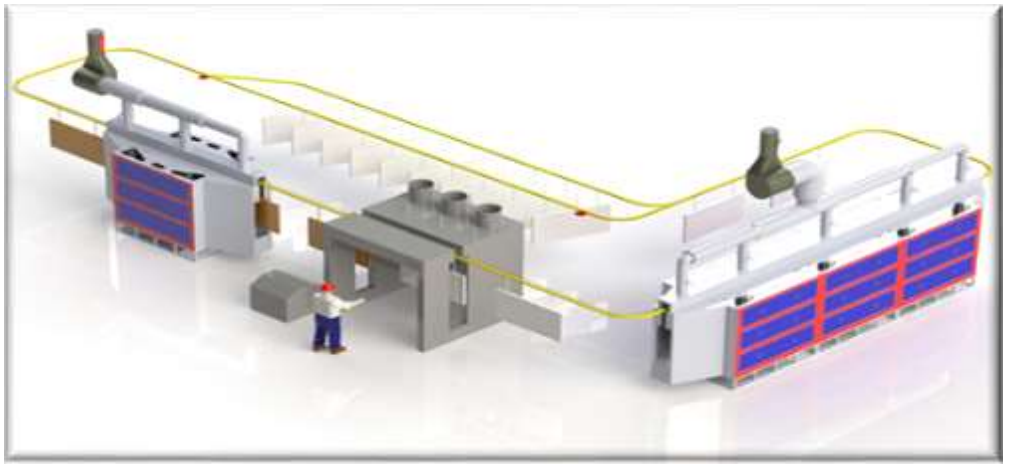
Serial No.	Channel	Point Count	Maximum	Minimum	Average	Duration	Standard Deviation	Time between 120 and 140 °C
P71351	Thermocouple 1	661	132.2 °C	43.0 °C	98.8 °C	00:11:00	26.00 °C	00:03:34
P71351	Thermocouple 2	661	134.1 °C	38.4 °C	94.0 °C	00:11:00	37.98 °C	00:04:52
P71351	Thermocouple 3	661	139.2 °C	42.2 °C	104.0 °C	00:11:00	34.5 °C	00:04:50
P71351	Thermocouple 4	661	127.5 °C	36.3 °C	93.5 °C	00:11:00	32.3 °C	00:03:06
P71351	Thermocouple 5	661	140.9 °C	41.4 °C	103.8 °C	00:11:00	34.46 °C	00:04:37

3D Configuration IR oven setpoints

Recommended IR Catalytic Gas Oven Set Up

Conditions	MDF Board Size	
	12” x 12”	8” x 8”
Preheat: line speed	3ft/min	3 ft/min
Preheat: dwell time	4m 39s	4m 39s
Preheat: exit temp	90.9°C	94.4°C
Temp: at spray	65.4°C	67.8°C
Temp: before cure	54.5°C	52.7°C
Cure: line speed	3ft/min	3ft/min
Cure: dwell time	7m 10s	7m 10s
Cure: exit temp	125+/- 3°C	125 +/- 3°C





MDF Supplier: cabinetdoormart.com

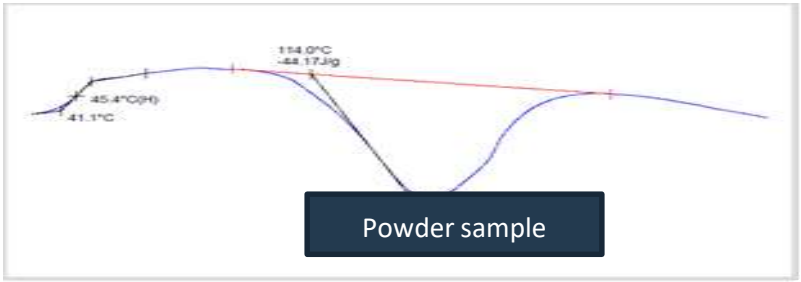
Performance Characteristics [white]

Properties	Test method	Target	Value
Dry Film Thickness	ASTM D 7091	100 – 150 mm	100 - 125 mm
Smoothness | PCI	PCI #20	> 6	5-6
Cure [>80% DSC | Gas Catalytic IR]	N/A	> 80% DSC	92% DSC
Gloss | 60˚	ASTM D 523	10 - 40	14
Pencil Hardness	ASTM D 3363	2H	5H
Crosshatch Adhesion	ASTM D 3359	4B	5B
MEK Resistance | IKEA (50 rubs)	PCI #8	No effect	No effect

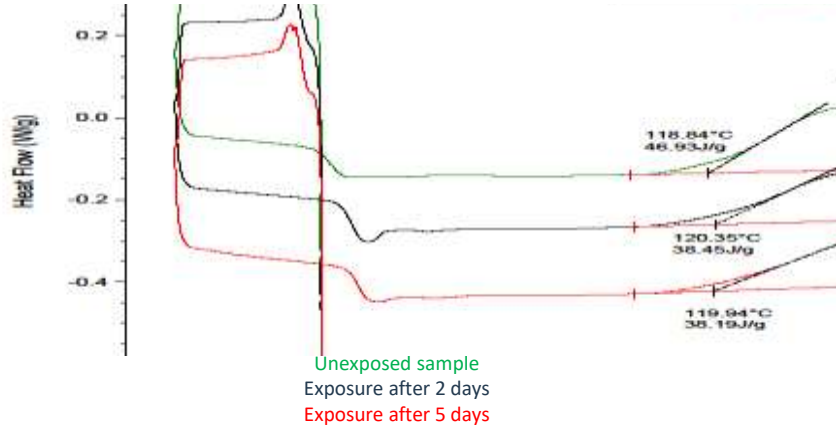
OSM technology capable of achieving 10 – 20 units gloss at 125°C

Performance Characteristics [white]

T_g of Unapplied Powder (DSC)



Storage Stability at 35°C Thermal analysis

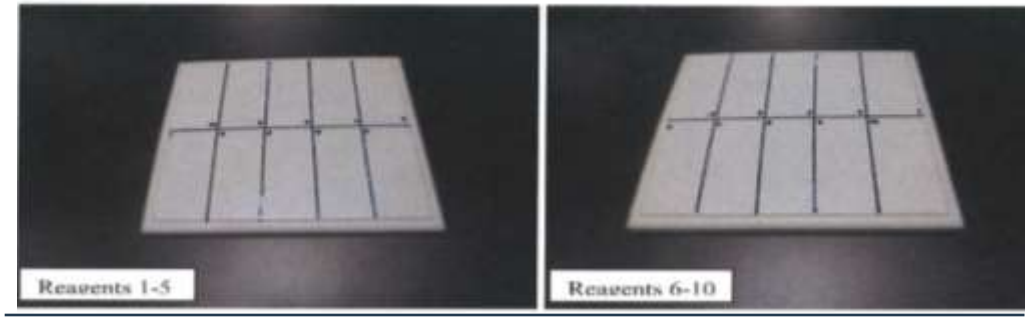


Demonstration of Powder Stability

- Absence of aging
- Absence of premature curing at standard use condition
- No significant change on the Onset Tg after 5 days at 35°C
- No performance changes after 60 days at RT (20 – 22°C).

Performance Characteristics
Chemical & Stain Resistance

Certified Testing by UL Labs
ANSI/KCMA A161.1-2017, SEC. 9.3



Specimen	Staining Agent	Observations (1 hour)	Observations (24 hours)
2358012	Heinz Vinegar	N/A	Unaffected
	Lemon Juice	N/A	Unaffected
	Welches Grape Juice	N/A	Unaffected
	Orange Juice	N/A	Unaffected
	Heinz Ketchup [Catsup]	N/A	Unaffected
	Folgers Coffee	N/A	Unaffected
	Pompeian Olive Oil	N/A	Unaffected
	Vodka 100 Proof	N/A	Unaffected
	Palmolive Green	N/A	Unaffected
	French's Mustard	N/A	Unaffected

Edge Cracking Ledro Test

IKEA
IOS-TM-0022

No cracking after 48 hours exposure

Performance Characteristics
Physical Tests Resistance

Certified Testing by UL Labs

Physical Test	Requirement	Observations	Result
Shrinkage and Heat Resistance Test	ANSI/KCMA A161.1	No glue line failures, open joints, cracks, or discoloration	Met Requirement
Hot and Cold Check Resistance		No discoloration, blistering, cold checking, or other film failure	Met Requirement
Chemical Resistance Test		Unaffected – see chemical resistance	Met Requirement
Cabinet Surface Finish			
Hot Water	SEFA 8 – 5th Edition	No visible effect from the hot water	Met requirement
Impact		No visible cracks or checks in the finish	Met requirement
Paint Hardness		5H pencil did not break through	5H
Dart Impact		No visible cracks in the finish	Met requirement
Wear Resistance (abrasion)		Informational only @ 1,000 cycles	0.83 g

Hot & Cold Resistance

Hot Water Resistance: SEFA 8

Shrinkage & Heat Resistance

Summary

OSM 130°C Cure	MDB 130°C Cure	High Gloss 125°C Cure
		
Gloss level 10 – 20 units	Gloss level 25 – 40 units	Gloss level 85 – 110 units

Thank you

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