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Introducing a novel high-speed crosslinking technology for powder coatings based on Michael addition chemistry

Achim Hemeke

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OUTLINE

- Low Temperature/Fast curing powder coatings: why & what's the challenges?
- Conventional Curing technologies
- ULB Novel: Value Proposition
- ULB Novel: a new 'toolbox' for curing powder paints
- ULB Novel: examples
- Matt finishes

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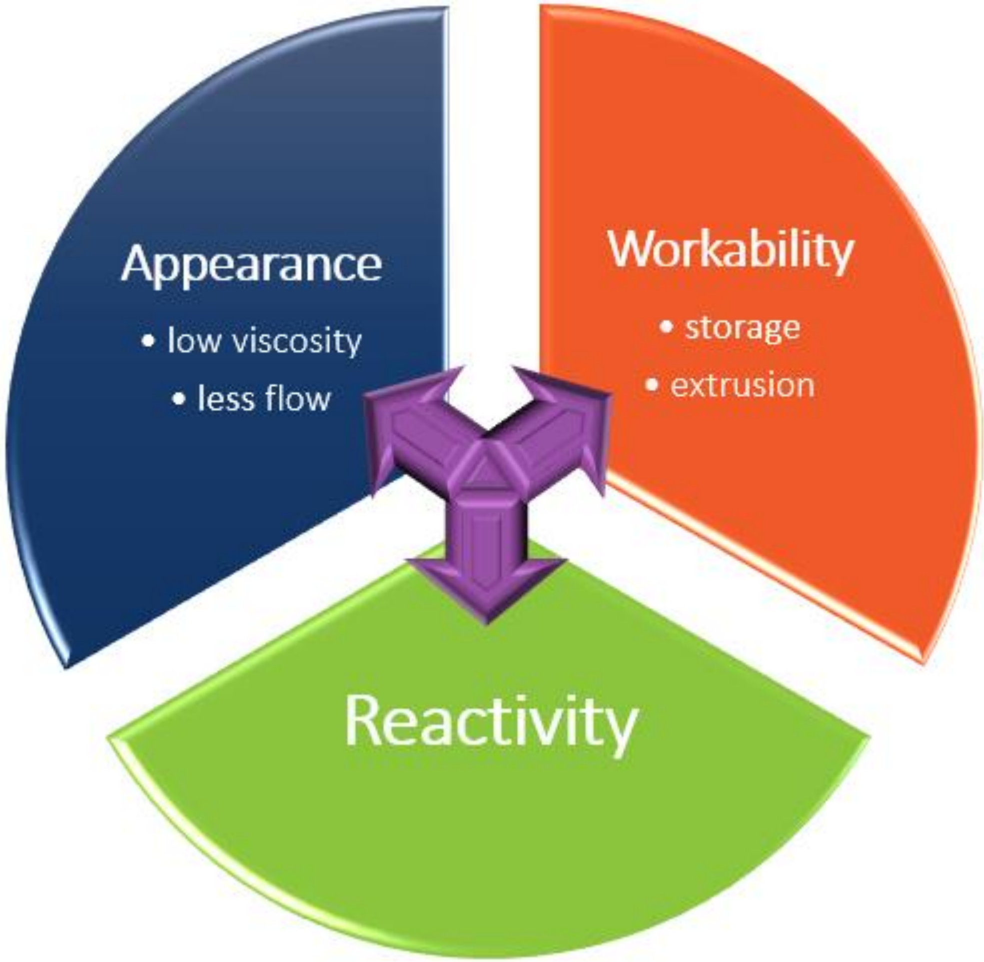
Thermally sensitive substrates

- simplified one coat 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 SB 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 (eg ACE, structural metal)
- lower curing temperatures means massive components can be coated faster increasing throughput & productivity
- lower cure temperatures increase applicator production efficiency & energy savings

What's the challenge?



Conventional Curing Technologies - What are the limitations?

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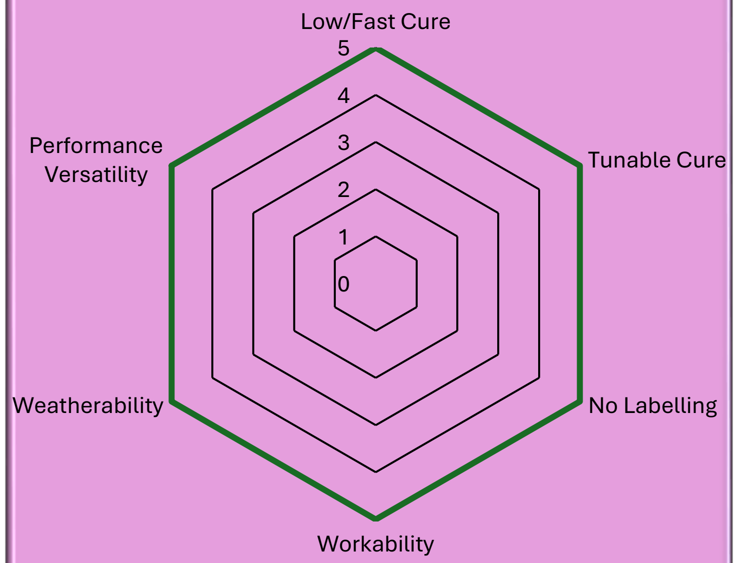
Carboxy-Epoxy Thermal Cure	Thermal Free-Radical Cure	UV Cure
• standard saturated resins with epoxy crosslinker, cure accelerated by catalyst	• unsaturated resins and thermal radical initiator	• unsaturated resins & UV initiator
• 130 °C curing possible	• very reactive free-radical chemistry	• de-couples flow & curing
• limited flow & storage stability	• poor flow	• investment for UV line
• interior application (hybrid)	• complex manufacturing process	• problems for complex structures & certain colours
• labeling issues (TGIC)		

Introducing a novel platform technology - Value Proposition

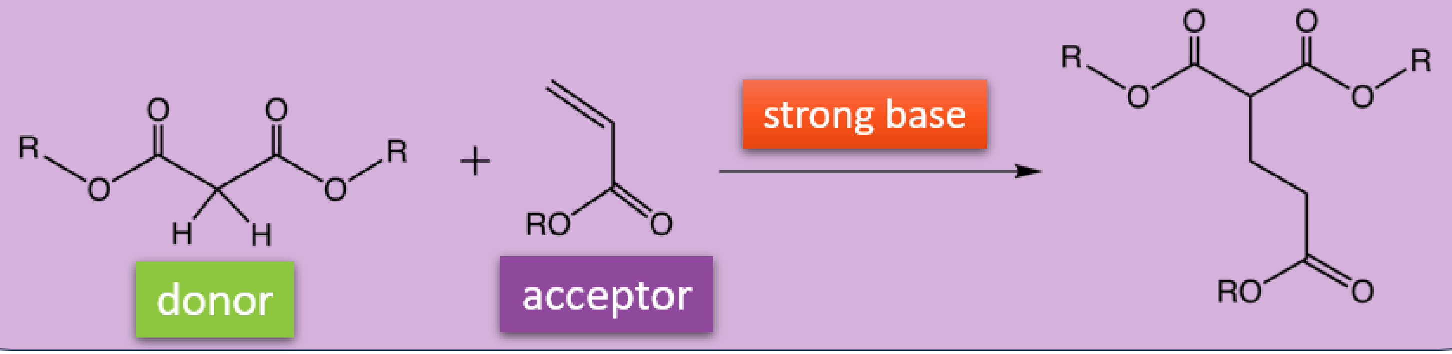


Control of cure.
Control of performance.

Innovation in powder crosslinking chemistry

- intrinsically fast reactivity
- tunable reactivity
- no labelling
- straight forward manufacturing & storage
- for indoor & outdoor application
- full range of gloss levels

Real (or carbon) Michael addition chemistry



Reaction	Donors	Acceptors	Catalyst
• donor (acidic C-H) with an acceptor (electron poor C=C) • creating C-C linkages	• malonates • acetoacetates • cyanoacetates	• acrylates • methacrylates • maleates • fumarates • itaconates	• high reactivity in the presence of *strong base* • no reactivity without strong base

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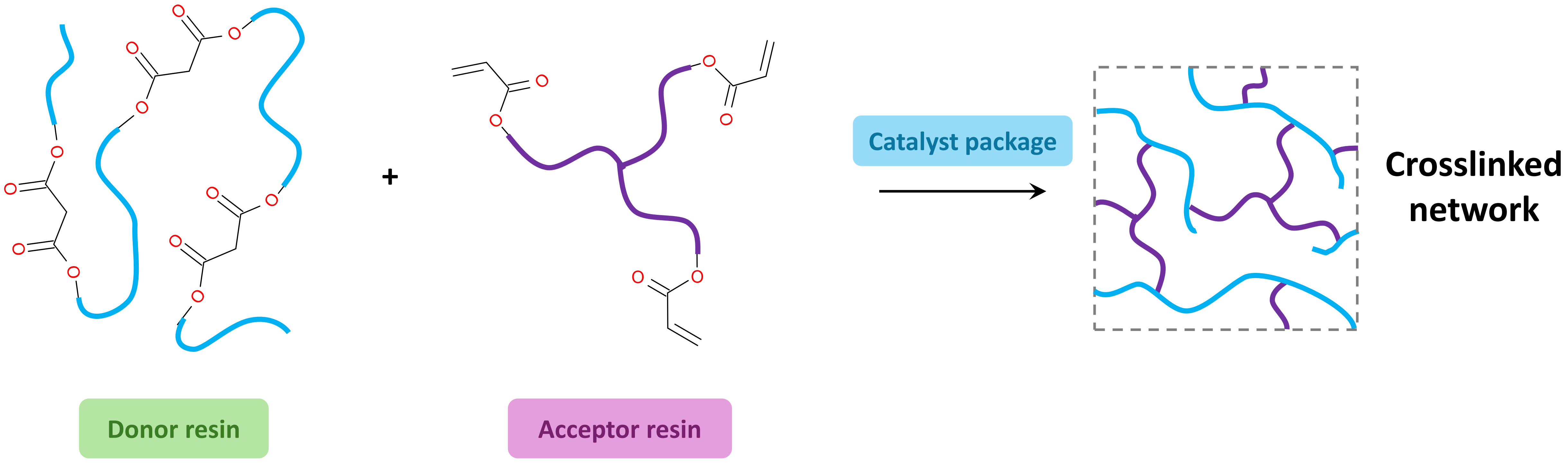
Resin design for Michael addition-based crosslinking

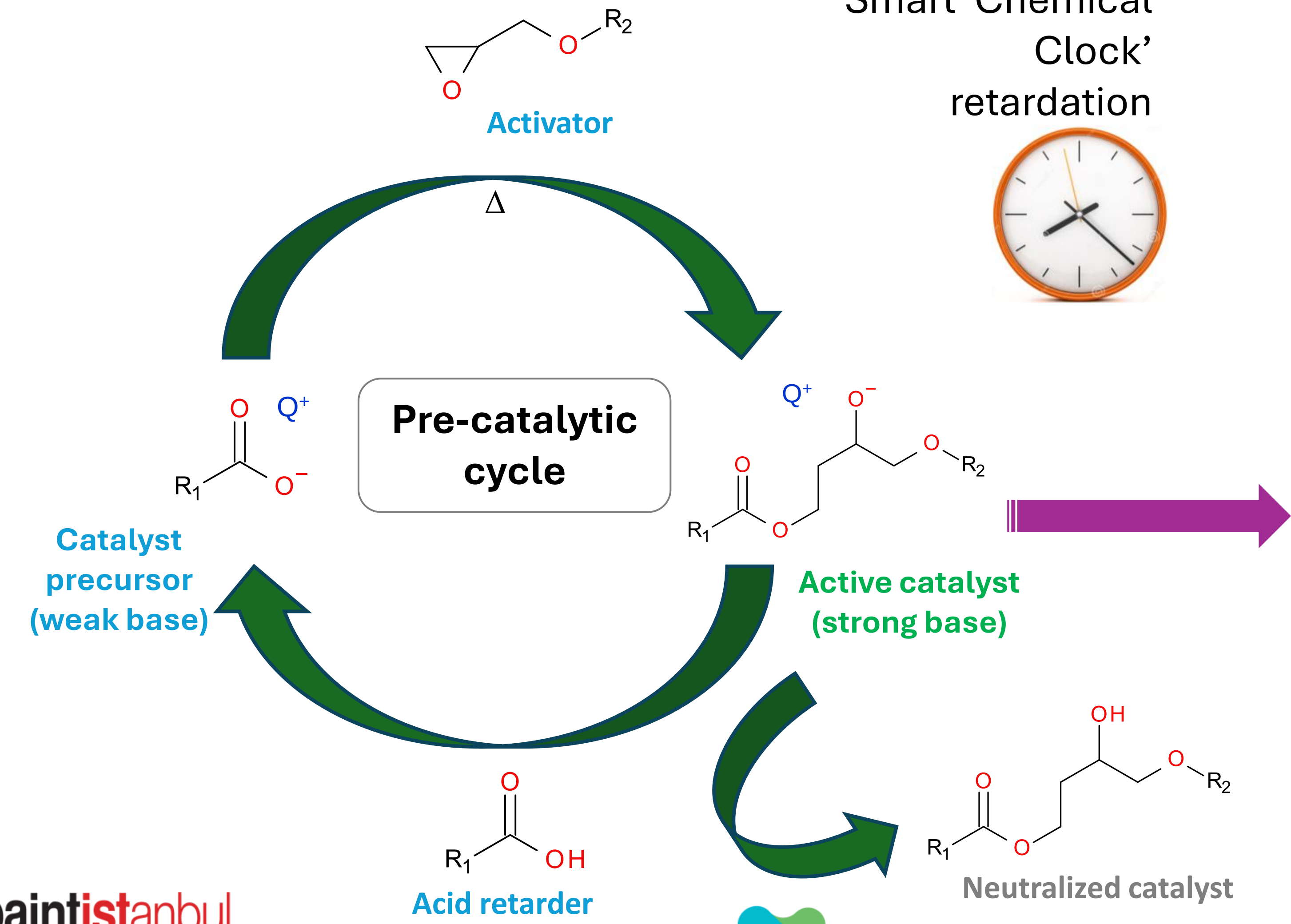


The catalyst package: a pre-catalytic cycle and delayed cure

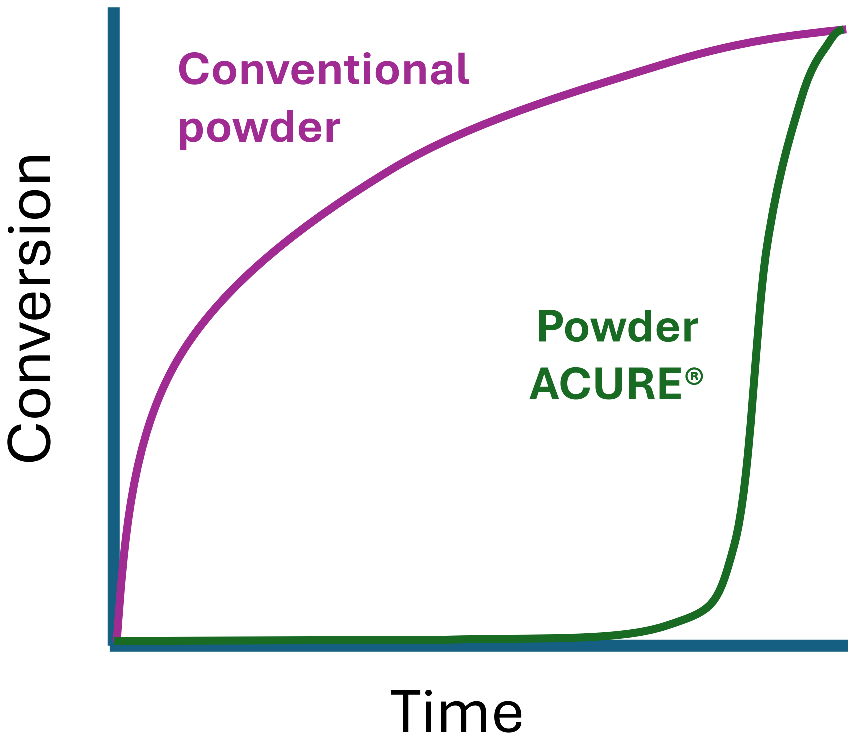
Multi-component catalyst package

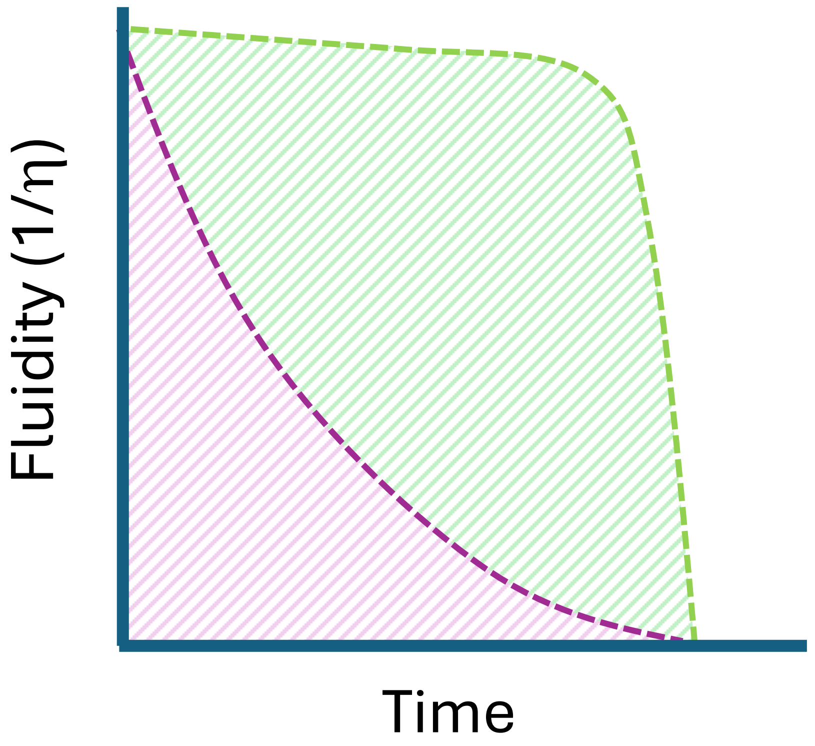
- Control over presence/absence of (strong) base
- “On/off-switch” on chemical reactivity/crosslinking
- Control over onset of crosslinking reaction in time (=> extrusion, appearance)

Smart ‘Chemical Clock’ retardation



Maximizing paint flow in a highly reactive crosslinking system

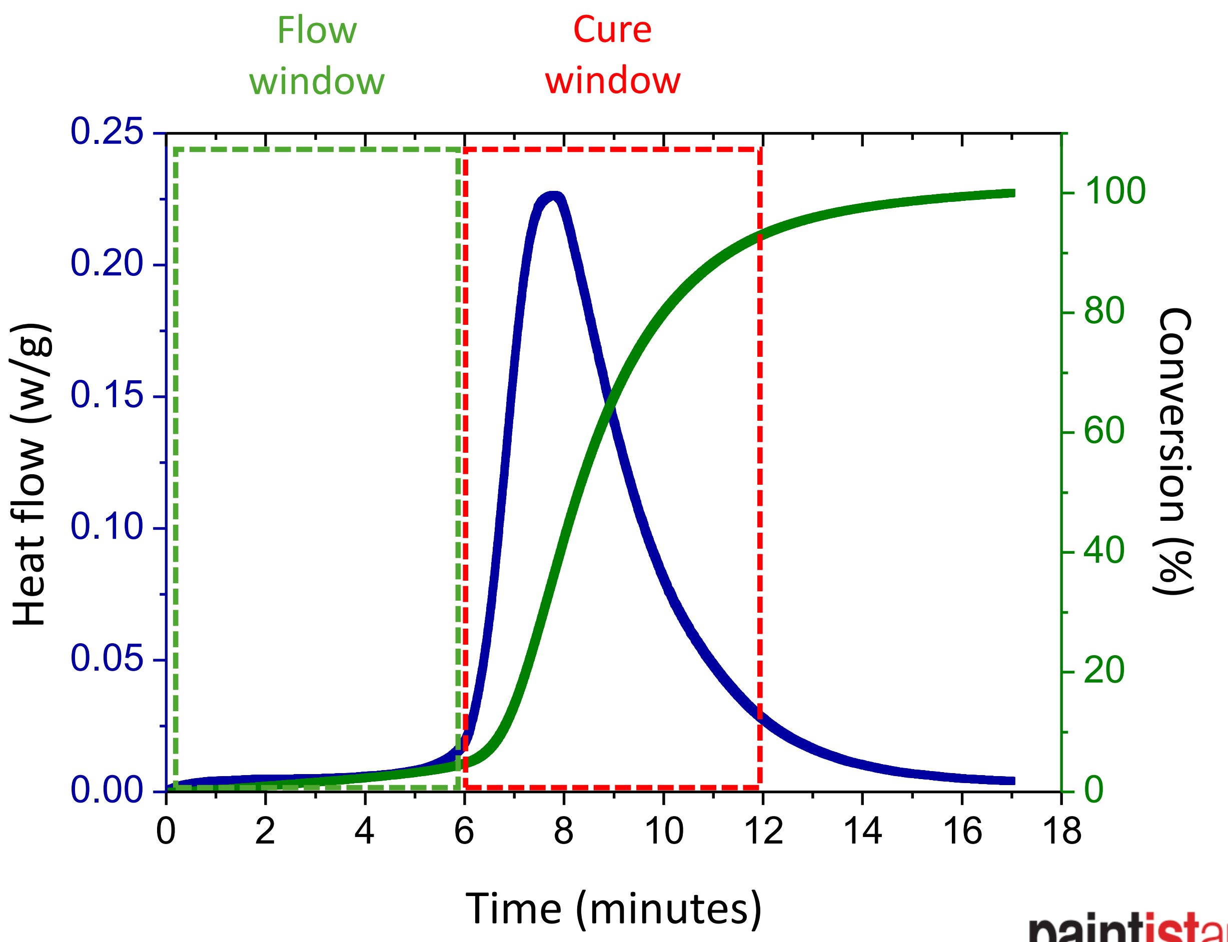


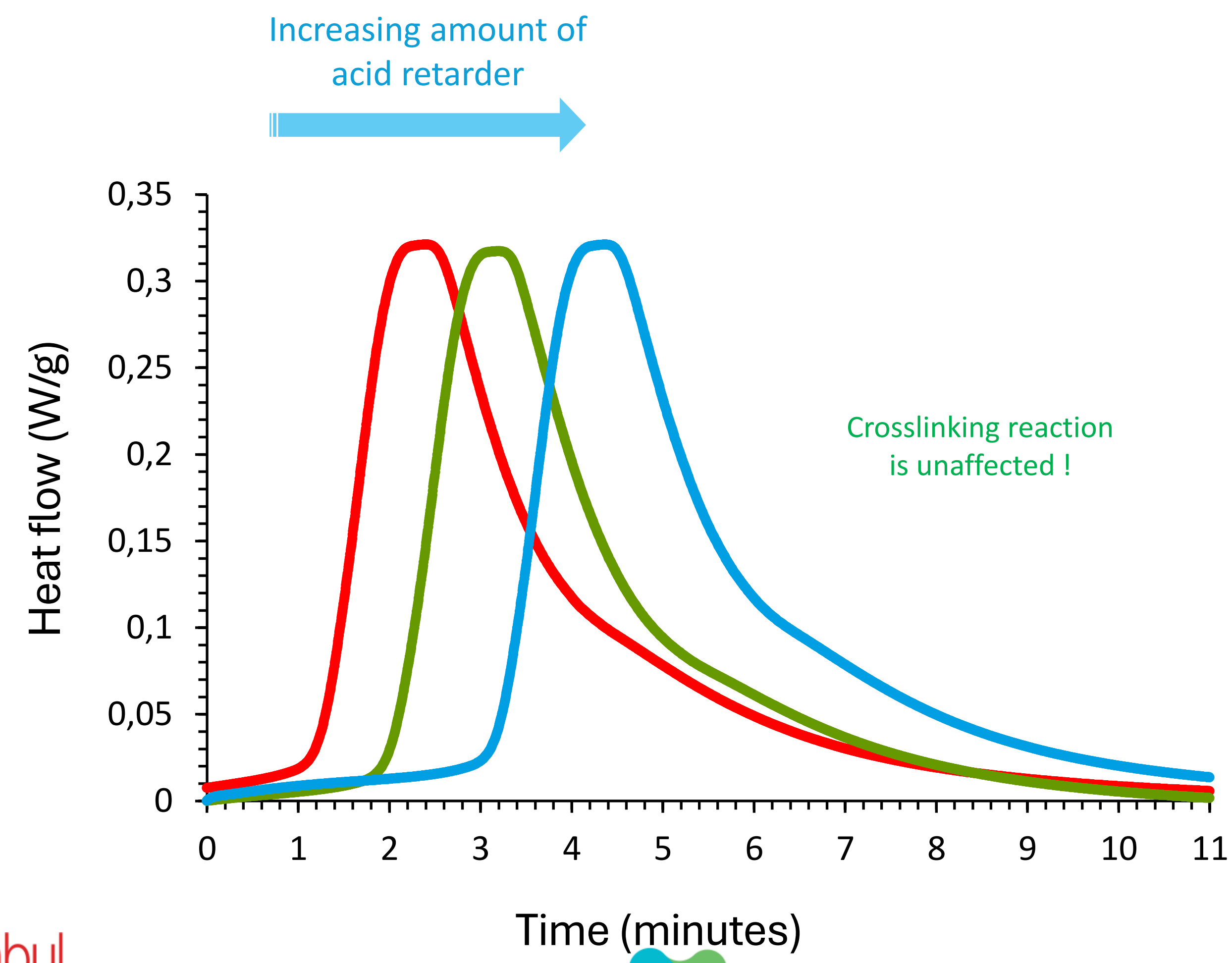


Advantages

- Maximize total paint flow for given cure time
- Maximize appearance
- Prevent premature reaction during extrusion
- Decouple flow and cure stages (similar to UV-curing powders)

Decoupling of flow and cure stages





Decoupled flow and cure: effect on appearance and performance

Controlling induction time

- Increasing gel time and PCI with increasing amount of retarder
- Final crosslinking not affected: >300 MEK double rubs in all cases

Paint No.	Equivalents retarder	MEK double rubs	Gel time @120 ºC	PCI
RD572/13	0	>300	90’’	2
RD572/14	0.5	>300	160’’	4
RD572/15	1	>300	324’’	6

Clear coats, cured at 120°C

ULB Novel: Examples on MDF

Target Profile

- 100-130 °C
- infrared heating < 10 mins
- single layer, 80-100 µm
- applications for furniture

Coating Performance

- stain resistance (water, alcohol, coffee & fat)
- solvent resistance (MEK & acetone)
- heat resistance
- scratch resistance
- adhesion
- edge cracking (Ledro)

Paint 1

- Epoxy acrylate (EA) acceptor
- Higher flexibility and flow (PCI)
- Slower cure than UA

Paint 2

- Urethane acrylate (UA) acceptor
- Higher reactivity: cure @100°C possible
- More brittle than EA

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Coating performance: a case study on MDF

Performance of ACURE® paints

- Excellent solvent-, scratch- and stain resistance
- High crosslinking density
- High film Tg
- Tunable PCI

	Paint 1	Paint 2
Curing condition: 6 minutes @130°C (IR heating)		
Paint T_g [°C]	46	51
Layer thickness [µm]	80-100	80-100
Gloss [60°]	90-97	90-97
Solvent resistance (DIN 6886-1)		
Acetone (10s)	4	4
MEK (50 rubs)	pass	pass
Stain resistance (EN 12720)		
Water (24h)	5	5
Fat (24h)	5	5
Coffee (6h)	5	5
48 % Ethanol (6h)	5	5
Adhesion (EN ISO 2409)	Class 1	Class 1
Wet heat resistance (EN 12721)	5	5
Dry heat resistance (EN12722)	5	5
Scratch resistance, 5N (SS 839117)	4	4
Scratch and fat resistance, 5N/24h (SS 839122)	4	4
PCI smoothness	4-5	2-3

2K dry-blend technology for smooth low-gloss finishes

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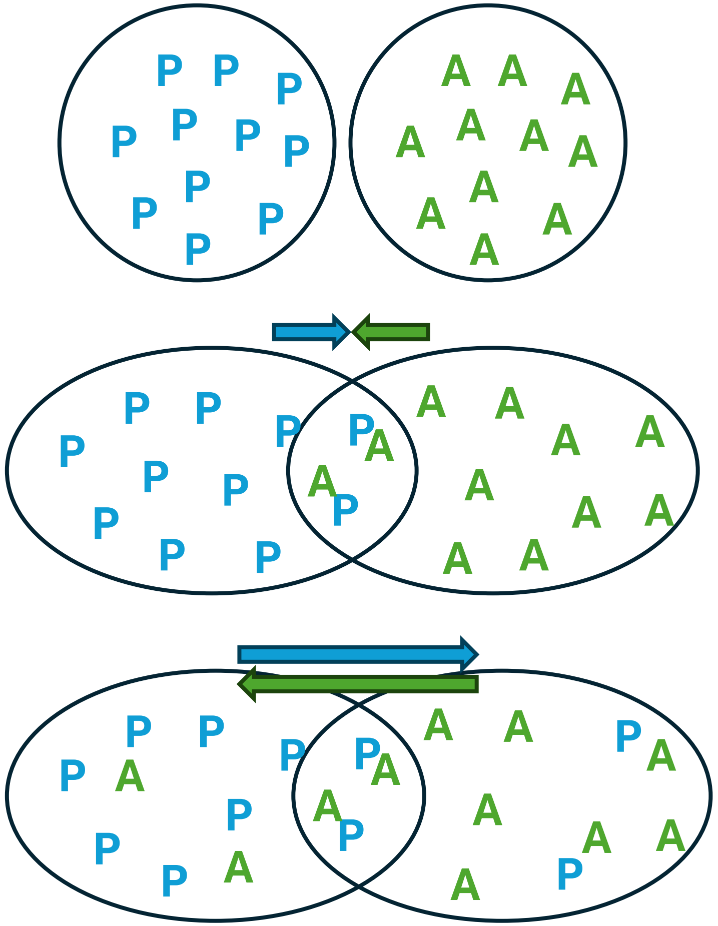
Gloss control by separating catalyst components

- Two separate paints consisting of the same binders
  - Paint A only contains catalyst precursor **P** (by itself inactive)
  - Paint B only contains catalyst activator **A** (by itself inactive)

- (Delayed) curing process starts when P and A mix
  - First at particle interfaces, followed by particle cores
  - Local difference in curing onset creates matting effect
  - Surface still smooth because of flow window before cure



15

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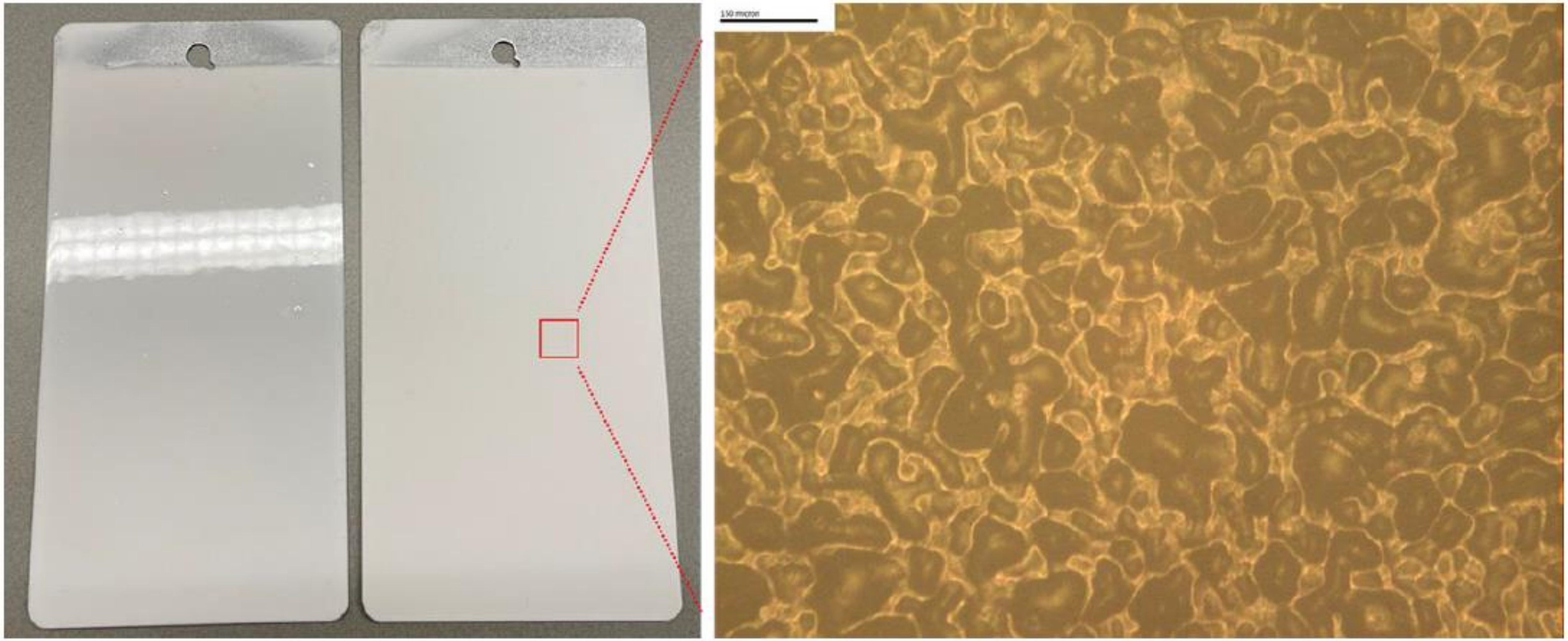

Dead matte (< 10 GU @60°) with smooth appearance

16

Summary

Toolbox Features

- Intrinsically fast reactivity
- Tunable reactivity
  - strong catalysis correlated response
  - *'chemical clock'* catalysis with dial-in retardation
- Broad design options
  - donor, acceptor & catalyst components
  - tune paint and final coating properties
- Favorable HSE profile
  - no labelling

Potential Coating Performance

- Low temperature/fast curing
  - 100 °C curing possible
  - tunable curing profile
- Workability
  - ease of extrusion
  - storage stability at ambient condition
- Coating performance
  - chemical resistance
  - adhesion
  - weatherability
- Coating finish versatility
  - gloss and matt options
  - special effects

17

Thank you for your time and interest!

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