A TOOLBOX APPROACH TO ENHANCED APPLICATION SPECIFIC PERFORMANCE IN **ACURE™** SYSTEMS

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TODAYS SPEAKERS

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ALLNEX AT A GLANCE

Our global manufacturing network and market footprint makes allnex an attractive and preferred business partner. With a highly skilled and dedicated staff, we focus on what we do best and are the best at doing.

TOTAL REVENUES
EUR 2.4 billion in 2021

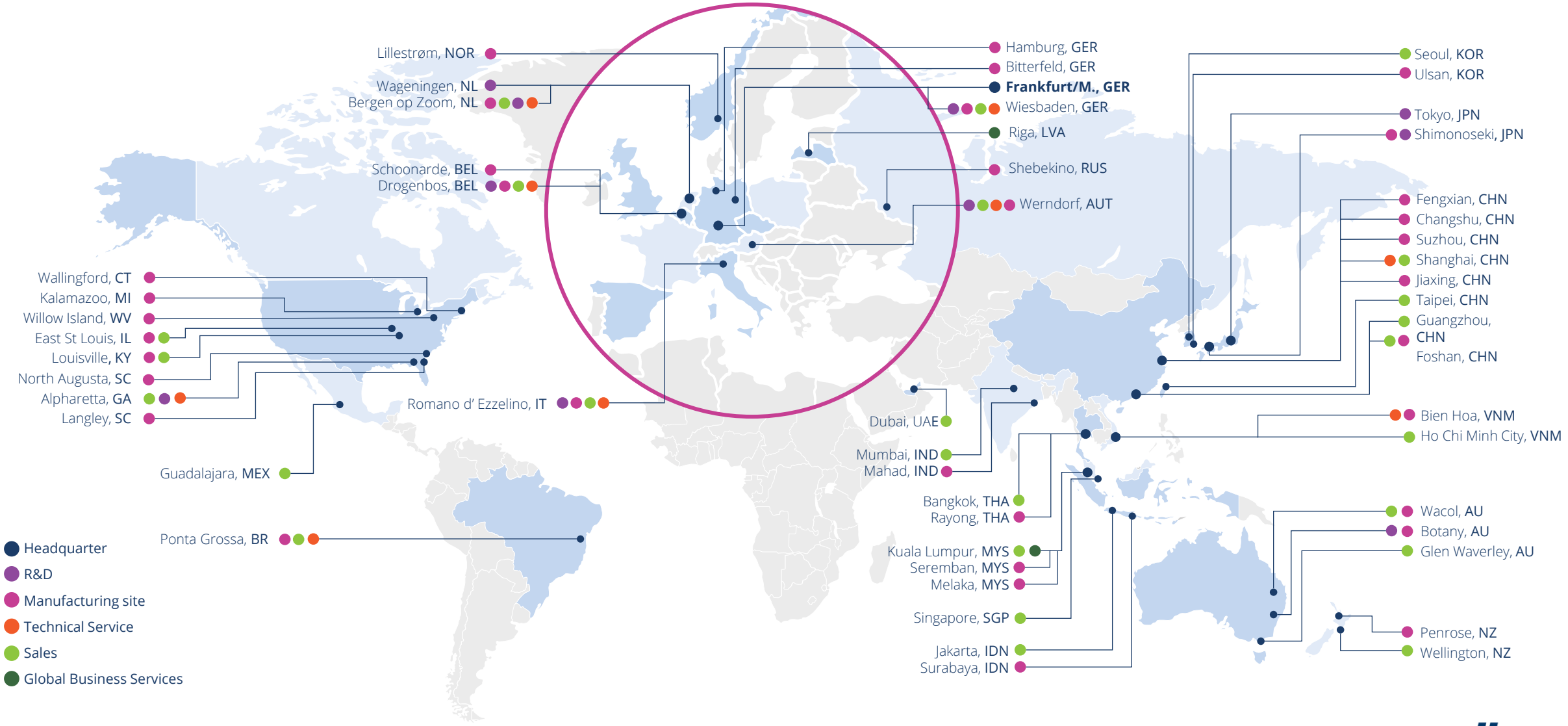
4 BUSINESS AREAS

3,865 TOTAL STAFF
2021 (FTE)

33 MANUFACTURING SITES
worldwide

SALES PER REGION

OUR GLOBAL FOOTPRINT



OUR SUSTAINABILITY PILLARS

These pillars form the basis of allnex's ambitious Sustainability Program, which covers all aspects from product development, raw material sourcing and manufacturing to supply chain management and customer service.

13 CLIMATE ACTION

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

7 AFFORDABLE AND CLEAN ENERGY

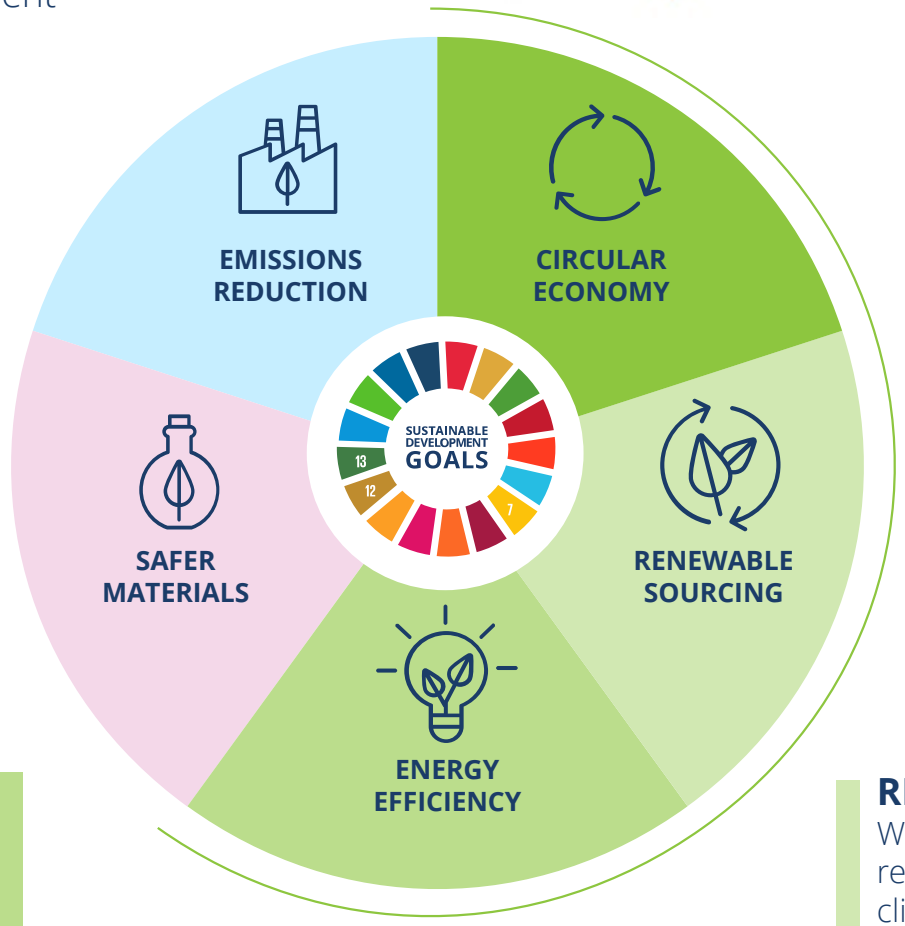
PLATINUM Top 1% 2022 ecovadis Sustainability Rating

EMISSIONS REDUCTION

We work to reduce the emissions of volatile organic solvents across the product lifecycle to protect people and the environment.

SAFER MATERIALS

We are committed to making the substitution of potentially harmful chemicals by safer options one of our guiding considerations.



CIRCULAR ECONOMY

We diligently explore options to limit the consumption of resources, keep them in use as long as possible, and eventually recover and recycle them at the end of service life.

ENERGY EFFICIENCY

We design our product and manufacturing process in a way that enables maximum efficiency in energy utilization across the product lifecycle.

RENEWABLE SOURCING

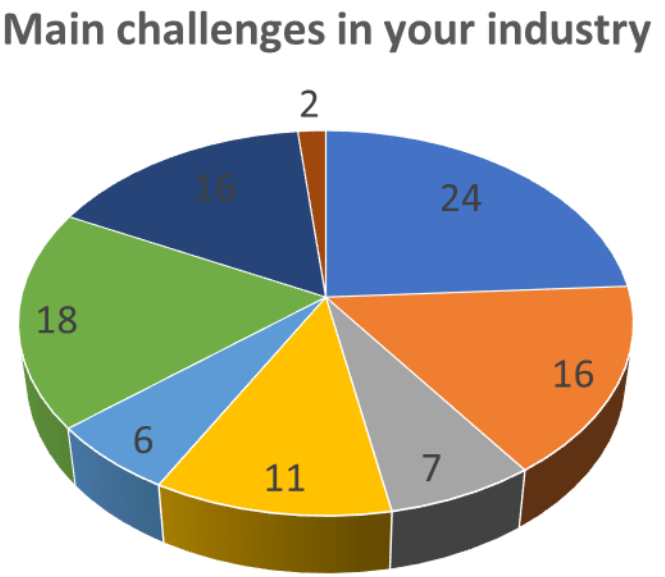
We aim at minimal use of finite resources and strive to reduce climate impacts by looking at renewable alternatives for raw materials and the energy we use.

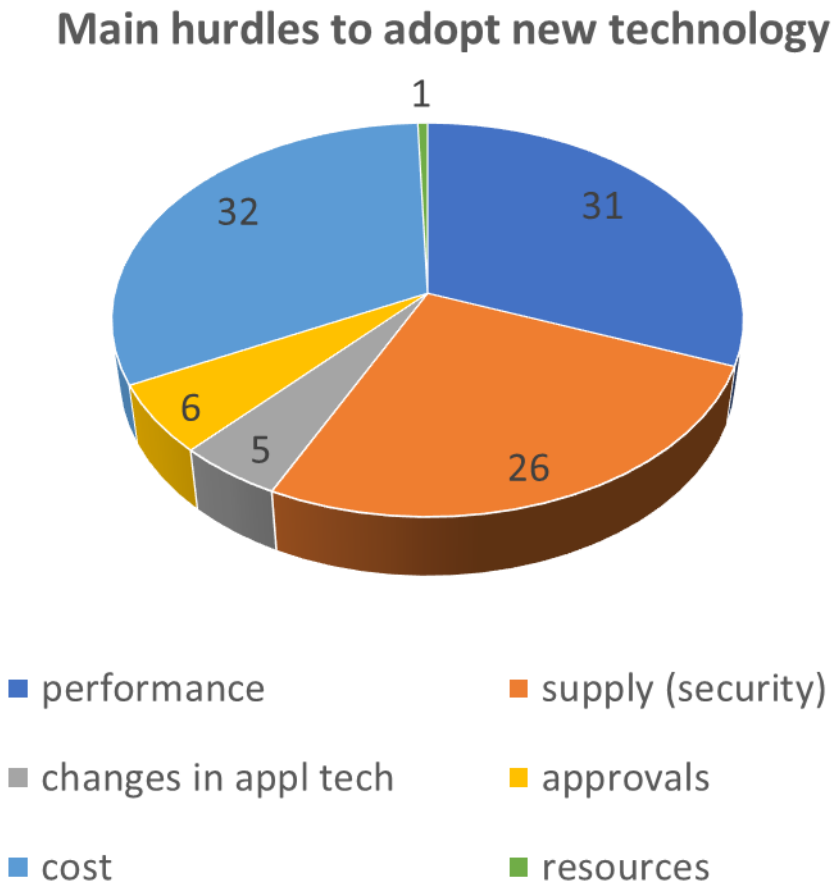
allnex The Coating Resins Company

OUTLINE

- ACURE™ Introduction
- Sustainable Performance
  - saving energy
  - ultra-high solids & biobased
- The ACURE™ Toolbox
  - product selection
  - primers & sealers
  - formulation examples

THANK YOU FOR YOUR FEEDBACK!





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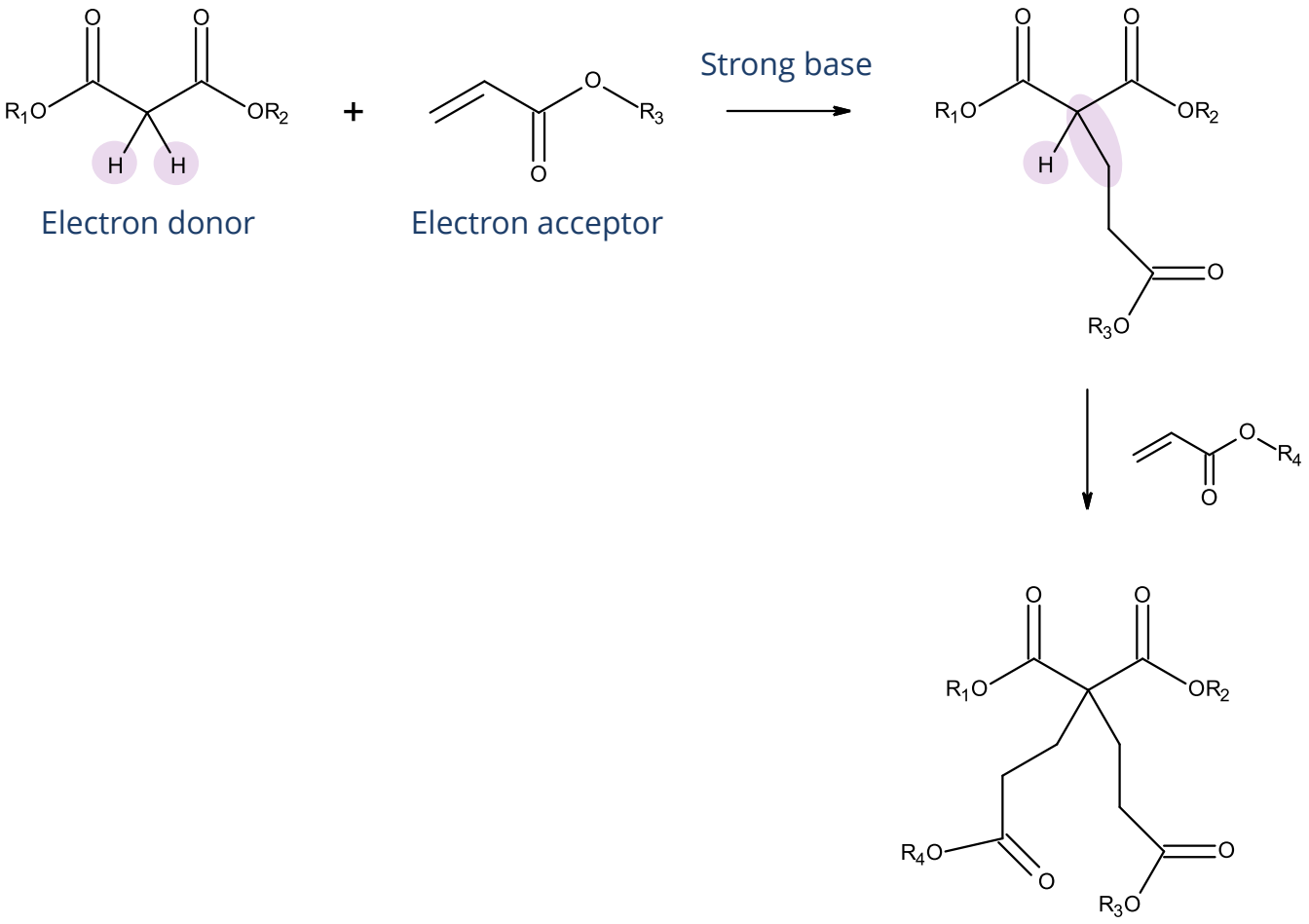
ACURE™ Introduction

Chemistry & Performance profile

ACURE™ CHEMISTRY IS BUILT ON MICHAEL ADDITION

Real Michael addition (RMA) topcoats



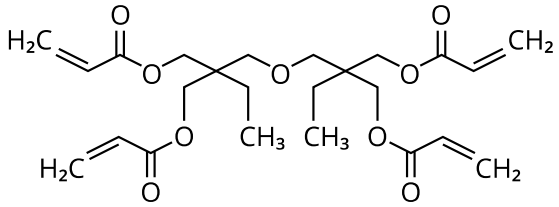
- Malonate functional polyester (pKa ≈ 13)
- Acrylate functional oligomer
- Strong base required (pKa > 13)
- Creating C-C bond (robust)

- Few polar functional groups (OH, NH): low viscosity and VOC

COMBINING LONG POT LIFE WITH FAST DRYING

Resin components

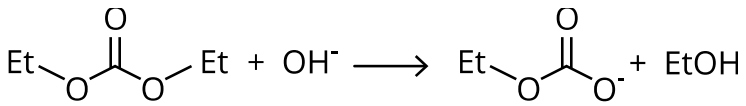
- Malonate functional polyester
- Acryloyl functional oligomer, e.g. DiTMPTA

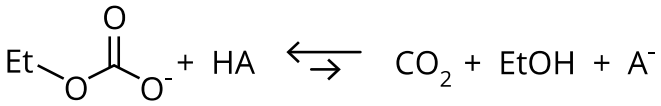


Di(trimethylolpropane) tetra-acrylate, DiTMPTA

- Blocked base catalyst

→ combined with primary, volatile alcohol to further extend potlife

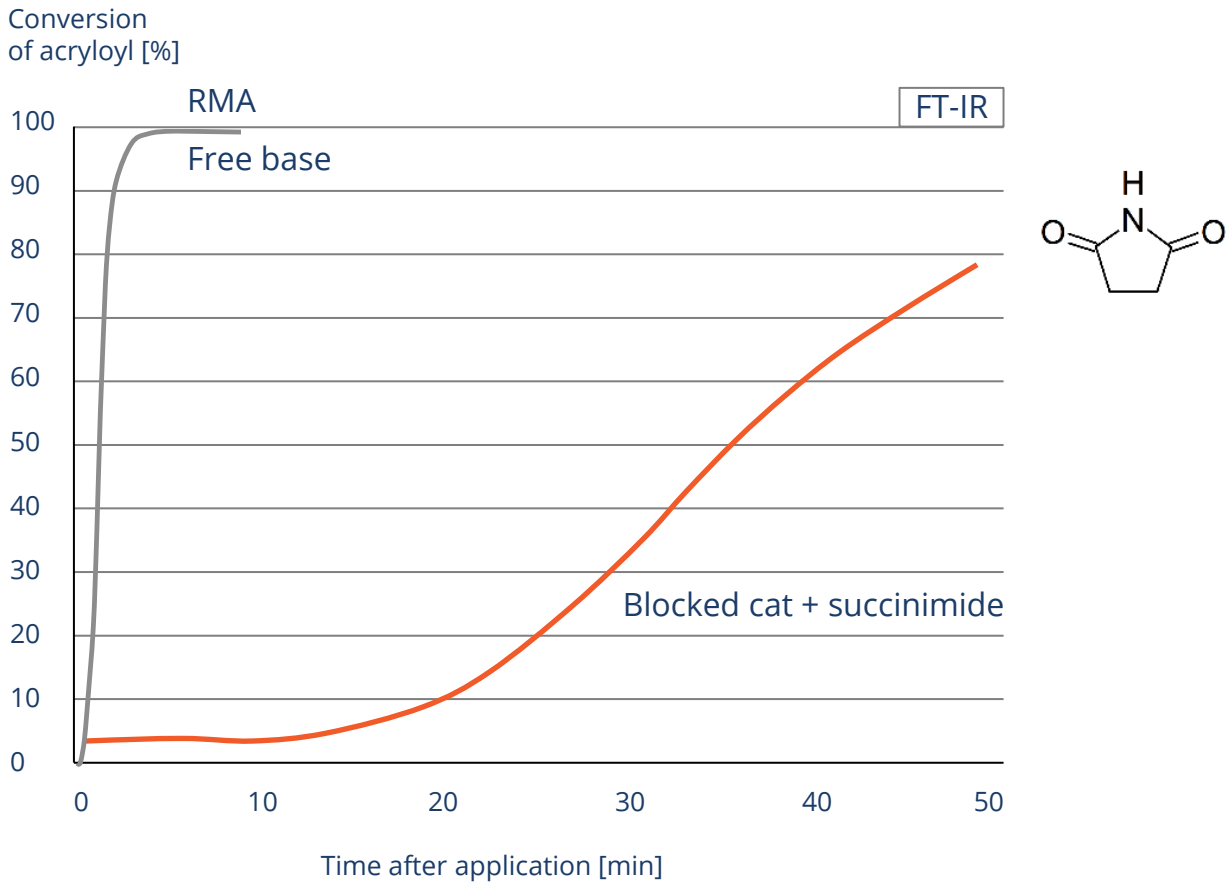




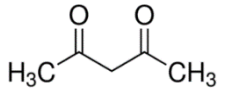
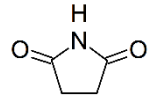
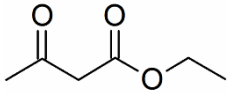
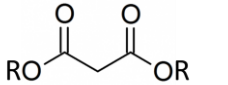
- ACURE™ uses a special blocked base catalyst combined with kinetic additives
  - decoupling between pot life and dry time
  - excellent control of open time
- Donor and acceptor form stable, non-reactive mixtures
- Acidic species in resin and paint formulation should be avoided

PREVENTING THE OPEN TIME WINDOW FROM SLAMMING SHUT

Controlling the RMA reaction



- Acidic species used to control open time
- Succinimide very effective at low dosage
- ACURE™ malonates available with and without succinimide

Structure	Name	pKa (in water)
	acetylacetone	9.0
	succinimide	9.5
	ethylacetoacetate	10.7
	malonate	13

ACURE PROVIDES A TUNABLE BINDER PLATFORM FOR USE ACROSS A BROAD RANGE APPLICATIONS

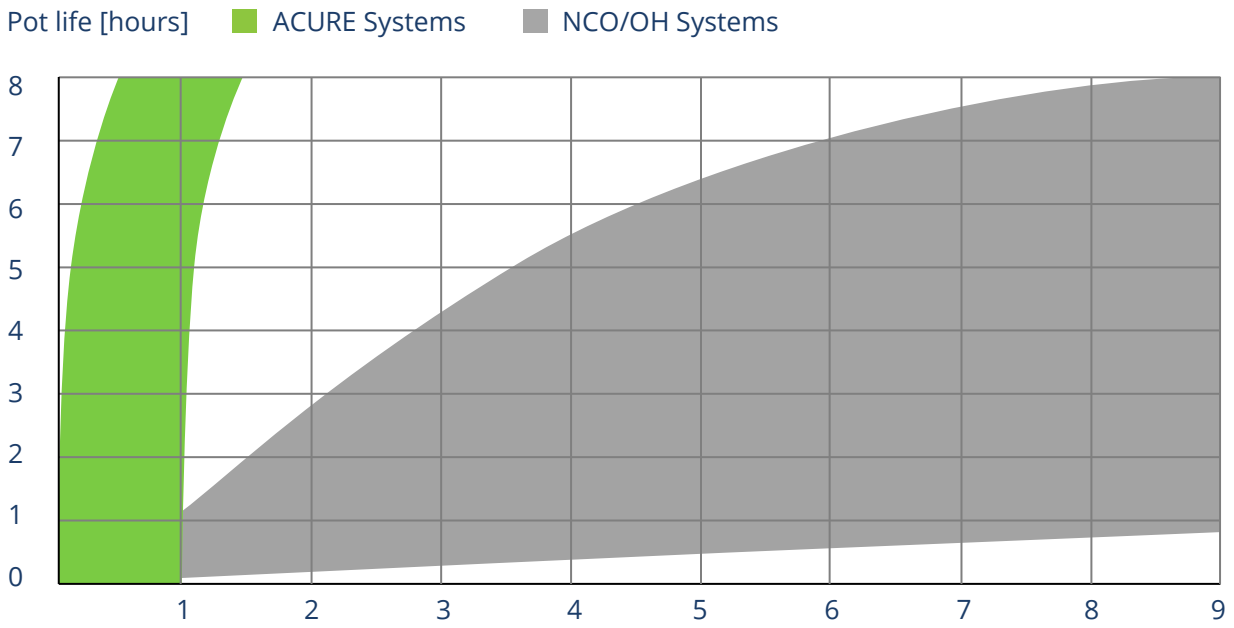
Performance profile of RMA paints

Tunable drying properties

- Pot life: between 1.5 hrs and >24 hrs
- Tack-free time: 5–90 minutes at RT
- Open time: 5–30 minutes

- Rapid hardness development and dry to handle
- Excellent chemical and mechanical resistance
- Platform technology, applicable on multiple substrates

The de-coupling of dry time and pot life



Note: tack-free time corresponds to stage 3 dry

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Sustainable Performance

HSE, raw material sourcing & energy use

be ECOWISE™

allnex

GREENER BY NATURE

ACURE™ hits all five of allnex's sustainability pillars

ENERGY EFFICIENCY Reduction in curing energy due to the speed of Michael addition chemistry: lower temperature and shorter cycle times

CIRCULAR ECONOMY Reduced paint waste from longer pot lives, enabled by ACURE™'s unique blocked catalyst

AIR EMISSIONS VOC levels 200g/L lower than traditional systems: in line with trend towards ultra-high solids paints; WB version available

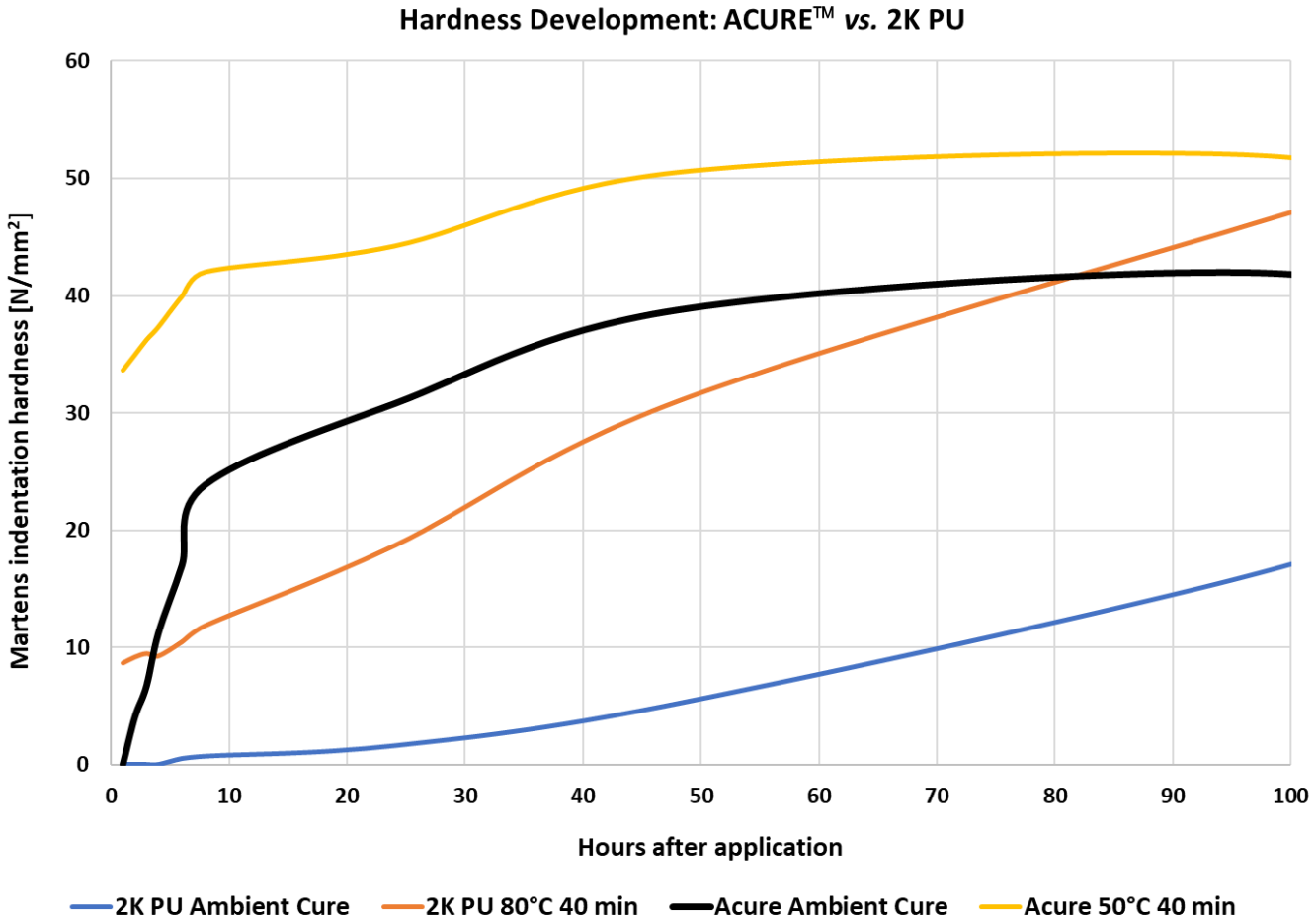
SAFER MATERIALS ACURE™ paints do not require isocyanate, tin or formaldehyde and can be formulated without H317 label

RENEWABLE SOURCING Bio-content potentially over 50% within 2–4 years, over 80% within 5–8 years

be ECOWISE™

NO MORE CURING ENERGY COST ANXIETY!

ACURE™ offers ultra fast drying and property development at room temperature



- Study performed on green tinted topcoats
- 2K PU: SETALUX® 27-1551 / Desmodur N 3390
- ACURE™: 510-300, 510-400, 550-100, 550-405
- Ambient conditions: 20 °C, 38% R.H.
- DFT: 55 µm
- baked panel preparation
  - Conventional air spray
  - 10 minutes flash-off
  - 40 minutes bake at specified temperature
  - 10 minutes cool down
  - Hardness measured

LEVERAGE ACURE'S REACTIVITY TO YOUR BENEFIT !

Fast cure with long potlife enables:

- Greatly reduced energy consumption
  - reduce oven temperature or eliminate baking altogether
- Signficant increases in productivity
  - multiple layers in 1 working day, at ambient conditions!
- Reduced $C0_2$ footprint – improved sustainabilty

REDUCING AIR EMISSIONS

Ultra-high solids topcoat for primed metal applications

Component	Function	wt%
PART A		
ACURE™ 550-105	Acceptor resin	25.59
ADDITOL™ XL 6592	Dispersing additive	0.68
Kronos 2310 TiO_2	Pigment	35.16
ACURE™ 510-202	100% reactive donor resin	19.53
ACURE™ 510-272	100% reactive donor resin	5.86
ACURE™ 510-174	Low EQW donor resin	3.91
Tinuvin 292	Light stabilizer	0.39
ADDITOL™ XL 123N	Flow & leveling	0.49
ADDITOL™ VXL 4951N	Defoamer	0.39
ADDITOL™ XL 6531	Air release additive	0.20
N-propanol	Potlife extension	3.91
Butyl acetate		0.98
PART B		
ACURE™ 500	Blocked base catalyst	2.93

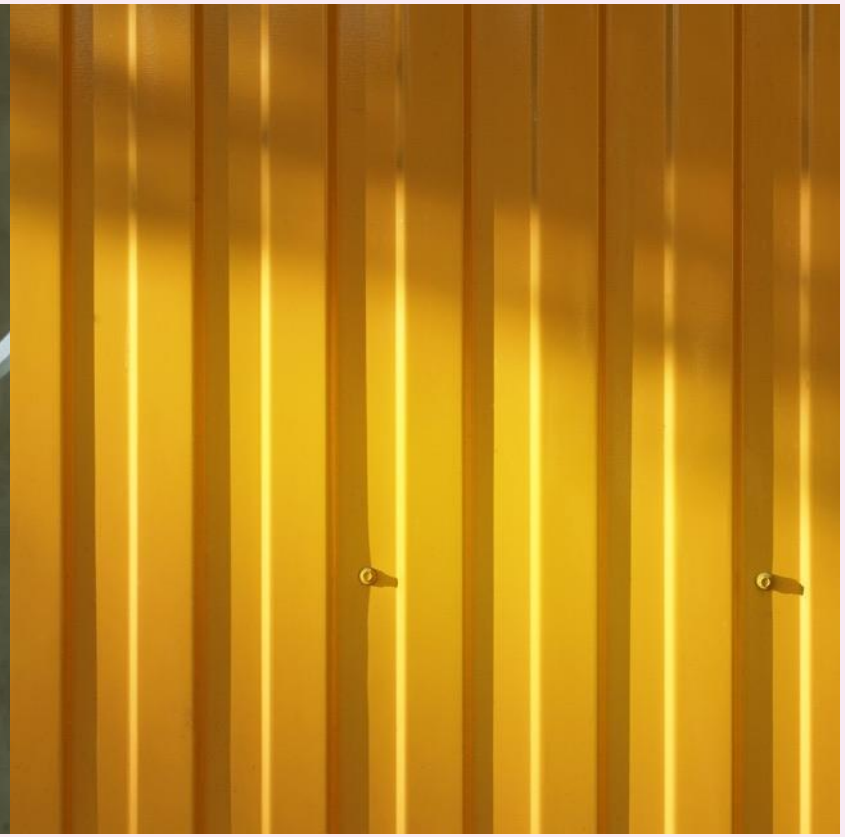
KEY FIGURES:
stoichiometry A/D = 1.0
0.47 cat. eq. succinimide
SC = 91.8%

REDUCING AIR EMISSIONS

Ultra-high solids topcoat for primed metal applications

PERFORMANCE CHARACTERISTICS

König hardness at 2 hours	30 seconds
König hardness at 1 day	50 seconds
König hardness at 1 week	90 seconds
Tack-free time	40 minutes
Pot life	4 hours



- Ambient cure
- Excellent adhesion to epoxy primers
- Outstanding weathering resistance

BRINGING IN BIOBASED

Pathways to higher biobased content

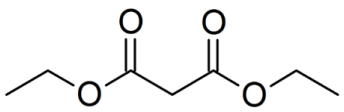
Polyester-based resins allow for easy incorporation of biomass-derived monomers/oligomers

Aim
Develop malonated polyesters with significant BB content, having similar or better performance as benchmark petro-based products

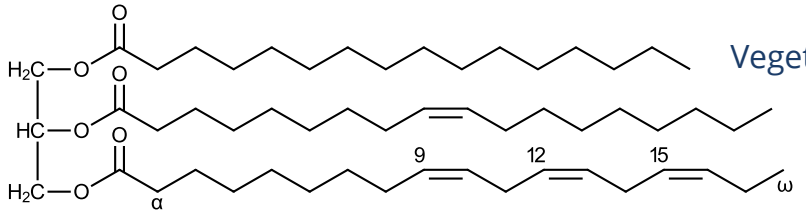
Two approaches

1
Drop-in monomer replacement by BB version

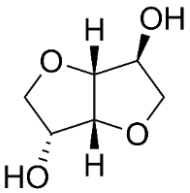
2
Alternative BB monomers



Bio-DEM™



Vegetable oils/fatty acids



Isosorbide

Potential biomass content in RMA resin products:

Drop in: malonate binders: 41–77% (bioDEM + partly biobased polyols) or 70-93% (bioDEM + fully biobased polyols)

New binders: up to 85–90% (bioDEM + fully biobased polyols)

BB FORMULATION AND PERFORMANCE

	Weight (g)
Mill base	
Ditrimethylolpropane tetraacrylate	238.7
Dispersing agent	36.3
Kronos® 2310 TiO_2 pigment	725
Total	1000
Component 1	
MPE Ref (85 wt% in BuAc)	302.9
Ditrimethylolpropane tetraacrylate	29.3
Mill base	588.9
Succinimide	2.1
n-Propanol	21.3
Butyl acetate	21.3
ADDITOL® XL 123 N surface additive	2.6
ADDITOL® VXL 4951 N defoamer	4.3
Light stabilizer	4.3
Component 2	
Carbonate-blocked base (in solution)	23.0
Total	1000
Butyl acetate until spray viscosity	± 45
Paint characteristics	
Solids content (at spray viscosity)	84.3 wt%
PVC	20.3%
VOC (theoretical)	210 g/L
Spray viscosity	26 s DIN-4, 23 °C

Resin	BB content potential [%] [1]	Tack-free time [min]	Persoz hardness (1 d, 60 µm) [s]	appearance (visual) [2]	wet adhesion on epoxy primer [3] [% delam. (ISO score)]
MPE Ref	50	60	143	++	0 (0)
MPE BB 1	63	65	142	+/-	10 (2)
MPE BB 2	58	40	130	+	15 (2)
MPE BB 3	49	n.d.	130	++	40 (4)
MPE BB 4	56	58	133	++	3 (0-1)

[1] (potentially) BB monomers: isosorbide, succinic acid, vegetable oils, diethyl malonate and partially BB glycols

[2] ++ = excellent, + = good, +/- = acceptable, - = not acceptable, -- = poor

[3] percentage of delamination upon cross-hatch adhesion testing performed after 4 weeks of exposure in a Quick Condensation Testing apparatus

MPE BB 4

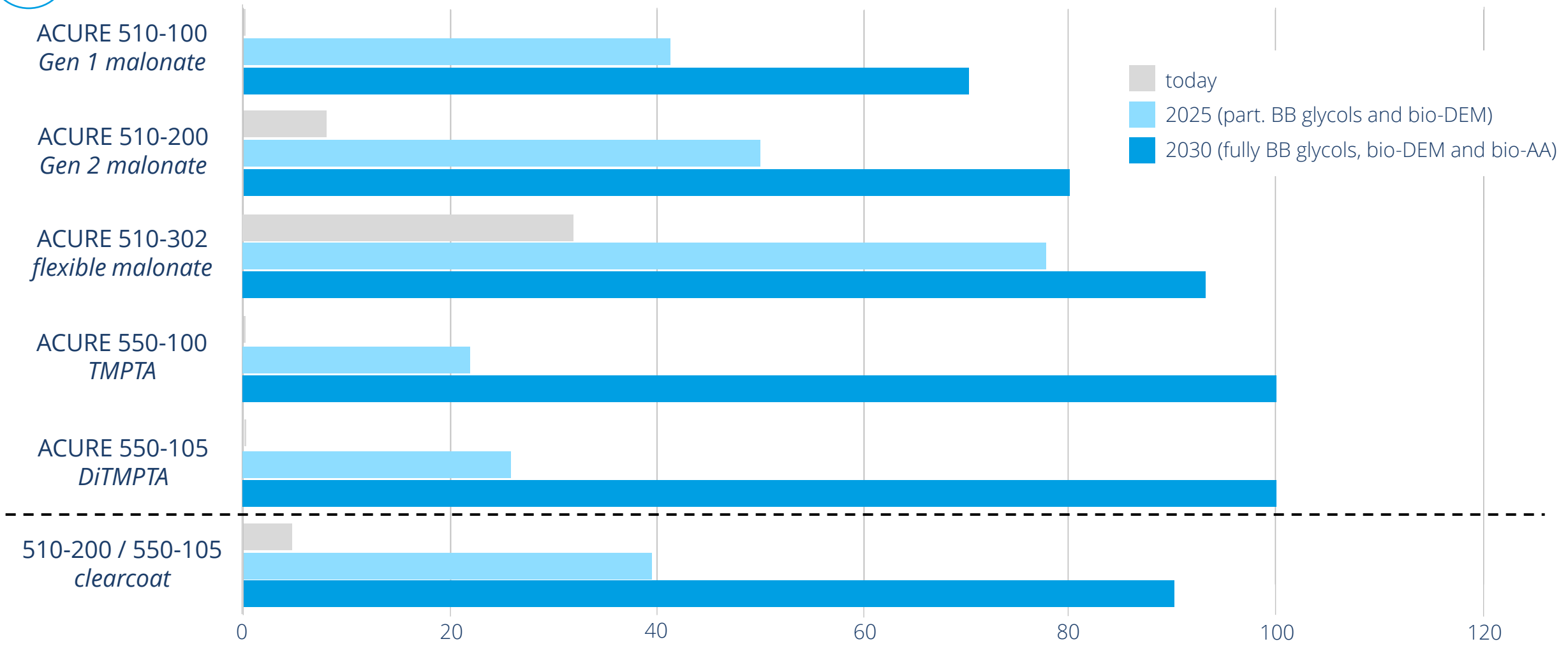
substrate: baked epoxy primer

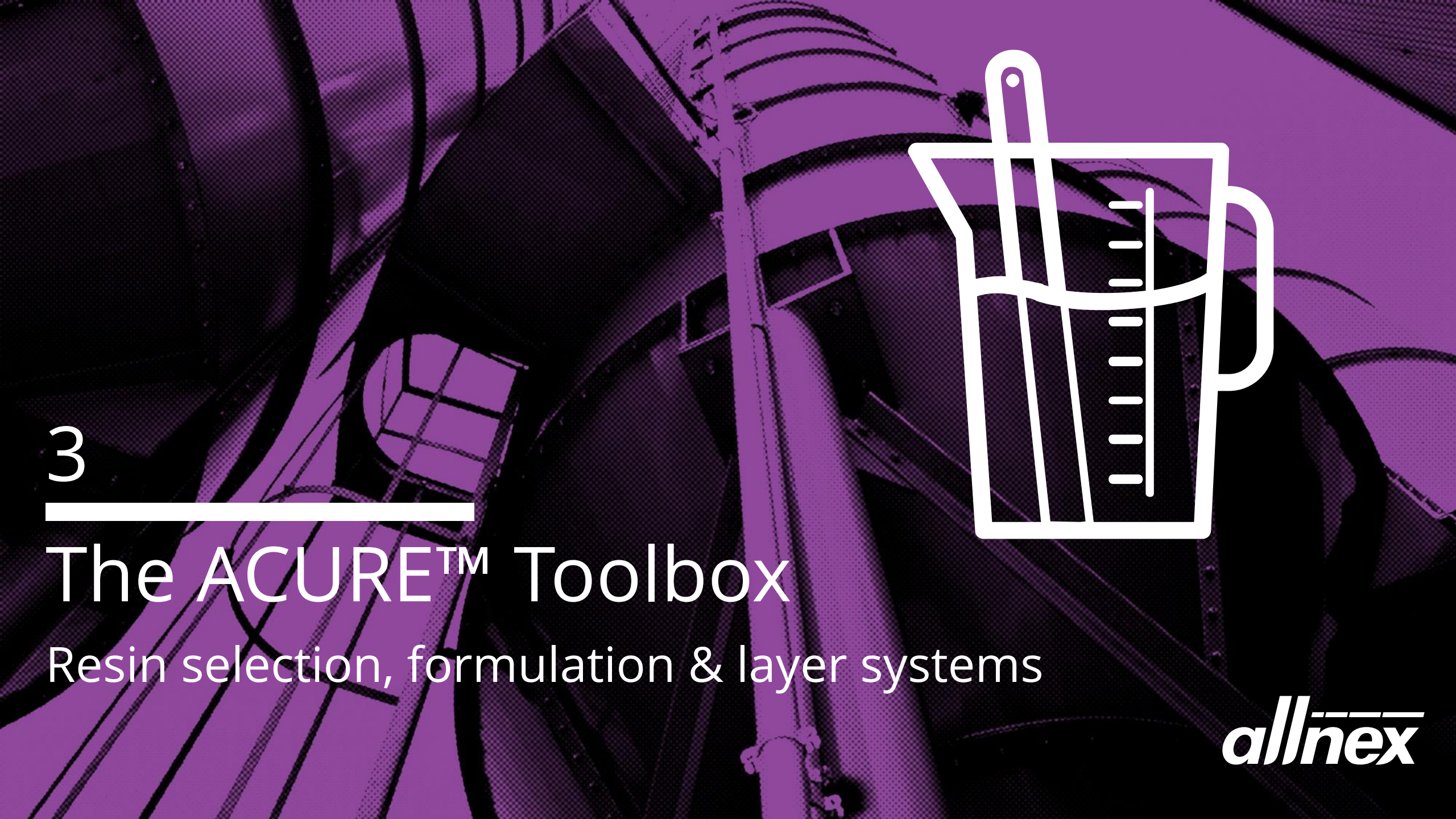
- excellent wet adhesion on epoxy and good hardness development
- BB resin performance on par with current best reference

Source: J. Coat. Technol. Res. 17, p.1123–1130 (2020)

THE GREEN ROAD AHEAD

Potential renewable content in ACURE™ binders [wt%]





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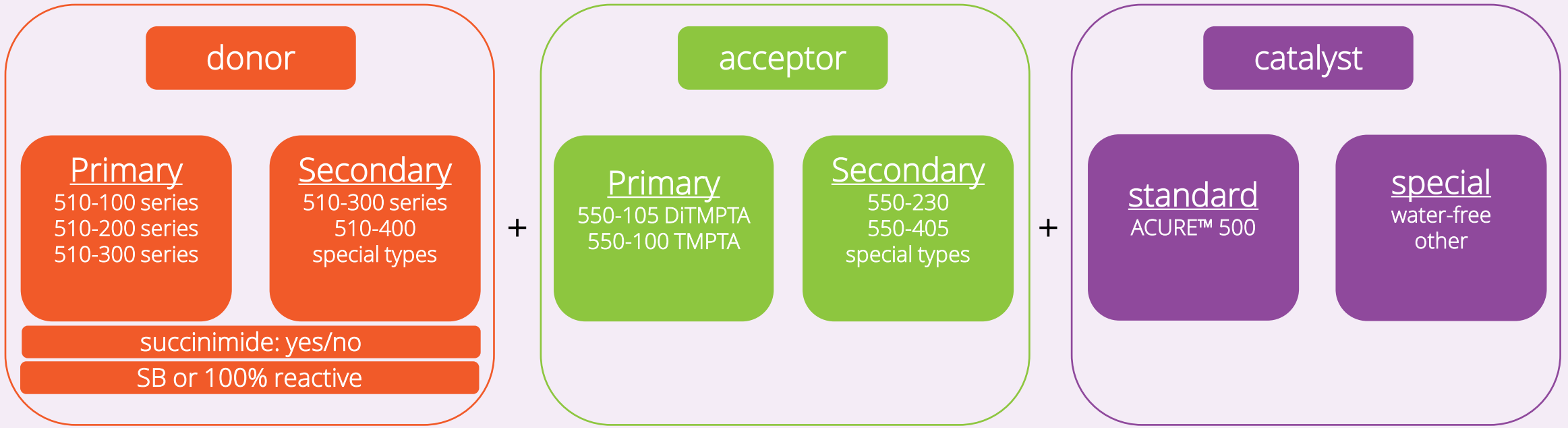
The ACURE™ Toolbox

Resin selection, formulation & layer systems

EXPLORING ACURE™ FORMULATION SPACE

- Toolbox approach to cover a wide range of application fields
- Primary ACURE™ components: **donor**, **acceptor** & **catalyst**
- Toolbox options: **new primary** and **secondary** binders, **succinimide** and **solvent** content, layer configurations using **primer** / **sealer**



ACURE™ DONOR RESINS

- Platform of 3 versatile, primary malonate binders
- Available with or without succinimide
- 100 % reactive versions also available (DEM as a solvent)

Binder series	Key characteristics	Base resin for…
ACURE™ 510-100	Very fast drying; excellent durability	Primed metal, flooring
ACURE™ 510-200	Adhesion robustness; higher XLD; excellent appearance; low viscosity	(Primed) metal, wood
ACURE™ 510-300	Flexibility; excellent appearance and adhesion; 100% reactive	Flooring, wood

- Secondary binders include:
  - low EQW binders for super-fast drying and improved hardness
  - self-matting versions of ACURE 510-170 and 510-200
  - customer specific experimental grades with improved gloss, adhesion to specific substrates, bio content

ACURE™ ACCEPTOR RESINS

- Special, super-low acid content grades developed specifically for ACURE™
- 100% reactive with optimized functionality

Binder	Key characteristics	functionality
ACURE™ 550-100	TMPTA: good cure response; very low viscosity; economic	3
ACURE™ 550-105	DiTMPTA: excellent drying; hardness development; favourable EH&S profile	4

- Secondary binders include:
  - urethane and epoxy acrylates for improved adhesion: ACURE 550-405
  - flexibilized types to tune property balance: ACURE 550-230
  - improved hardness and appearance, e.g. acrylic acrylate: ACURE 550-200
  - self-matting versions of both main binders

ACURE™ CATALYSTS

- Carbonate-blocked TBAH base catalysts for optimal potlife
- Afford rapid drying upon deblocking (moderated with primary alcohols and succinimide)

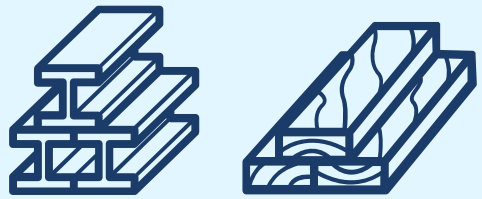
Binder	Key characteristics	EQW [g/Eq]
ACURE™ 500	Main catalyst with broad applicability	1077
ACURE™ 540	Water-free catalyst; enables use of e.g. aminosilanes in 2K configuration	1244

- Experimental types include:
  - increased carbonate content
  - higher flash point

New

ACURE™ COMPATIBLE PRIMERS AND SEALERS

- Various types of primers are suitable, incl. epoxy-amine, Ketac, 2k PU (WOD and WOW)
- On acidic substrates (e.g. wood, putty, WB basecoat), Ketac or a 1K acrylic can be used as sealers



Primer / sealer system	Features	products
Easy Cure epoxy-amine	Excellent adhesion; fast recoat; high solids	WB: BECKOPOX™ EP2384 + BECKOCURE™ EH 2261 SB: BECKOPOX™ 2688/80MEK + BECKOCURE™ 2240/70MP
Standard epoxy-amine	Excellent anti-corrosion; good adhesion	BECKOPOX™ EP 301/75X + BECKOPOX™ EH 651/70X
Ketimine - Acetoacetate	Very fast ambient dry; W-o-W; excellent blocking of acidic species (incl. tannins); adhesion; flexibility	KETAC: SETAL® 7205 BA-86 + SETALUX® 7006 SS-65
1K Acrylic	Fast drying; good blocking of acidic species; early sandability	MACRYNAL® SN 2770/33BAC

EXAMPLE 1 – HIGH-GLOSS TOPCOAT ON EPOXY PRIMER

Requirements

- dry time < 1 hr, tunable open time
- excellent dry and wet adhesion
- good early hardness / imprinting resistance

Resin and catalyst selection

DONOR	ACCEPTOR	CATALYST
primary: ACURE™ 510-200 / -270 secondary: ACURE™ 510-174 (20-70%)	primary: ACURE™ 550-105 secondary: ACURE™ 550-405 (15-30%)	ACURE™ 500
2nd generation donor combined with low EQW binder for early hardness	*DiTMPTA mixed with urethane acrylate for improved adhesion*	*Standard carbonate blocked ACURE catalyst based on TBAH*

EXAMPLE 1 – HIGH-GLOSS TOPCOAT ON EPOXY

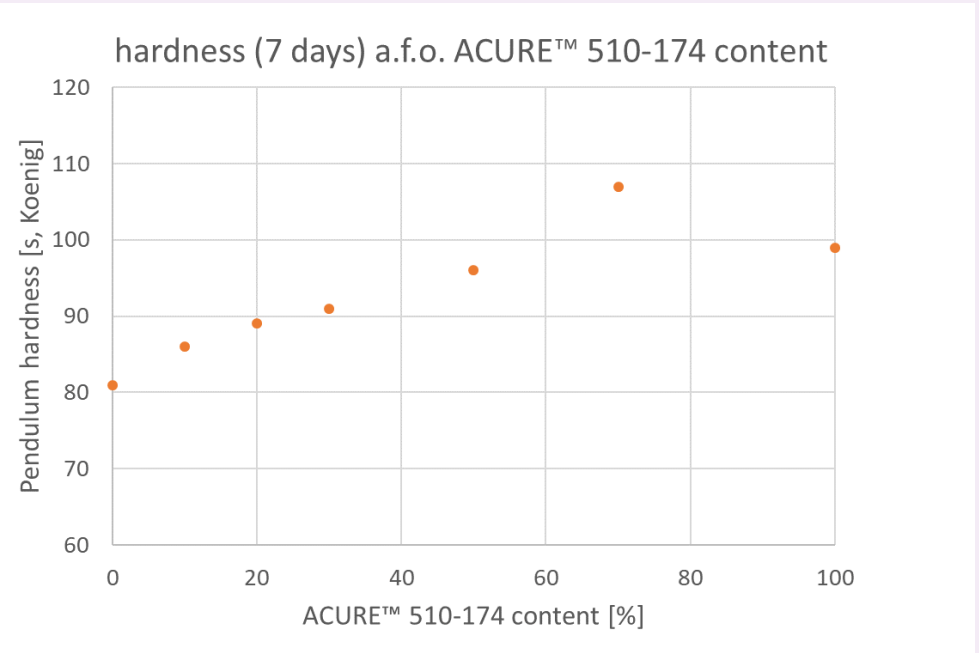
	Weight	Function
Mill base		
ACURE 550-105	30.06	acryloyl functional resin
ADDITOL® XL 6592 (80 % in MPA*)	1.35	dispersing additive
ADDITOL VXL 4951 N	0.67	defoamer
ADDITOL XL 6531	0.34	air release additive
Kronos 2310	67.58	pigment
grind until < 10 µm, keep temperature < 40 °C		
	100.00	
Component 1		
ACURE 510-200	21.98	malonate functional resin
ACURE 510-270 **	6.83	malonate functional resin
Mill base	65.04	
n-propanol	2.20	
Butyl acetate	0.88	
Mix and add:		
ADDITOL XL 123 N	0.26	surface additive
Tinuvin 292	0.44	light stabilizer
Component 2		
ACURE 500	2.37	catalyst
Total	100.00	
Butyl acetate until spray viscosity	± 8.0	

REC22048
white topcoat

Tack Free: 50-60 min
König 7 days: 82 sec
Potlife: 4 hours

%NV: 83.5%
VOC: 232 g/L

Introducing the low EQW ACURE™ 510-174



- dry time: 30-45 minutes
- hardness and dry speed tunable
- enhanced mechanical and chemical resistances
- robust dry and wet adhesion retained on epoxy primer

EXAMPLE 2A – FAST-DRYING CLEARCOAT ON WOOD

Requirements

- dry time < 1 hr
- excellent drying on acidic wood
- high hardness

Formulation input
sealer required to block tannins
2nd generation donor combined with low EQW binder for hardness
DiTMPTA for excellent drying and chemical resistance

Sealer, resin and catalyst selection

SEALER	DONOR	ACCEPTOR	CATALYST
KETAC for acidic wood or 1K acrylic for mildly acidic wood	primary: ACURE™ 510-200 / -270 secondary: ACURE™ 510-174 (30-50%)	primary: ACURE™ 550-105	ACURE™ 500

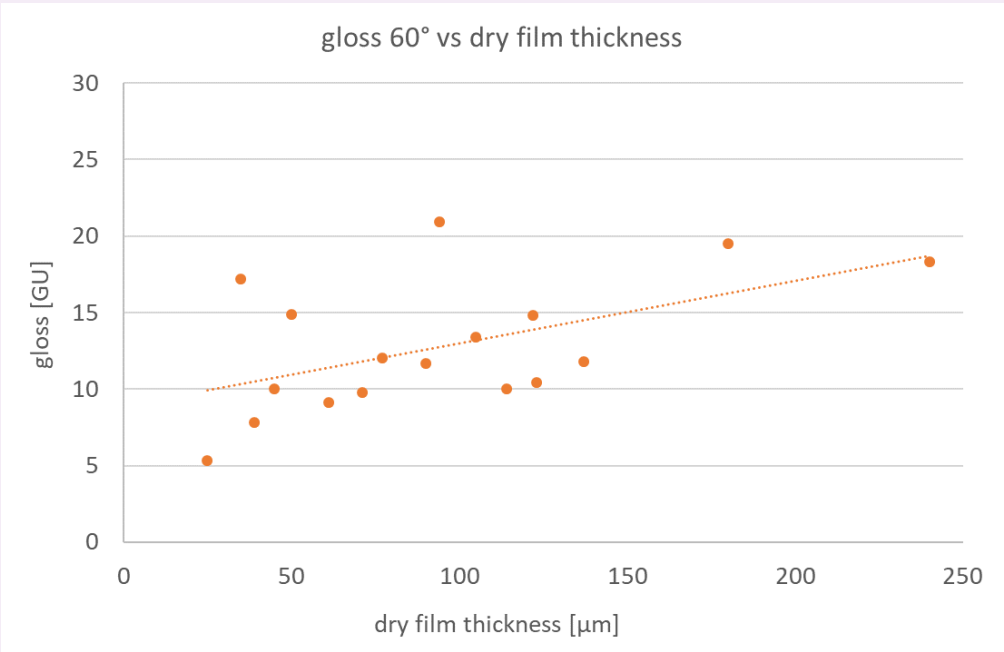
ACURE™ 510-200 / -270 based CC on 1K acrylic sealer; TFT = 35 min.

- effective blocking of tannins; dry time of ACURE™ CC: 30-50 min.
- high gloss finish
- hardness and resistances increase with 510-174 content
- broad range of non-volatile contents possible

EXAMPLE 2B - MATTING ACURE™ CLEARCOATS

Wood CC market is predominantly (very) low gloss

- matting high solids paint is not trivial
- commonly used matting agents may be acidic → drying retardation
- high loading of matting agents may compromise economic feasibility



Novel self-matting technology

- self-matting versions of main ACURE™ binders available
- gloss level may be tuned by combining with standard binder
- no cure retardation observed
- no detrimental effects on resistances or adhesion
- stable matting effect a.f.o. film thickness

EXAMPLE 3 – ULTRA HIGH SOLIDS CLEARCOAT ON CONCRETE

Requirements

- fast drying, with good tie-in
- very low VOC
- fast return to service

Formulation input
100% reactive main binder with low EQW binder for speed and hardness
DiTMPTA for excellent drying with standard ACURE™ 500 catalyst

Resin and catalyst selection

DONOR	ACCEPTOR	CATALYST
primary: ACURE™ 510-172 or 510-372 secondary: ACURE™ 510-400* or 510-176	primary: ACURE™ 550-105	ACURE™ 500

** not REACH registered, compliant alternatives available on request*

	Component	Function	wt%
PART A	**ACURE™ 550-105**	Acceptor resin	41.15
	ADDITOL™ XL 6507	Defoamer	0.74
	Modaflow® Lambda	Flow & leveling	0.74
	ACURE™ 510-372	Donor resin with succinimide	46.00
	ACURE™ 510-400	Low EQW ACAC donor resin	5.04
	Tinuvin 292	Light stabilizer	0.95
PART B	**ACURE™ 500**	Blocked base catalyst	5.42

KEY FIGURES:
stoichiometry A/D = 0.95
1.4 cat. eq. succinimide
SC = 95.5 %
VOC = 31 g/L

EXAMPLE 3 – ULTRA HIGH SOLIDS CLEARCOAT ON CONCRETE

Ultra-high solids CC for flooring applications

PERFORMANCE CHARACTERISTICS
(DFT 4.0 mils on Leneta chart)

Gloss (20˚)	83
Gloss (60˚)	89

Hardness at 2 hours
(DFT 4.0 mils on CRS panel)

König pendulum [seconds]	14
Martens hardness [N/mm²]	1.1

Hardness at 1 and 7 days

König pendulum [seconds]	103/127
Martens hardness [N/mm²]	63/74

Drying times [minutes]
(DFT 4.0 mils on Leneta chart)

Set-to-touch	37
Tack-free	41
Hard-dry	49
Through-dry	60

Tie-in time (lapping) [minutes] up to 20

APPEARANCE AND TIE-IN (LAPPING) PERFORMANCE (20 min.)

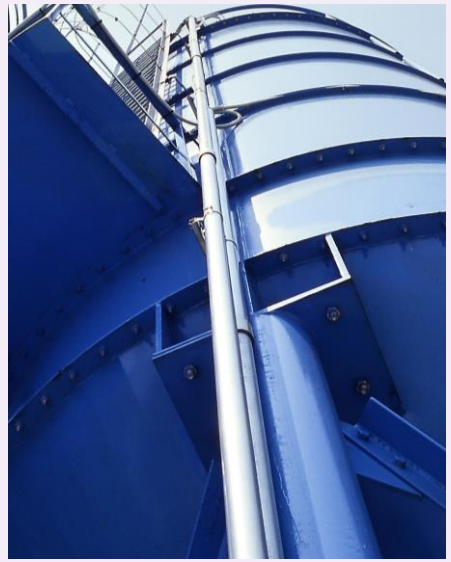
ACURE™

Premium commercial 2K polyaspartic

EXAMPLE 4 – IMPROVING DTM ADHESION

Requirements

- monocoat application
- dry and wet adhesion improvement
- formulating options to include adhesion promoters



Resin and catalyst selection

DONOR	ACCEPTOR	CATALYST
primary: ACURE™ 510-200 / -270	primary: ACURE™ 550-105 secondary: ACURE™ 550-230	ACURE™ 540

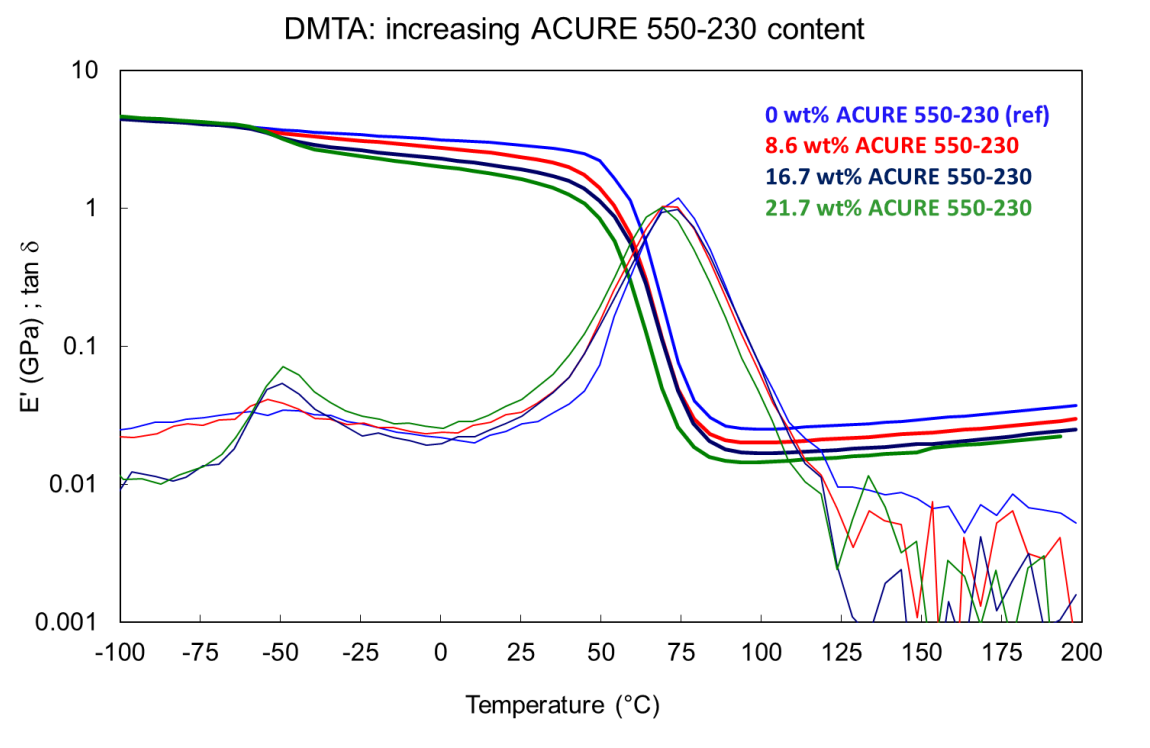
2nd generation donor combined with high EQW urethane acrylate (550-230) which provides ductility through phase separation

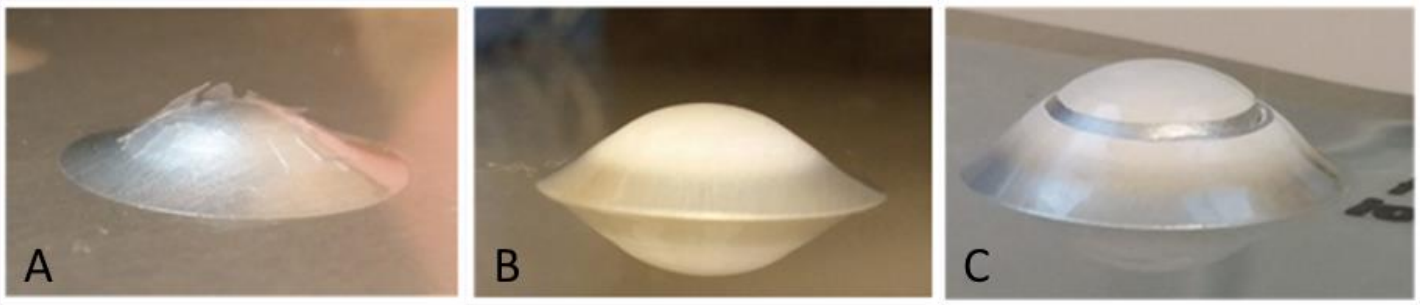
water-free catalyst enables use of aminosilane adhesion promoters

EXAMPLE 4 – IMPROVING DTM ADHESION

Improving ductility with ACURE™ 550-230

- reaction-induced phase separation
- soft phase not compatible with high M, crosslinked continuous phase
- improved ability of the coating to absorb energy and reduce/prevent crack propagation
- adhesion improvements observed over broad range of substrates, incl. epoxy primer, PU primer, E-coat, phosphated steel, cold-rolled steel and shot-blasted steel





A: Brittle failure of reference (0% 550-230) at 40 cm fall height, delamination of coating
B: Pass at 21% of 550-230 at 75 cm fall height, showing whitening, i.e. ductile deformation
C: Ductile failure at 21% 550-230 at 100 cm fall height, coating still adheres to aluminium

THE NEW ACURE™ TOOLBOX

Summary – new key ACURE™ products to improve your formulation

Enhanced adhesion (GI, ACE, Protective)	ACURE 540	water-free catalyst
	ACURE 510-200	malonated polyester
	ACURE 550-230	urethane acrylate
Ultra-high solids (Flooring, GI)	ACURE 510-172	100% reactive malonate
	ACURE 510-372	flexibilized, 100% reactive
Improved drying (Industrial Wood)	ACURE 510-174	low EQW malonate
	in conjunction with Ketac sealer	
Gloss reduction (Wood, GI)	Self-matting ACURE grades (malonates / acrylates)	

THE NEW ACURE™ TOOLBOX

ACURE - a truly sustainable coating chemistry platform

Sustainable performance - today

- Reduced energy consumption - increased productivity
- Ultra-high solids – Low VOC
- High biocontent potential and options
- Isocyanate and tin free

Formulation toolbox – in summary

- Choice between several main binders; donors, acceptors and catalysts
- Sealers and compatible primers available; application-specific layer systems
- New tools to increase adhesion robustness; acceptor resins and water-free catalyst
- The toolbox is not static and will be expanded to help you find the right solution

ENABLING YOUR NEXT SUSTAINABLE SOLUTION!

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The Ultra Fast Cure with the long pot life of ACURE™ now available in a waterborne system!

Webinar – December 1, 2022
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Register today
WEBINAR: ACURE AQ Fast Curing 2K Systems, No Popping Limit (ulprospector.com)

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THANK YOU FOR JOINING OUR WEBINAR!

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