

A close-up photograph of a hand holding a fiber optic cable. The hand is covered in multi-colored paint (red, blue, green, yellow) and has a blue and white patterned wristband. The fiber optic cable is illuminated with red and orange light, showing internal fibers. The background is dark with colorful bokeh lights in blue, green, and red.

Perstorp Cationic Offering

Perstorp in brief

- World leader in several sectors of the specialty chemicals market
- Pioneer in formalin chemistry, plastics and surface materials
- Since December 2005, Perstorp has been owned and controlled by PAI partners, a leading European private equity company
- In September 2018, Perstorp was transferred into a new investment fund managed by PAI Partners with Landmark Partners as lead investor, alongside other co-investors. In addition Landmark Partners and its co-investors have committed EUR 130 million to Perstorp for growth opportunities

1,350

EMPLOYEES

worldwide

138

YEARS

of professional
expertise

7

SITES

Perstorp
production

14.9

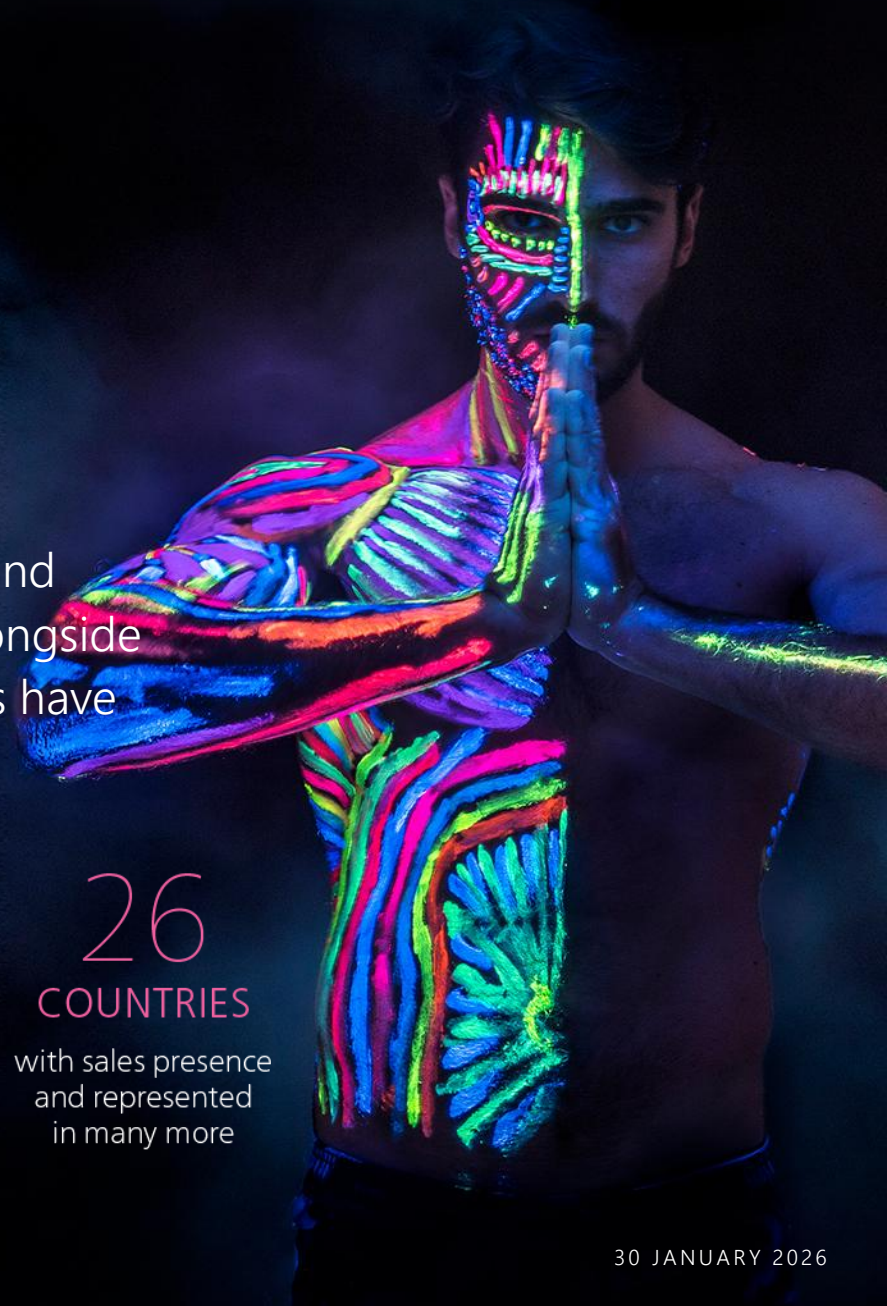
BILLION SEK

turnover in 2018

26

COUNTRIES

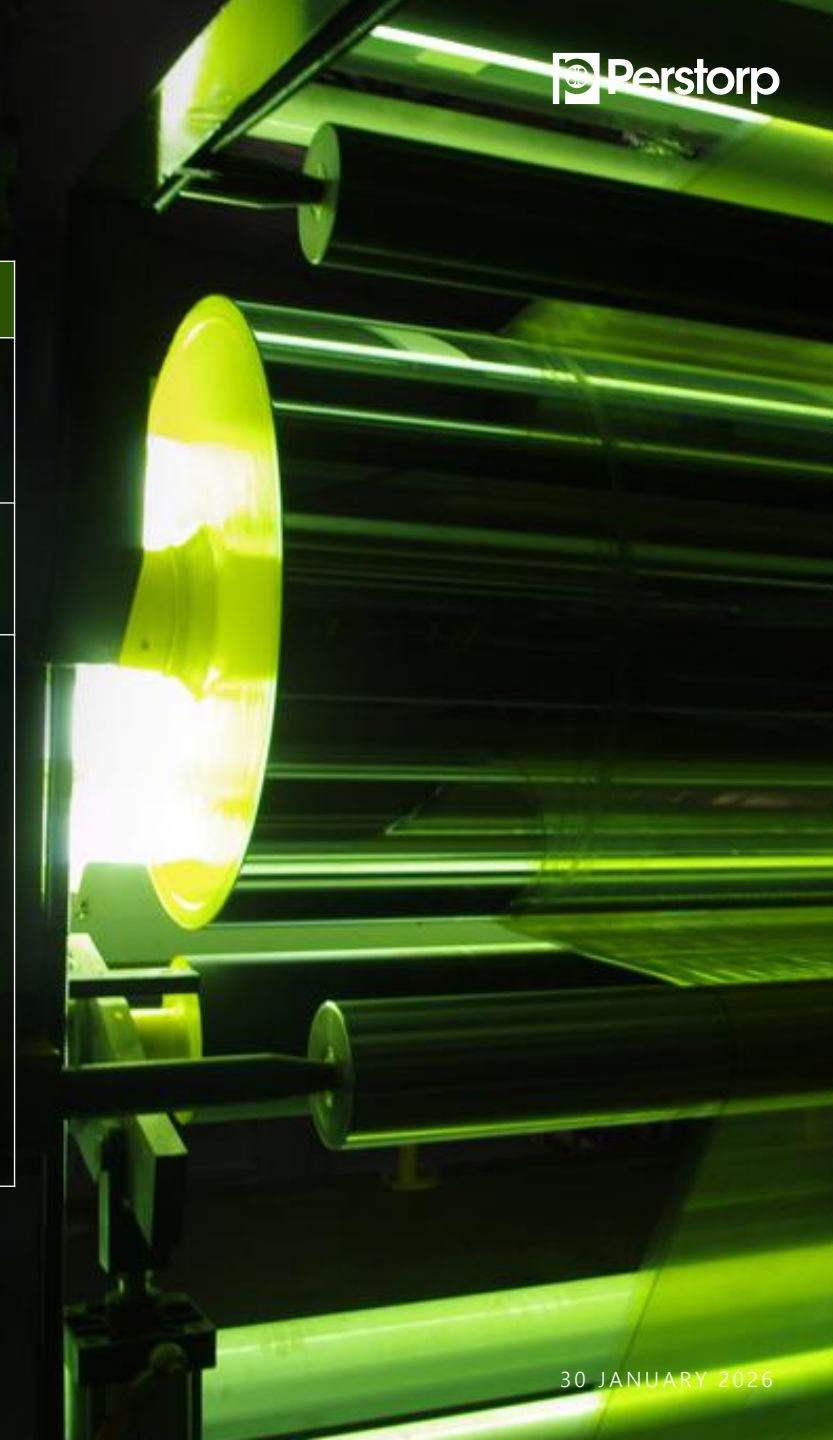
with sales presence
and represented
in many more



General introduction to Radiation curing

Different types of curing

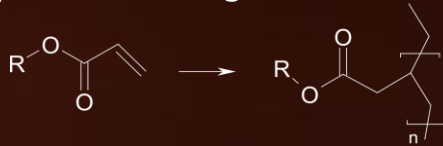
Technology	Advantages	Disadvantages
Solvent based	<ul style="list-style-type: none"> • Long history and experience • Low cost • Variety of materials 	<ul style="list-style-type: none"> • High VOC • Slow drying
Water based	<ul style="list-style-type: none"> • Seen as "safe" • Low VOC 	<ul style="list-style-type: none"> • Low solids • Slow drying
Radiation curing	<ul style="list-style-type: none"> • VOC-free - environmental friendly technology and no solvent wastes • Fast curing - higher speed in production lines • Space saving • Room temperature process - lower energy in processing • High performance & quality of finished materials (ex hardness, chemical resistance) • Versatile - solution for many applications 	<ul style="list-style-type: none"> • Often perceived as hazardous • Migration • Acrylates can have poor adhesion • Curing must be carefully controlled • Seen as high cost



Comparison of UV technologies

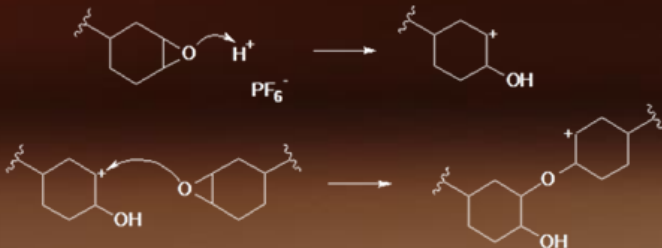
Free radical curing

- The dominant technology >95%
- A photo initiator creates a free radical when exposed to UV light



Cationic curing

- <5% of Radcure market
- A photo initiator generates an acid when exposed to UV light



Advantages	Disadvantages
<ul style="list-style-type: none"> • Speed • Low energy • High resolution 	<ul style="list-style-type: none"> • High shrinkage • Poor adhesion • Curing is inhibited by O₂ • Acrylates often are skin irritants & allergens
<ul style="list-style-type: none"> • Low shrinkage • Exceptional adhesion on difficult substrates • No O₂ inhibition • Exceptional flexibility • Low migration • Low levels of toxicity and irritation • Dark curing, offers complete curing 	<ul style="list-style-type: none"> • Curing is inhibited by humidity and amines • Limited range of raw materials



Free radical formulation

Binders

(Meth)-acrylated oligomers

[Example polyester, urethane or epoxy backbone in the oligomers]

Reactive diluents

(Meth)-acrylated monomers

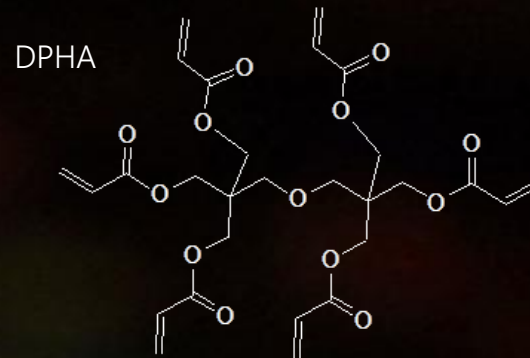
[Example HDDA, TMPTA, TPGDA, DPHA]

Photo initiator system

Additives

Pigments

Fillers

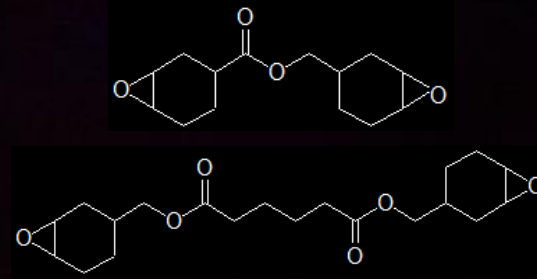


Cationic formulation

Binders

Cycloaliphatic epoxy

[Example 3,4-Epoxy cyclohexylmethyl 3,4-epoxycyclohexanecarboxylate]

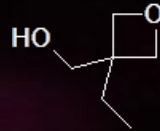


Reactive diluents

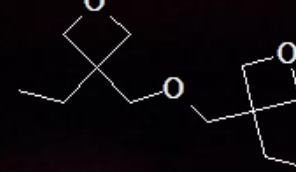
Oxetanes, epoxy monomers, vinyl ethers

[Example Curalite™ Ox and OxPlus]

Curalite™ Ox



Curalite™ OxPlus



Modifiers

Polyols

[Example Polyether polyols, Dendritic "Boltorn" polyols]

Photo initiator system

Additives

Pigments

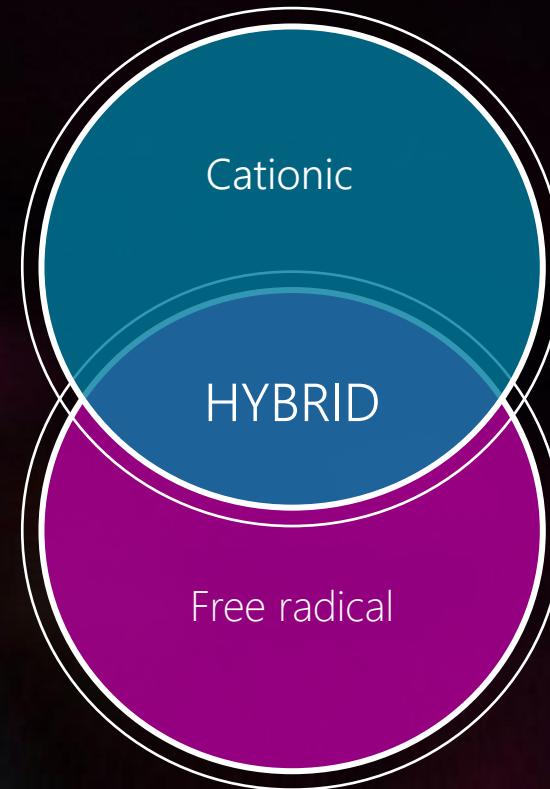
Fillers



Hybrid systems

Combination of cationic & free radical systems (Interpenetrating networks IPN)

Combine benefits of both technologies



Cationic Technology

Values and applications

Our offering for Cationic UV

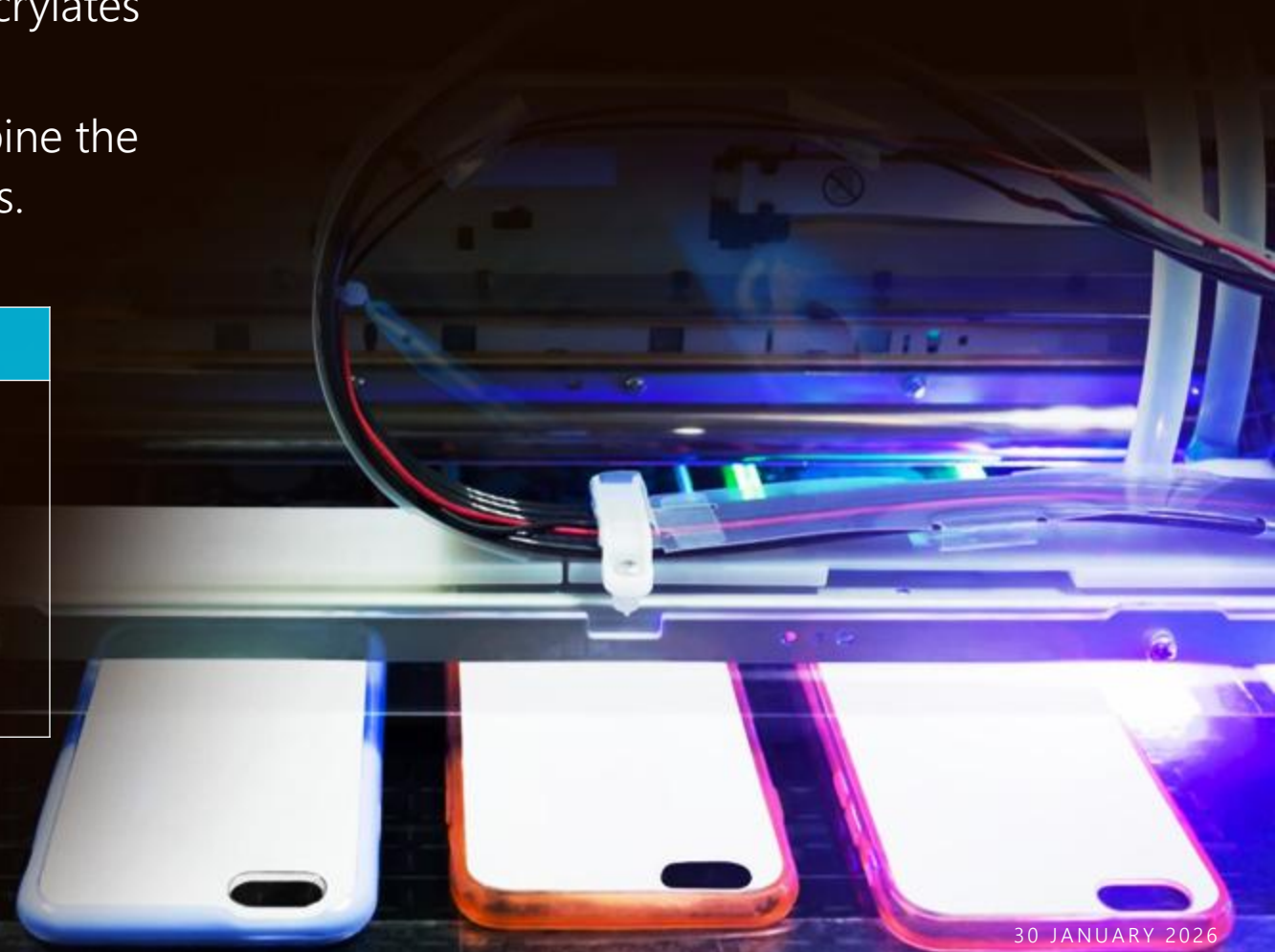


Why use Cationic

- Cationic technology is used when free radical/acrylates cannot meet the wanted properties.
- Hybrid systems can often be a solution to combine the benefits of cationic and free radical technologies.

Advantages

- + Low shrinkage
- + Exceptional adhesion on difficult substrates
- + No O₂ inhibition
- + Exceptional flexibility
- + Low migration
- + Low levels of toxicity and irritation
- + Dark curing, offers complete curing



Main applications Cationic UV curing

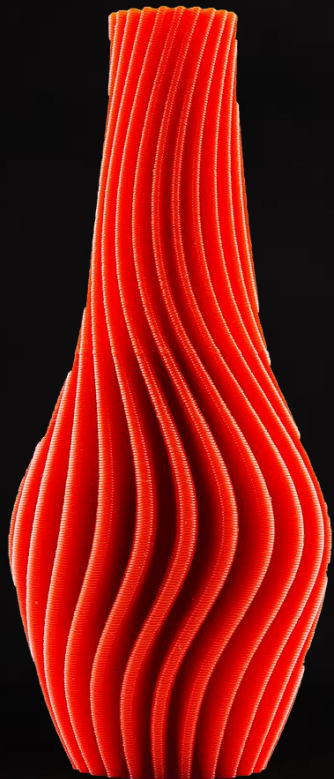


Coatings

Good adhesion on challenging substrates like metal, glass and plastic

Inks

Low migration in sensitive applications like food packaging & good adhesion on difficult substrates



3D printing

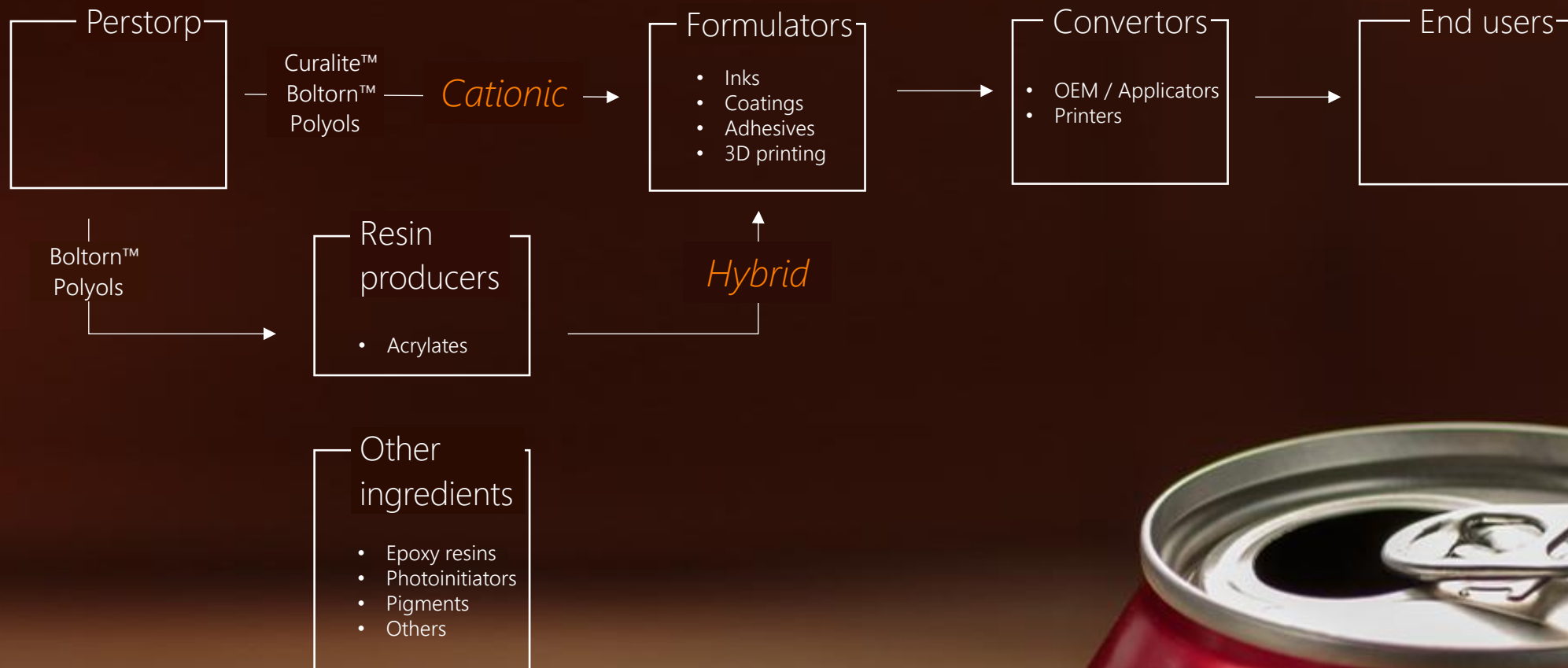
High quality prints for prototyping and manufacturing like dimensional stability and through cure

Adhesives

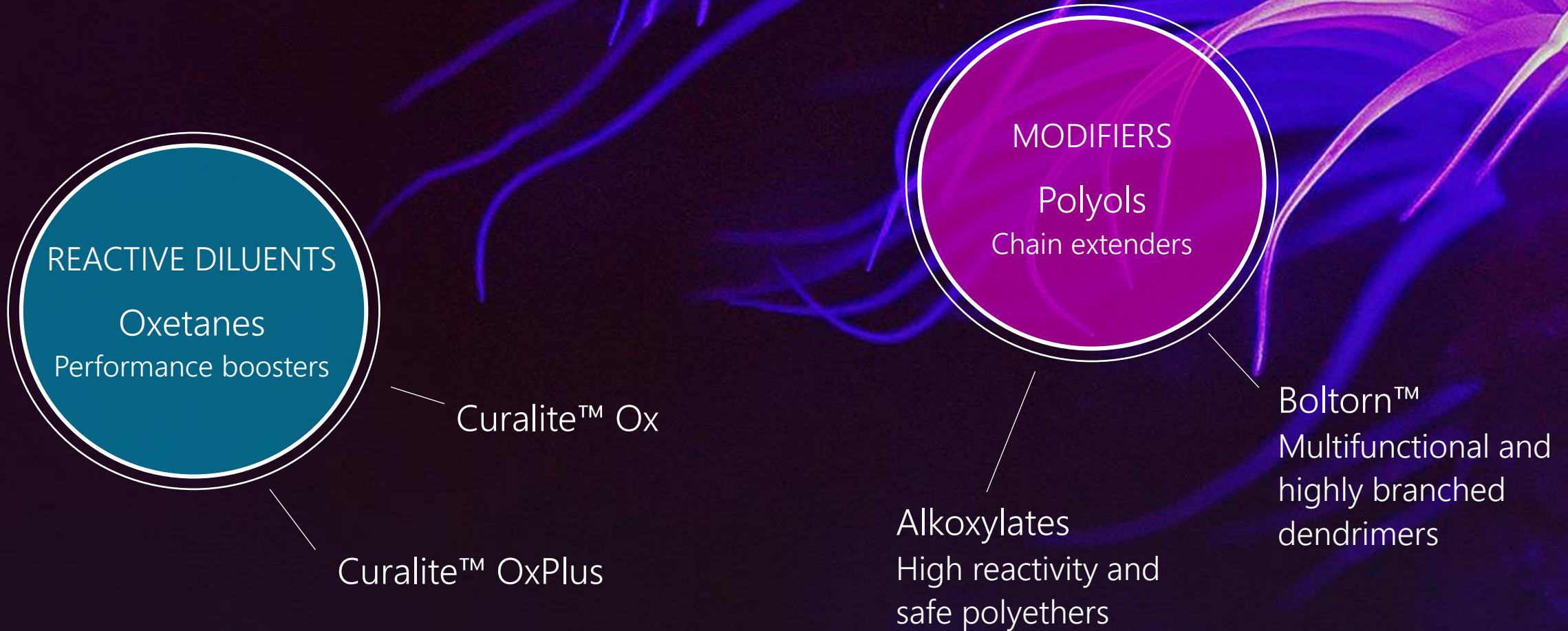
Good adhesion, flexibility and toughness



Where we support in the value chain



Product offering for Cationic technology



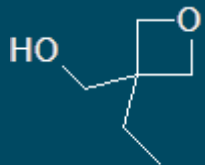
Curalite™

Designed to enhance Cationic UV Curing

- Reducing viscosity of your formulation
- Improving UV reactivity
- High surface and through cure
- No shrinkage during curing
- Colorless
- Low odor & no skin irritation

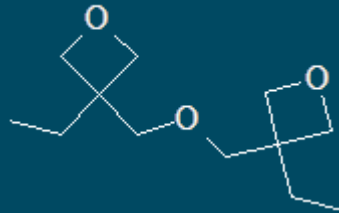
For flexibility

Curalite™ Ox



For crosslinking

Curalite™ OxPlus

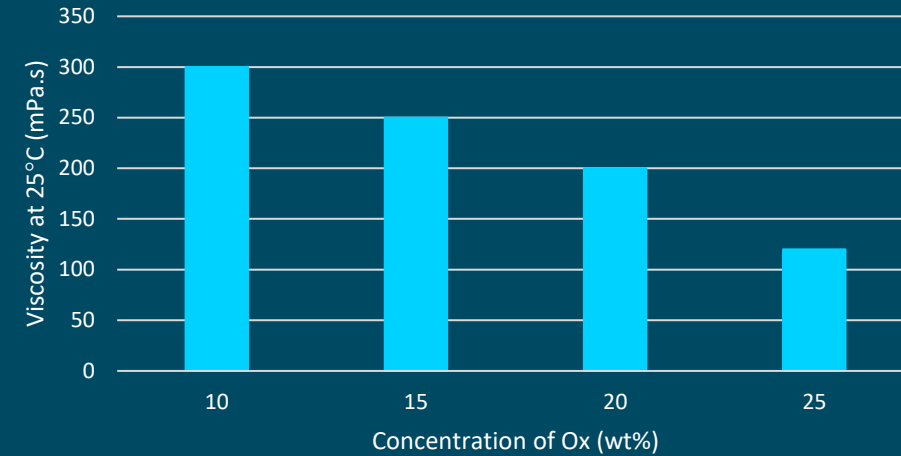


Typical properties	Curalite™ Ox	Curalite™ OxPlus
Appearance	Colorless liquid	Colorless liquid
Reactive groups	1 oxetane, 1 hydroxyl	2 oxetanes
Oxetane equivalent weight (g/eq)	116	107
Hydroxyl equivalent weight (g/eq)	116	-
Hydroxyl number (mg KOH/g)	485	-
Molecular weight (g/mol)	116	214
Viscosity at 20°C (mPa.s)	27	15
Color (APHA)	10	9
Acid number (mg KOH/g)	0,2	0,2

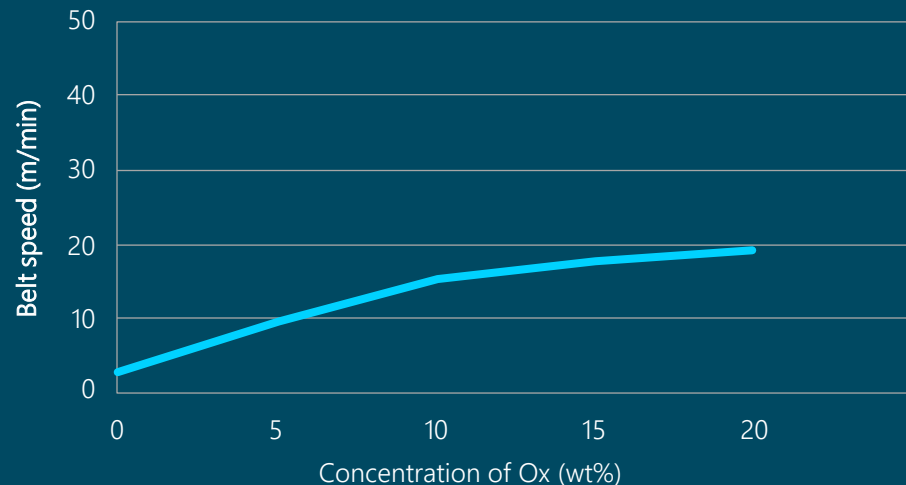
Curalite™ Ox

- Suitable in formulation in the range of 5 to 25 wt%
- Strong diluting power and increasing the reactivity
- Best performance for flexibility
- Through our Pro-Environment solutions, available as partly renewable
 - Curalite™ Pro Ox C20 – 20% renewable content
 - Curalite™ Pro Ox C50 – 50% renewable content

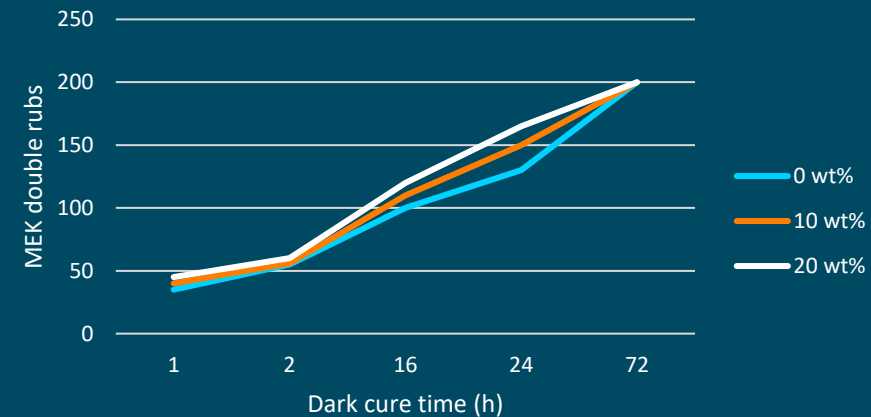
Viscosity



Surface cure (tack free)



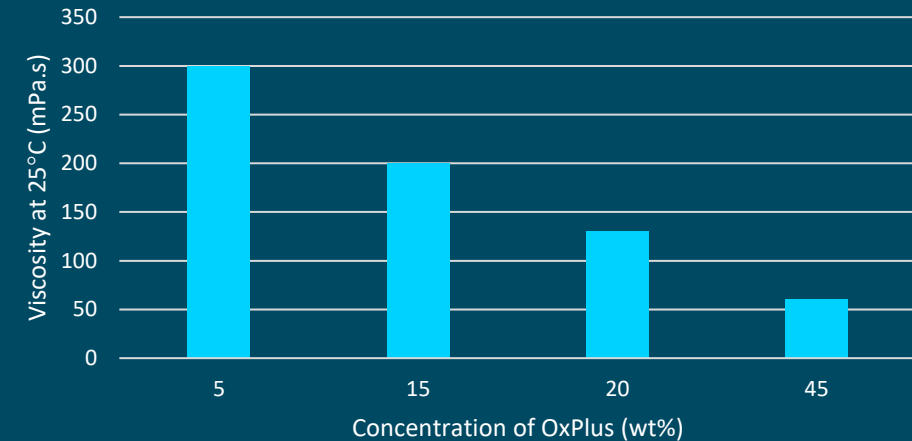
Through cure (chemical resistance)



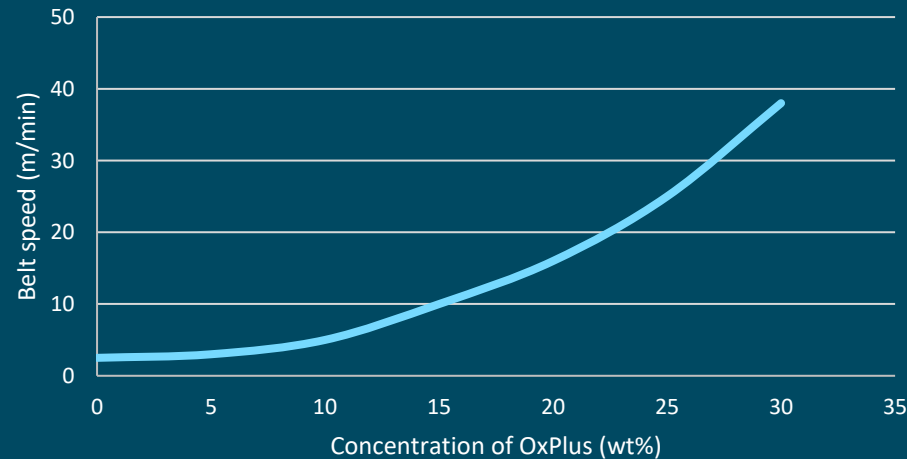
Curalite™ OxPlus

- Suitable in formulation in the range of 5 to 25 wt%
- Strong diluting power and increasing the reactivity
- A di-functional crosslinker
- Improved chemical resistance and hardness
- Less moisture sensitive compared to Curalite™ Ox

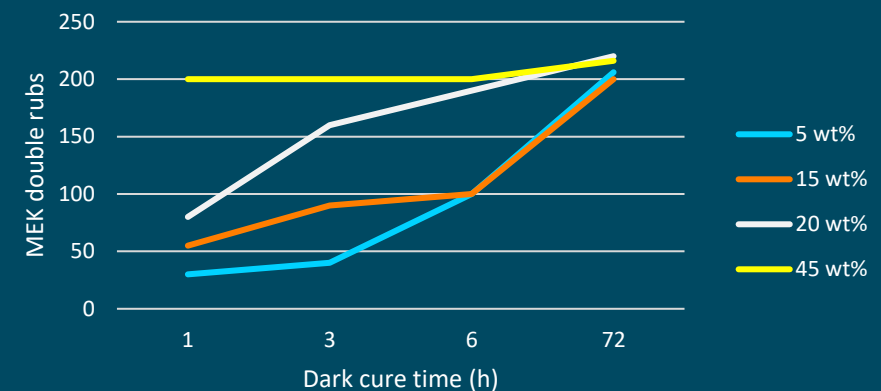
Viscosity



Surface cure (tack free)



Through cure (chemical resistance)



Curalite™ OxPlus has been formulated with cycloaliphatic epoxy and cationic photoinitiator, and cured with a Hg lamp

Curalite™

Performance & Value proposition

Performance

- Reducing viscosity of your formulation
- Improving UV reactivity
- High surface & through cure
- Reducing the Tg
- No shrinkage during curing
- Colorless
- Low odor, not skin irritating/sensitizing and very low migration as the system continues to cure after radiation



Value proposition

- Excellent dilution power
- Faster process
- Hardness & chemical resistance
- Flexibility
- Good adhesion and dimensional stability
- Transparent solutions
- Better alternative than standard free radical UV curable monomers in many applications

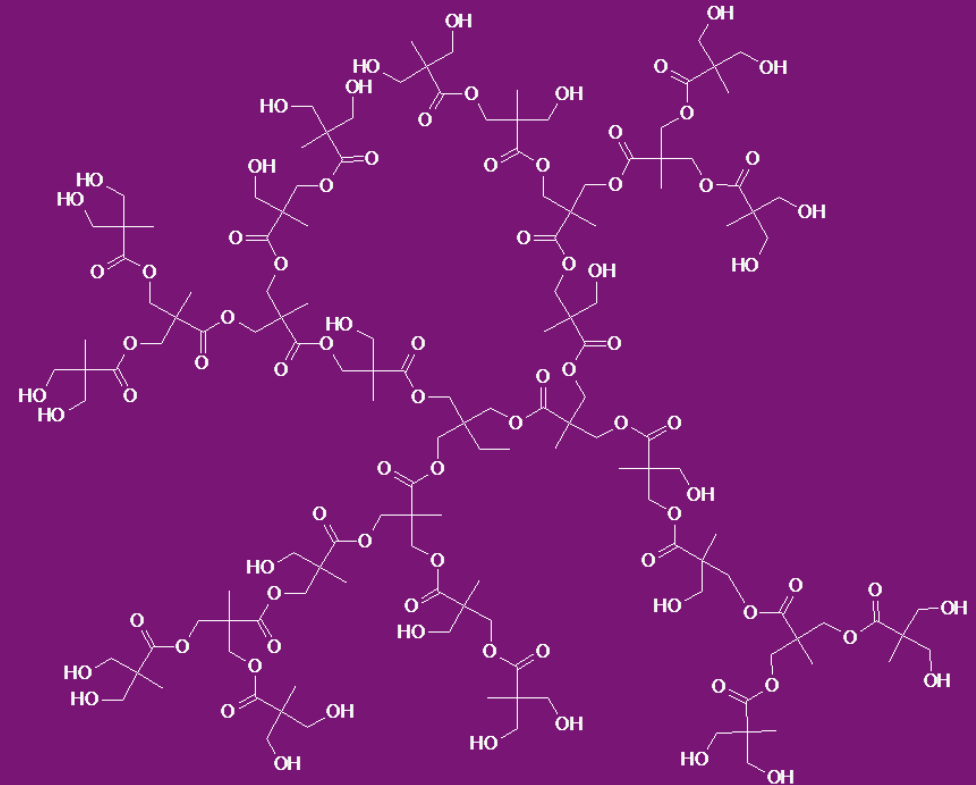
Dendritic Polymers – Boltorn™

Hyperbranched Polymers

- High functionality
- Highly branched polymer backbone

Boltorn™ H2004 recommended for

- Best effect when used in the range of 10 wt%
- Superior wear resistance
- Good flow while high functionality
- Improved flexibility
- High crosslinking
- Good chemical resistance



More Boltorn™ grades available to tailor-make your formulation

Polyether polyols

Broad offer in polyols for cationic formulations

- Di-, tri-, tetra- and hexa-functional polyols
- Ether bonds

Tailored properties

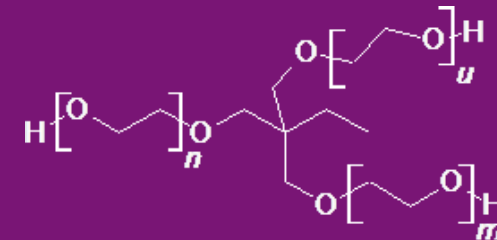
- Changing polyol and the ratio between epoxide/oxetane and polyol

Many grades allowing freedom to formulate

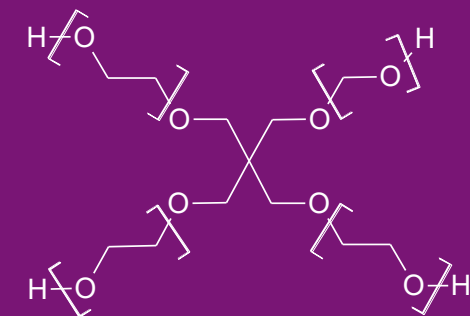
Difunctional propoxylated polyol



Trifunctional ethoxylated polyol



Tetrafunctional ethoxylated polyol



Other application areas

Curalite™

Oxetane chemistry advantages

High reactivity ingredient & powerful diluent offering possibility to explore other areas of use

- Efficient **curing agent** in cationic curing, thanks to its easy ring opening in presence of certain Lewis or Brönsted acid
- Powerful **reactive diluent**, allowing e.g. incorporation of inorganic materials like certain pigments
 - Advantages: low odor and no skin irritation, as well as low volatility vs many other (reactive) diluents
- Used as an **intermediate** e.g. in the production of stabilizers for many plastics like PC, PBT PVC
- Used in **formulations** e.g.:
 - As acid scavenger
 - In the production of casting molds for metal industry (foundry resins)

Lower acidity
than epoxy
pKa -2,02



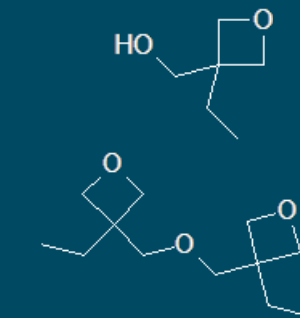
Allows easy ring opening

Lower ring-strain
than epoxy
106,7 kJ/mol



Stability vs epoxy

High thermal
stability



Multiple functionalities

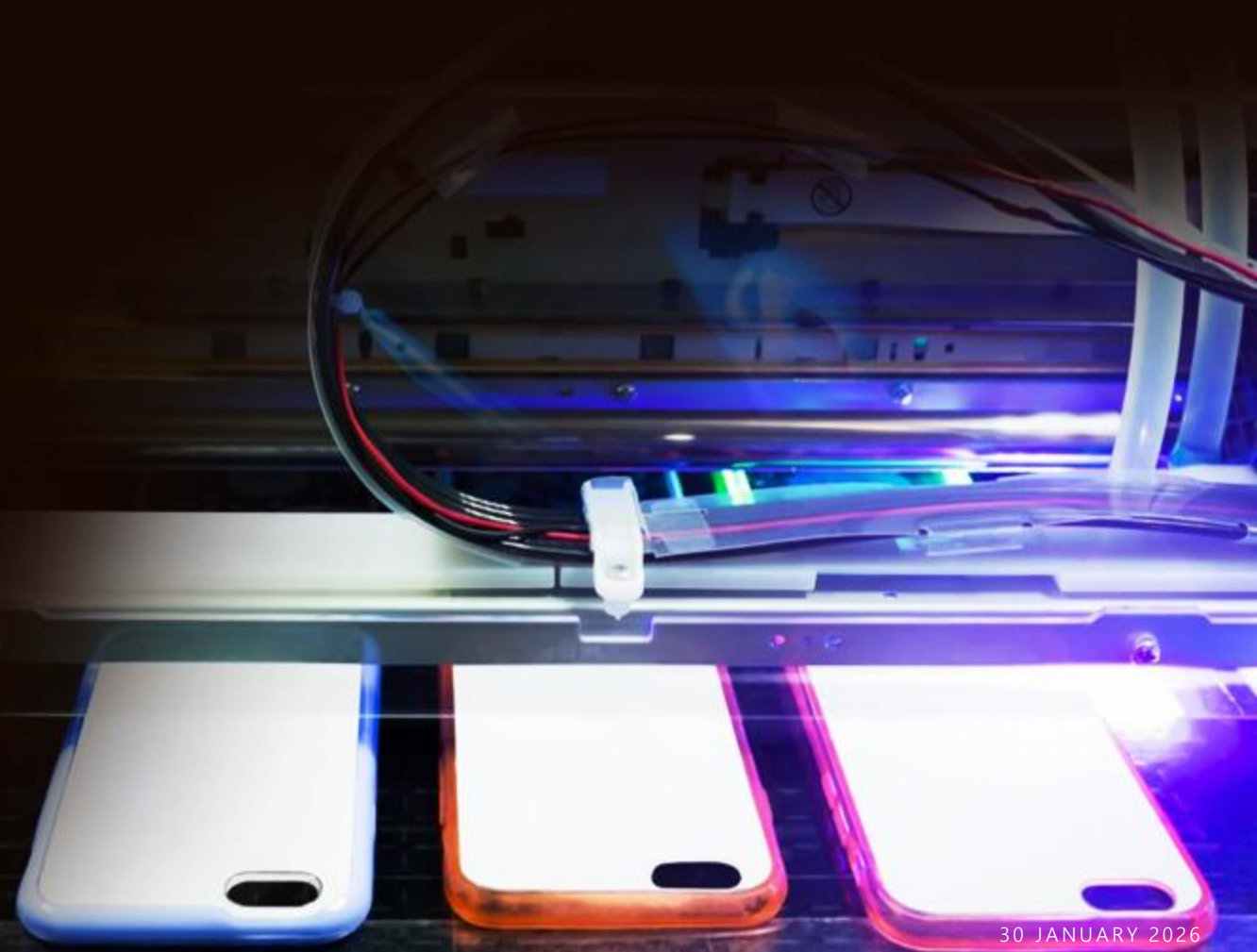
	Curalite™ Ox	Curalite™ OxPlus
Boiling point (°C)	220	119
Flash point (°C)	106	144
Viscosity (mPa.s) @20°C	27	15



Appendix

For your reference

- Products are available on all major markets
- Available documentation
 - TDS
 - SDS
 - Technical Information Leaflets
 - Perstorp products for cationic radiation curing (TI 0128)
 - Oxetanes, Basic information on their chemistry & application to UV cationic curing (TI 0134)
 - Cationic UV screen ink formulations (TI 0136)
 - Cationic UV flexographic ink formulations (TI 0138)
 - Cationic UV overprint varnish formulations (TI 0140)



EXAMPLES OF Cationic on challenging substrates

Plastics

- Polyethylene
- Oriented Polypropylene
- Polyester
- Polyacrylate
- Polycarbonate
- Polystyrene
- Polyvinyl Chloride
- Acrylonitrile-Butadiene-Styrene
- Thermoplastic Polyurethane
- Polyamide

Metals

- Aluminium
- Tin-plate
- Tin-free steel