Perstorp Cationic Offering

Perstorp

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

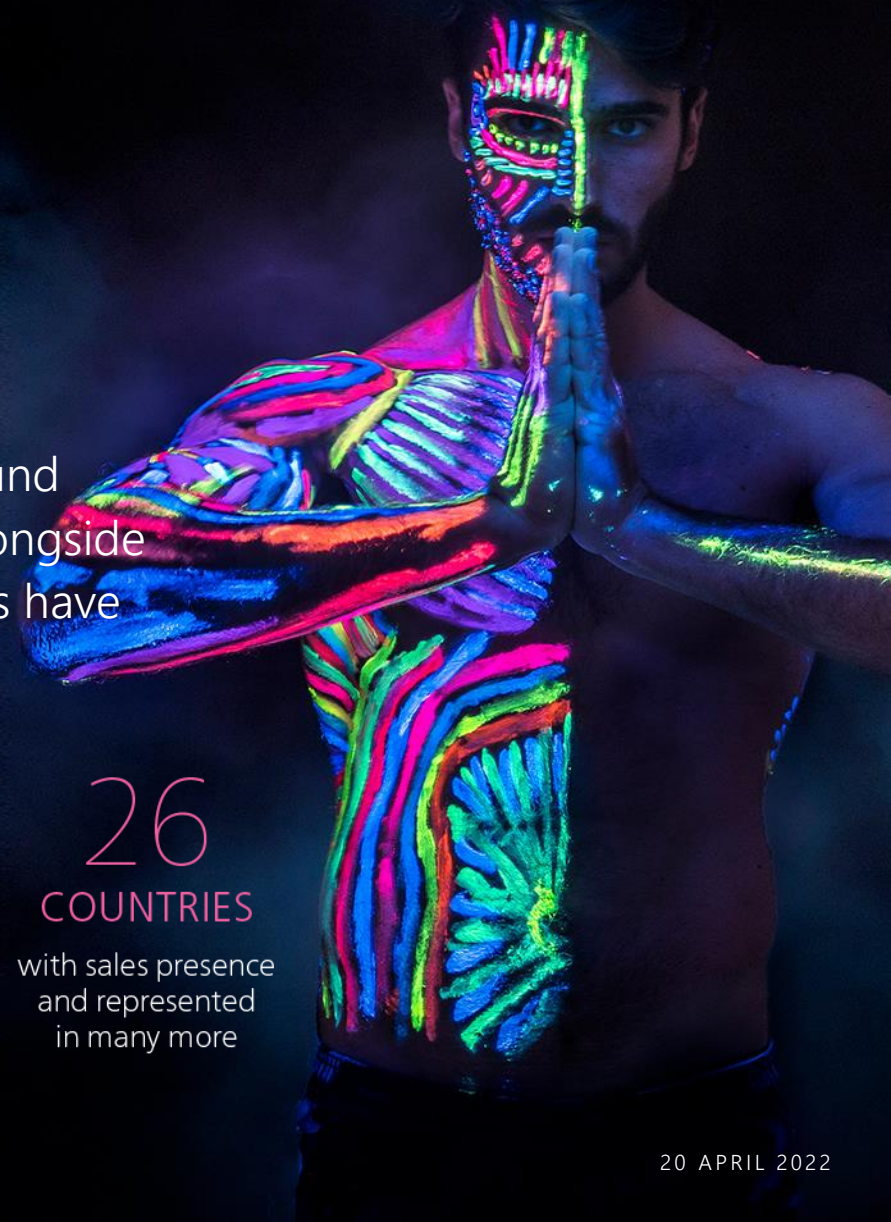
1,350
EMPLOYEES
worldwide

138
YEARS
of professional expertise

7
SITES
Perstorp production

14.9
BILLION SEK
turnover in 2018

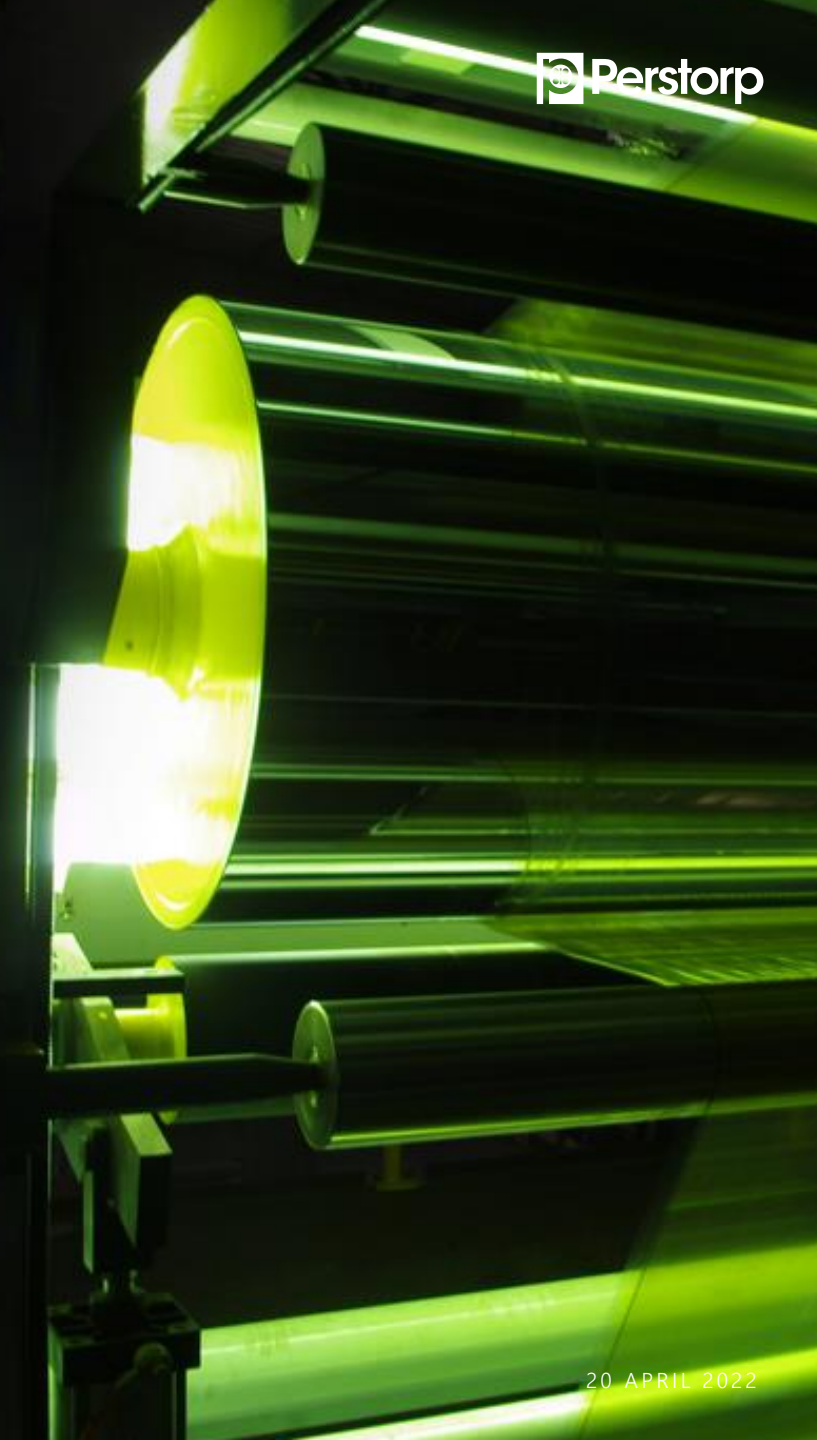
26
COUNTRIES
with sales presence and represented in many more



General introduction to Radiation curing

Different types of curing

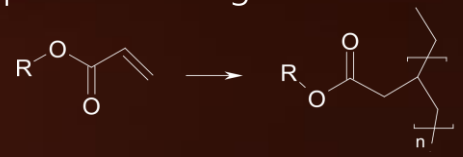
Technology	Advantages	Disadvantages
Solvent based	• Long history and experience • Low cost • Variety of materials	• High VOC • Slow drying
Water based	• Seen as “safe” • Low VOC	• Low solids • Slow drying
Radiation curing	• VOC-free - environmental friendly technology and no solvent wastes • Fast curing - 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	• Often perceived as hazardous • Migration • Acrylates can have poor adhesion • Curing must be carefully controlled • Seen as high cost



Comparison of UV technologies

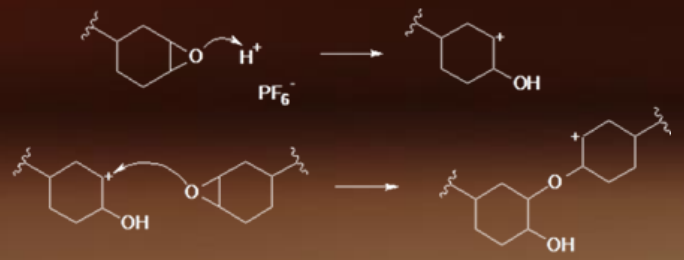
Free radical curing

- 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
• Speed • Low energy • High resolution	• High shrinkage • Poor adhesion • Curing is inhibited by O_2 • Acrylates often are skin irritants & allergens
• Low shrinkage • Exceptional adhesion on difficult substrates • No O_2 inhibition • Exceptional flexibility • Low migration • Low levels of toxicity and irritation • Dark curing, offers complete curing	• 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]

DPHA

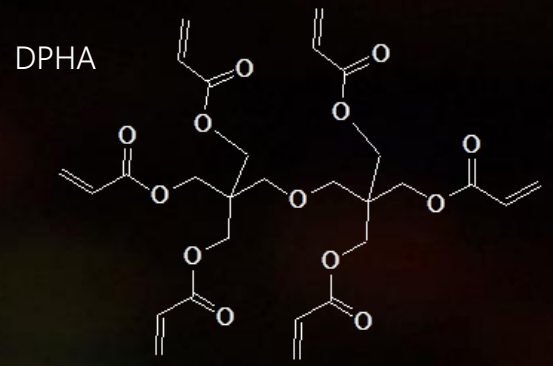


Photo initiator system

Additives

Pigments

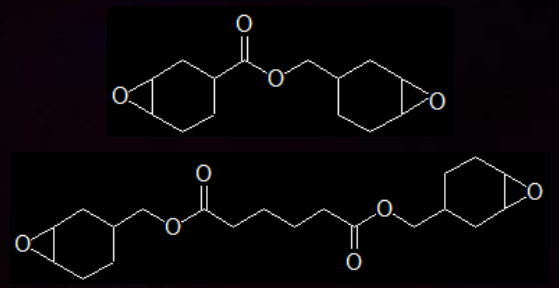
Fillers

Cationic formulation

Binders

Cycloaliphatic epoxy

[Example 3,4-Epoxycyclohexylmethyl 3,4-epoxycyclohexanecarboxylate]

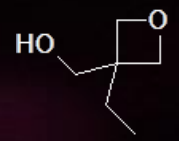


Reactive diluents

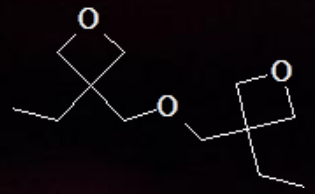
Oxetanes, epoxy monomers, vinyl ethers

[Example Curalite™ Ox and OxPlus]

Curalite™ Ox



Curalite™ OxPlus



Modifiers

Polyols

[Example Polyether polyols, Dendritic “Boltorn” polyols]

Photo initator system

Additives

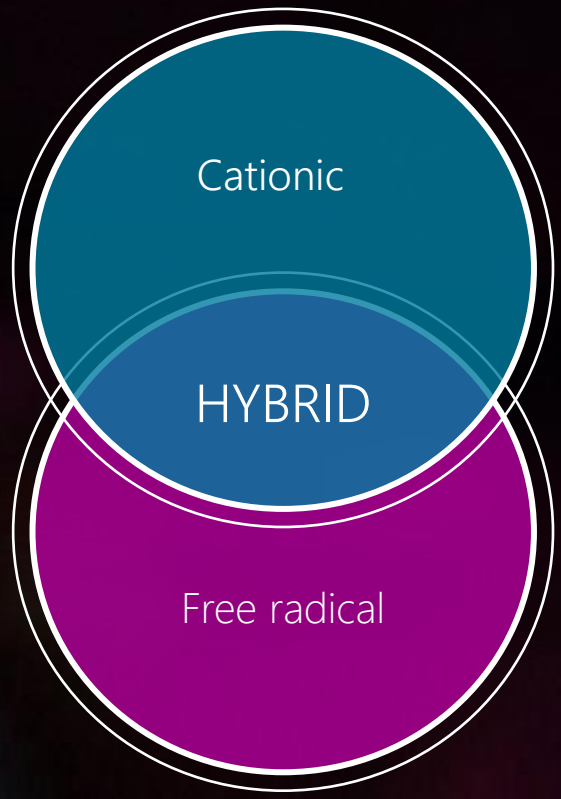
Pigments

Fillers

Hybrid systems

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

Combine benefits of both technologies



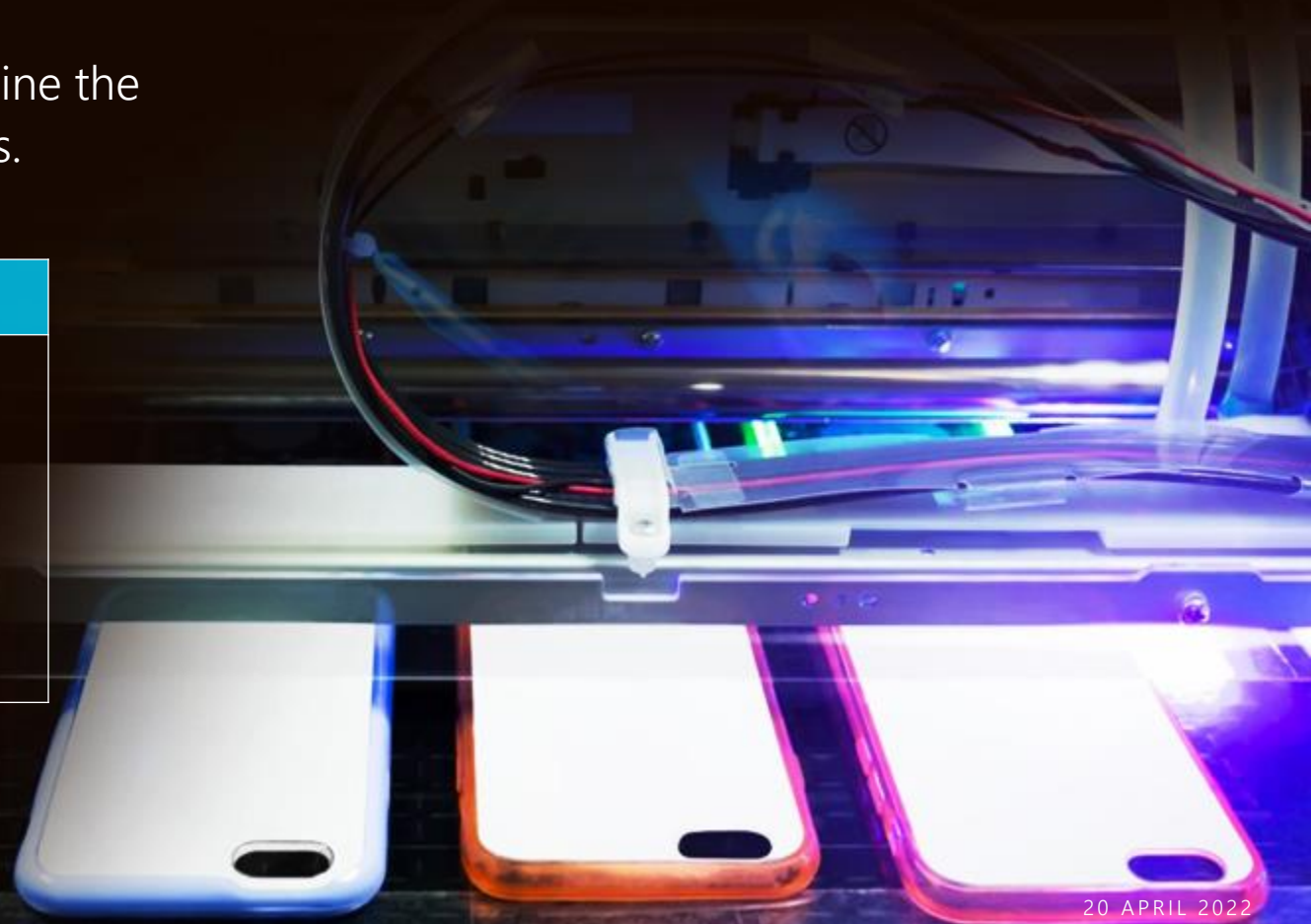
Cationic Technology

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.

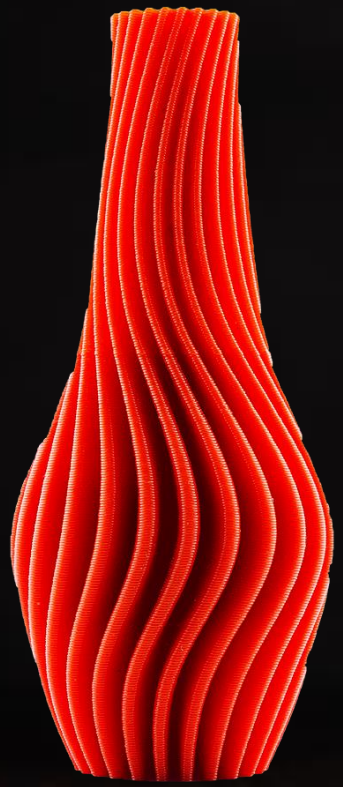
Advantages
+ Low shrinkage
+ Exceptional adhesion on difficult substrates
+ No O_2 inhibition
+ Exceptional flexibility
+ Low migration
+ Low levels of toxicity and irritation
+ Dark curing, offers complete curing



Main applications Cationic UV curing

Coatings

Good adhesion on challenging substrates like metal, glass and plastic

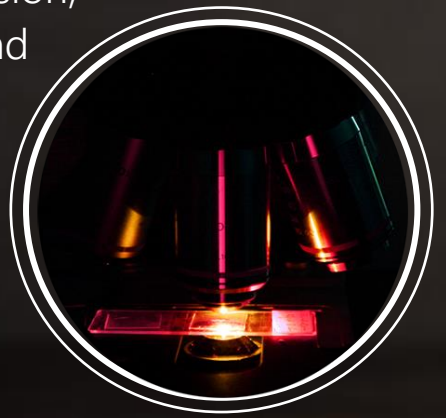


3D printing

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

Adhesives

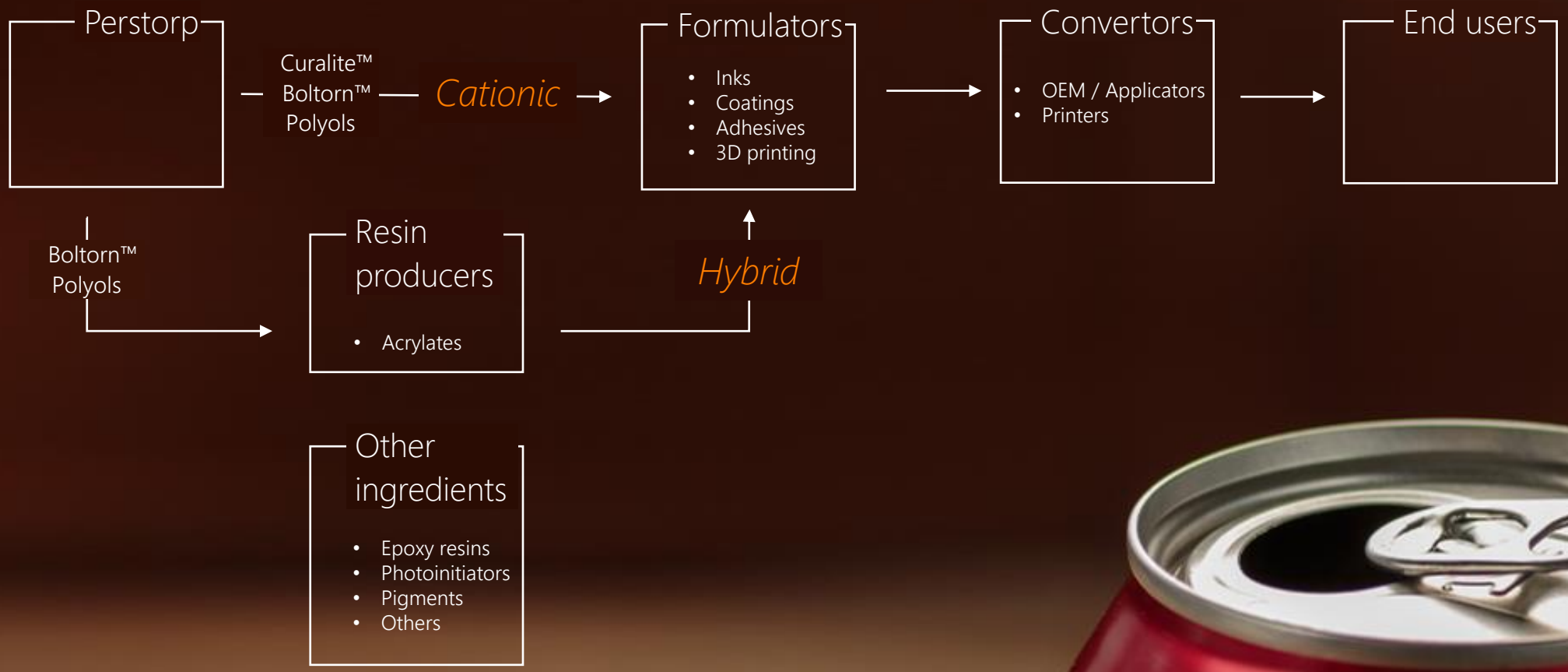
Good adhesion, flexibility and toughness



Inks

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

Where we support in the value chain



Product offering for Cationic technology

REACTIVE DILUENTS

Oxetanes

Performance boosters

Curalite™ Ox

Curalite™ OxPlus

MODIFIERS

Polyols

Chain extenders

Alkoxylates

High reactivity and safe polyethers

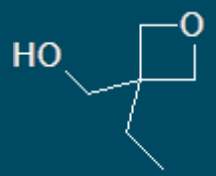
Boltorn™

Multifunctional and highly branched dendrimers

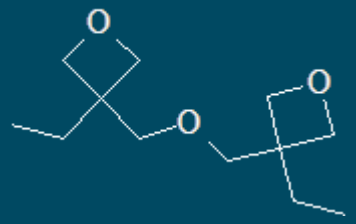
Curalite™
Designed to enhance Cationic UV Curing

- 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

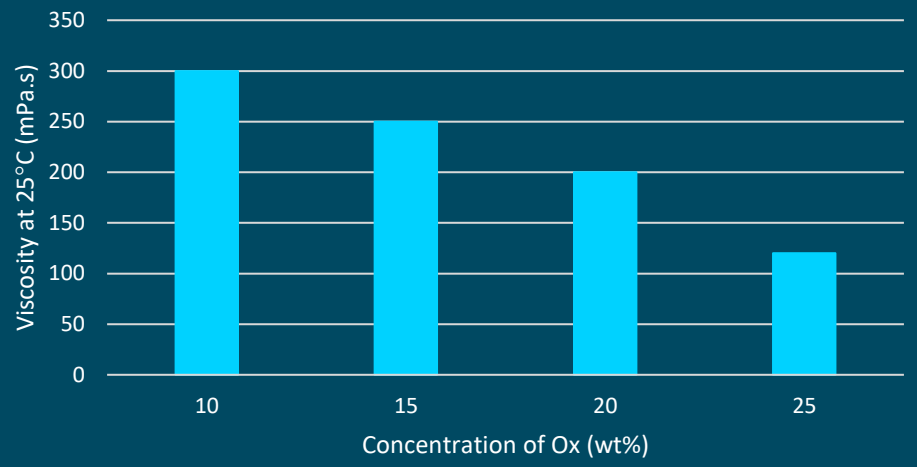


Typical properties	Curalite™ Ox	Curalite™ OxPlus
Appearance	Colorless liquid	Colorless liquid
Reactive groups	1 oxetane, 1 hydroxyl	2 oxetanes
Oxetane equivalent weight (g/eq)	116	107
Hydroxyl equivalent weight (g/eq)	116	-
Hydroxyl number (mg KOH/g)	485	-
Molecular weight (g/mol)	116	214
Viscosity at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

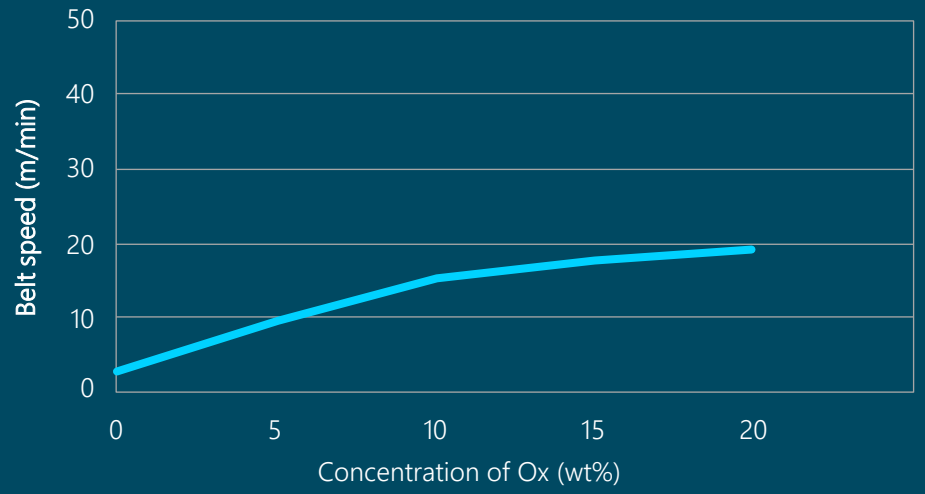
Curalite™ Ox

- 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

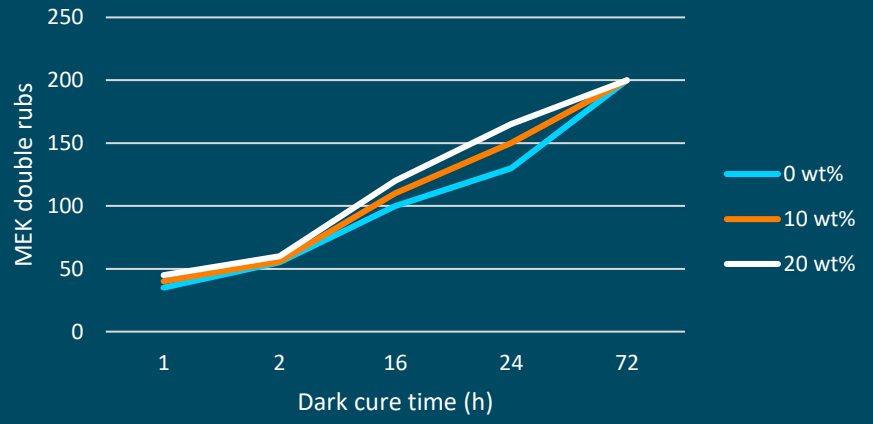
Viscosity



Surface cure (tack free)



Through cure (chemical resistance)

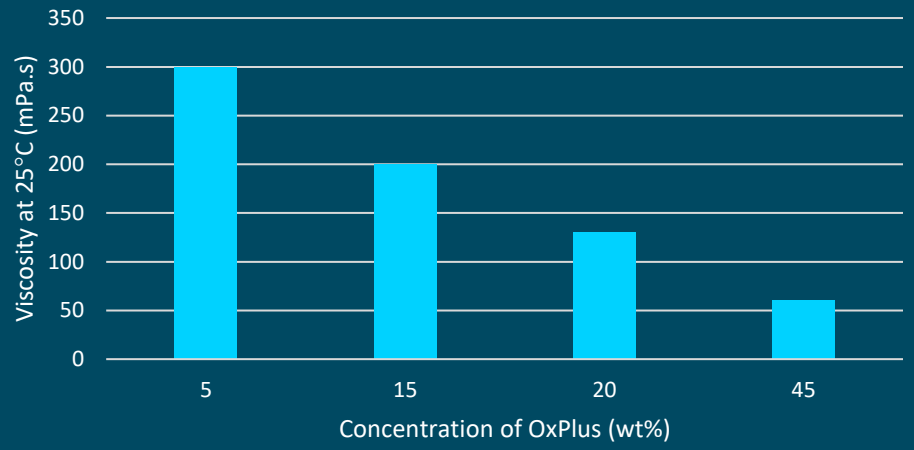


Curalite™ Ox has been formulated with cycloaliphatic epoxy and cationic photoinitiator, and cured with a Hg lamp

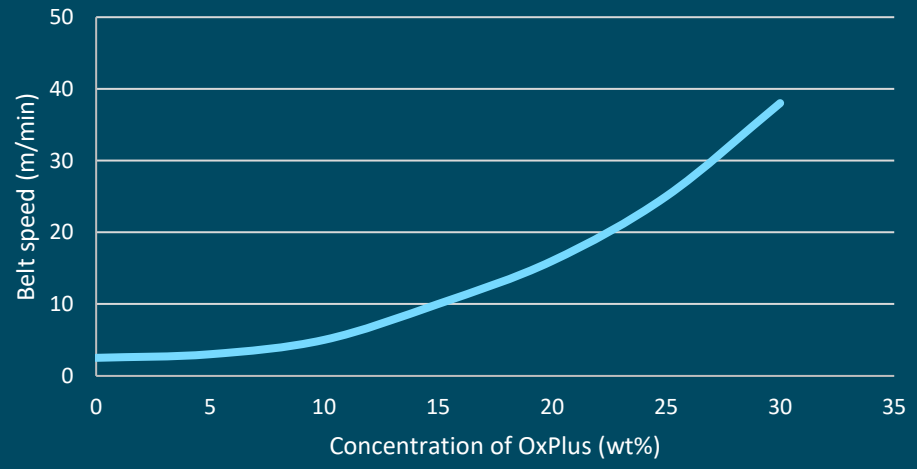
Curalite™ OxPlus

- 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

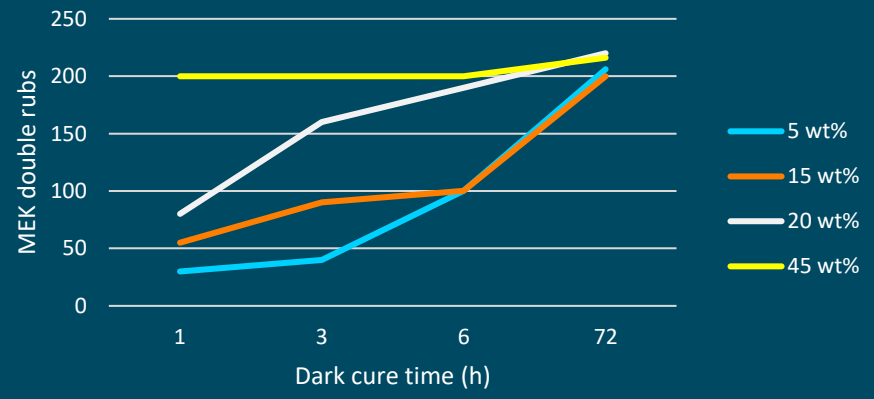
Viscosity



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

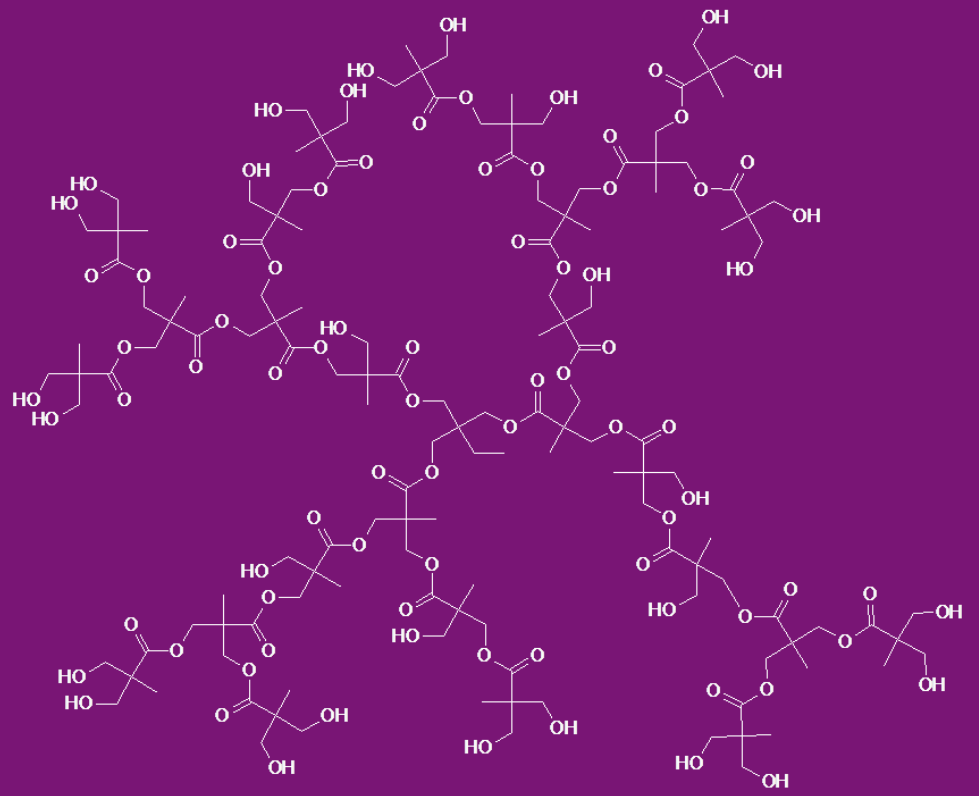
Dendritic Polymers – Boltorn™

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

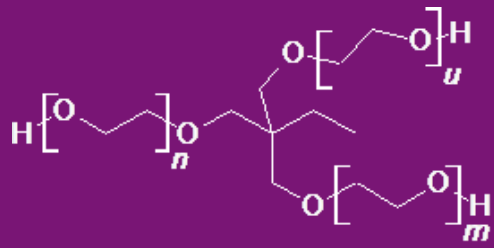
Tailored properties

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

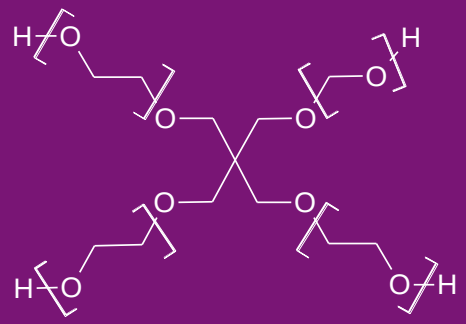
Many grades allowing freedom to formulate

Difunctional propoxylated polyol

Trifunctional ethoxylated polyol



Tetrafunctional ethoxylated polyol



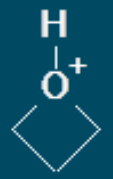
Other application areas

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

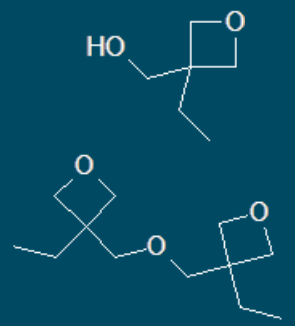


Allows easy ring opening

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

High thermal stability

Stability *vs* epoxy



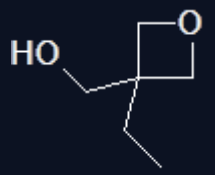
Multiple functionalities

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

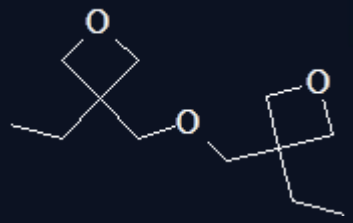
Conclusions

- Cationic – a fast growing, specialty segment
- Leading supplier in cationic ingredients
- Your partner in cationic formulations

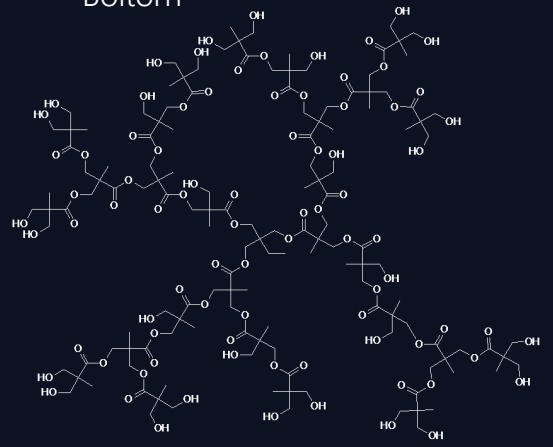
Curalite™ Ox



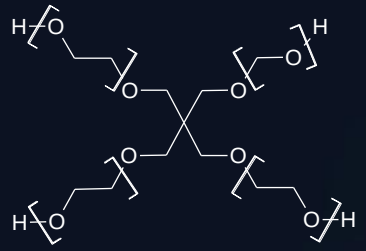
Curalite™ OxPlus



Boltorn™



Polyether polyols

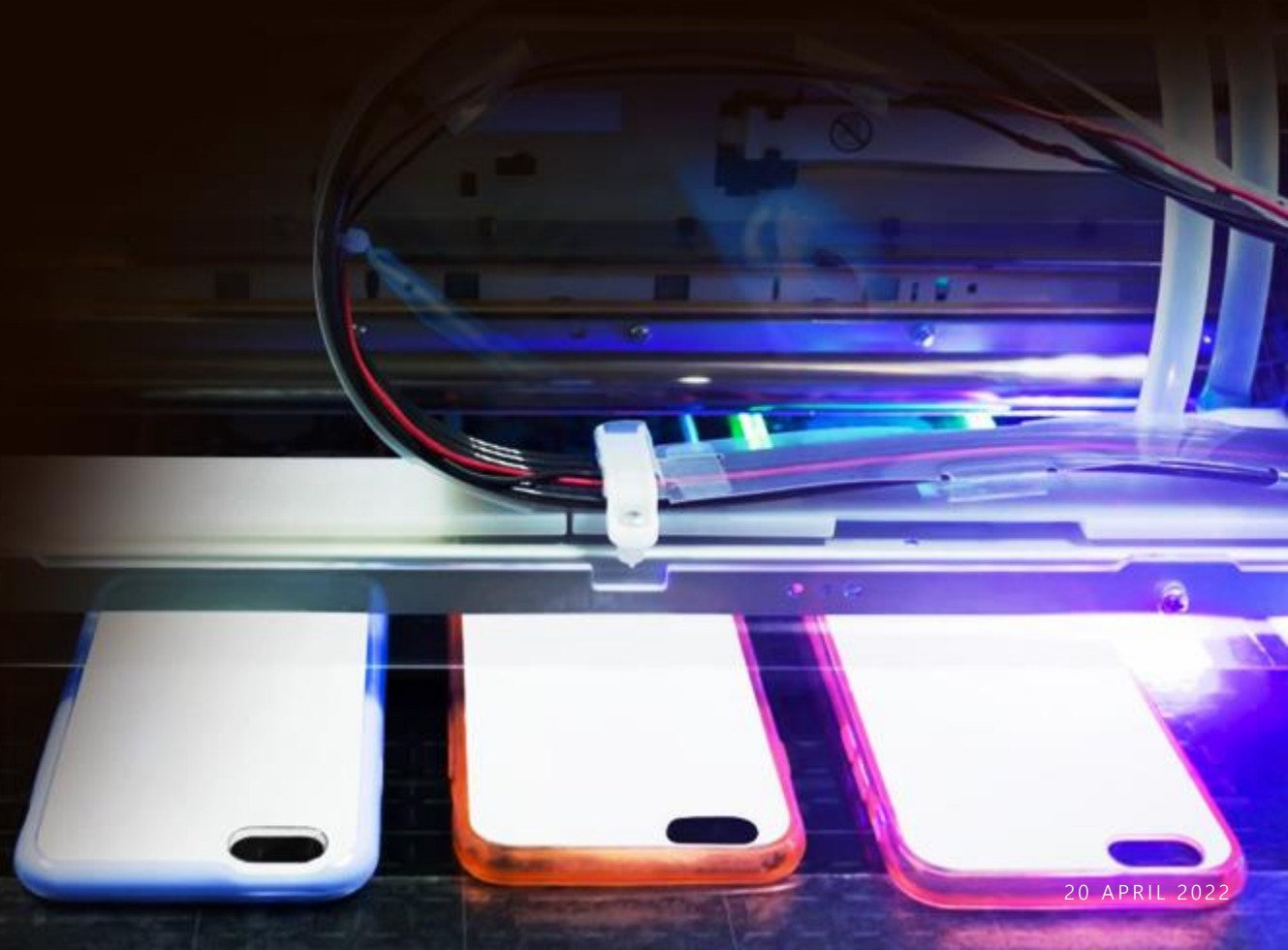



Perstorp

Appendix

For your reference

- Products are available on all major markets
- Available documentation
  - TDS
  - SDS
  - Technical Information Leaftlets
    - 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