



# 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

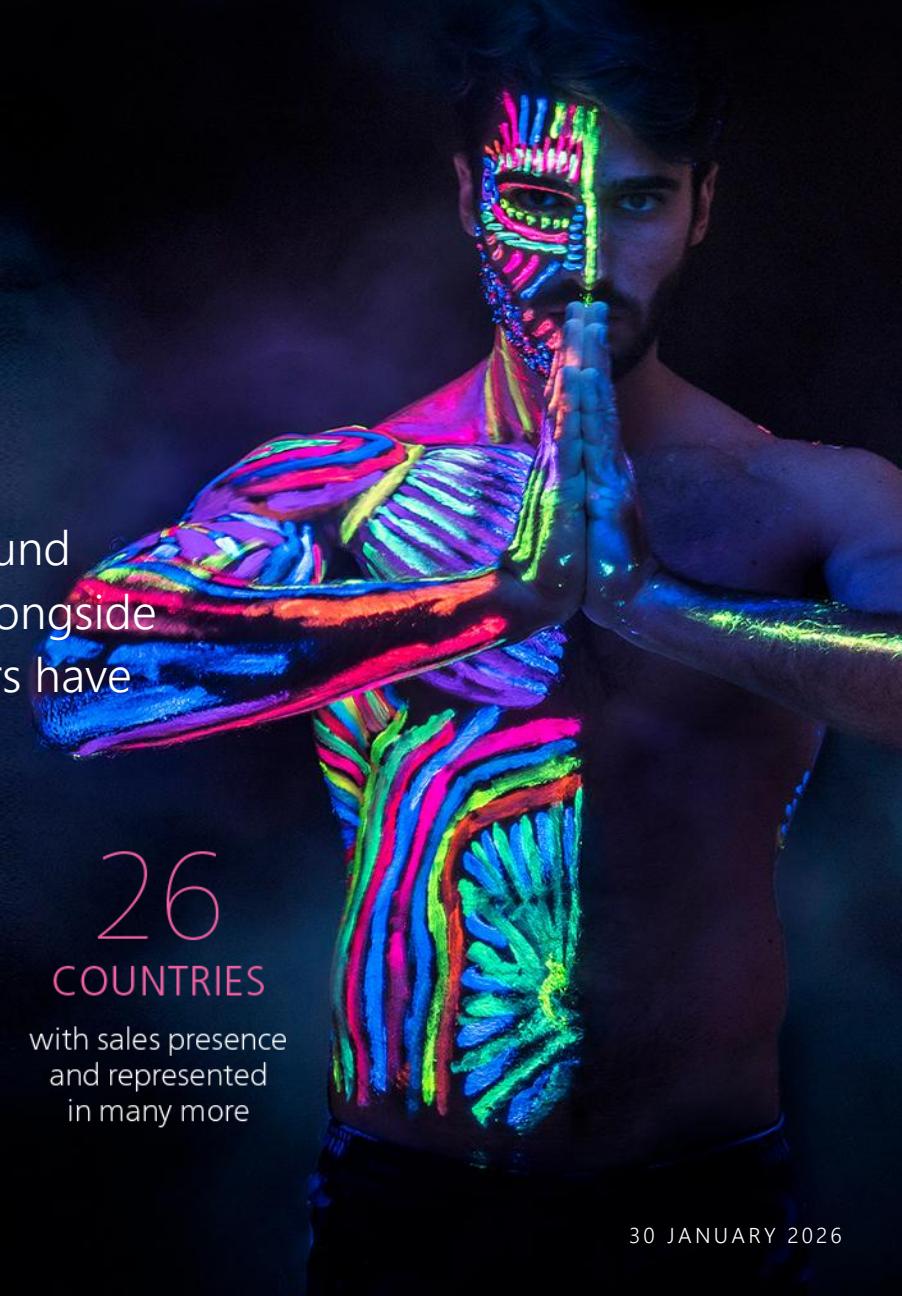
1,350  
EMPLOYEES  
worldwide

138  
YEARS  
of professional  
expertise

7  
SITES  
Perstorp  
production

14.9  
BILLION SEK  
turnover in 2018

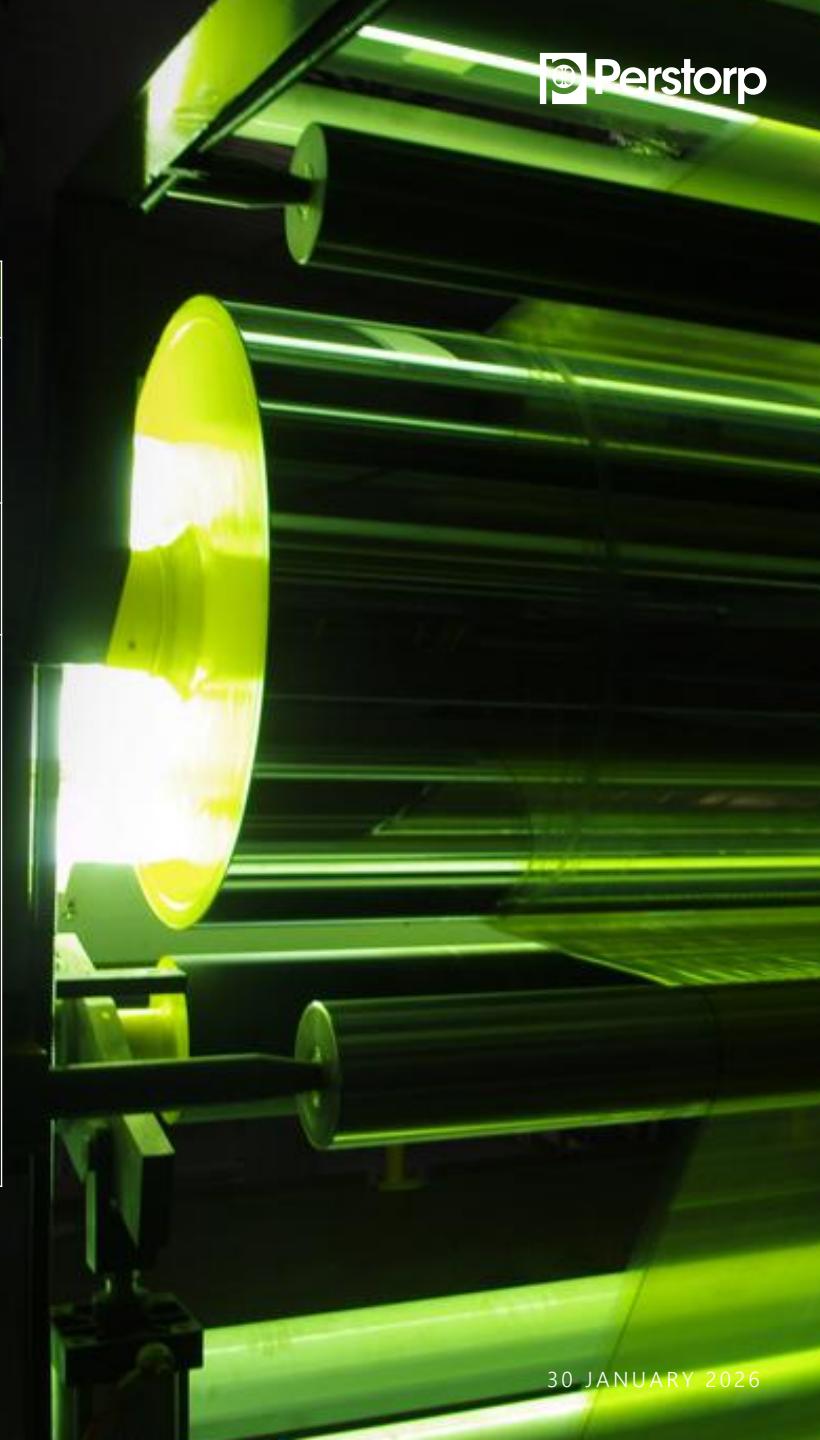
26  
COUNTRIES  
with sales presence  
and represented  
in many more



# General introduction to Radiation curing

# Different types of curing

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



# Comparison of UV technologies

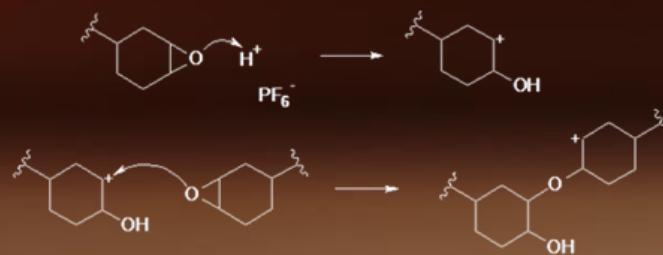
## Free radical curing

- 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"> <li>• Speed</li> <li>• Low energy</li> <li>• High resolution</li> </ul>	<ul style="list-style-type: none"> <li>• High shrinkage</li> <li>• Poor adhesion</li> <li>• Curing is inhibited by O<sub>2</sub></li> <li>• Acrylates often are skin irritants &amp; allergens</li> </ul>
<ul style="list-style-type: none"> <li>• Low shrinkage</li> <li>• Exceptional adhesion on difficult substrates</li> <li>• No O<sub>2</sub> inhibition</li> <li>• Exceptional flexibility</li> <li>• Low migration</li> <li>• Low levels of toxicity and irritation</li> <li>• Dark curing, offers complete curing</li> </ul>	<ul style="list-style-type: none"> <li>• Curing is inhibited by humidity and amines</li> <li>• Limited range of raw materials</li> </ul>



# Free radical formulation

## Binders

(Meth)-acrylated oligomers

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

## Reactive diluents

(Meth)-acrylated monomers

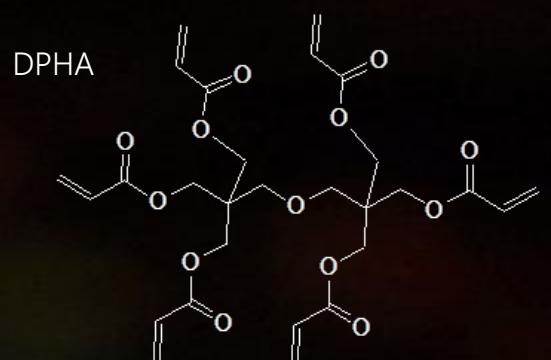
[Example HDDA, TMPTA, TPGDA, DPHA]

## Photo initiator system

Additives

Pigments

Fillers

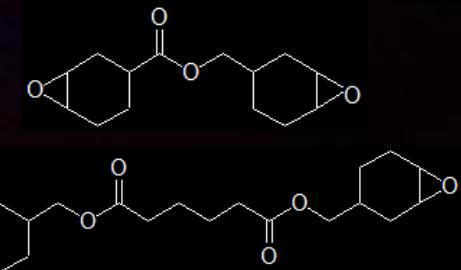


# Cationic formulation

## Binders

Cycloaliphatic epoxy

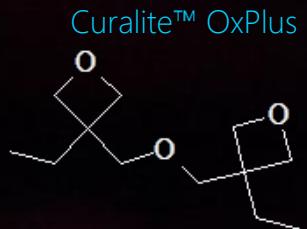
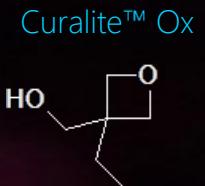
[Example 3,4-Epoxy cyclohexylmethyl 3,4-epoxycyclohexanecarboxylate]



## Reactive diluents

Oxetanes, epoxy monomers, vinyl ethers

[Example Curalite™ Ox and OxPlus]



## Modifiers

Polyols

[Example Polyether polyols, Dendritic "Boltorn" polyols]

## Photo initiator system

Additives

Pigments

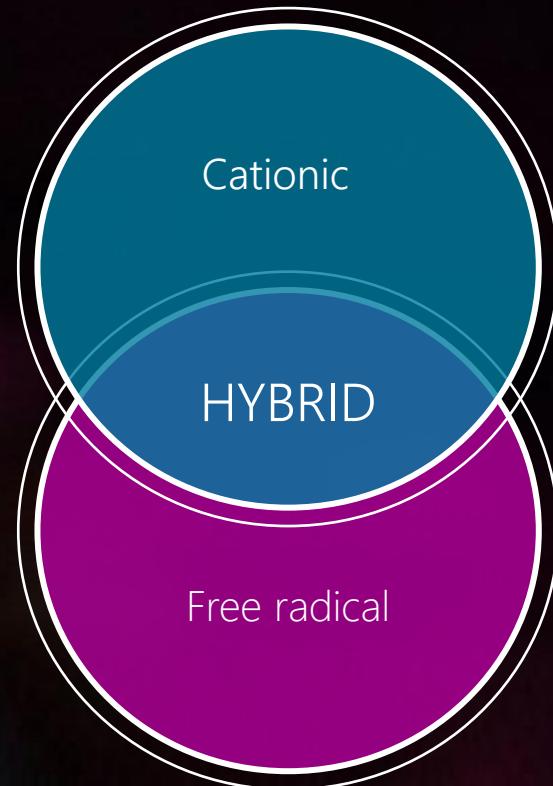
Fillers



# 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

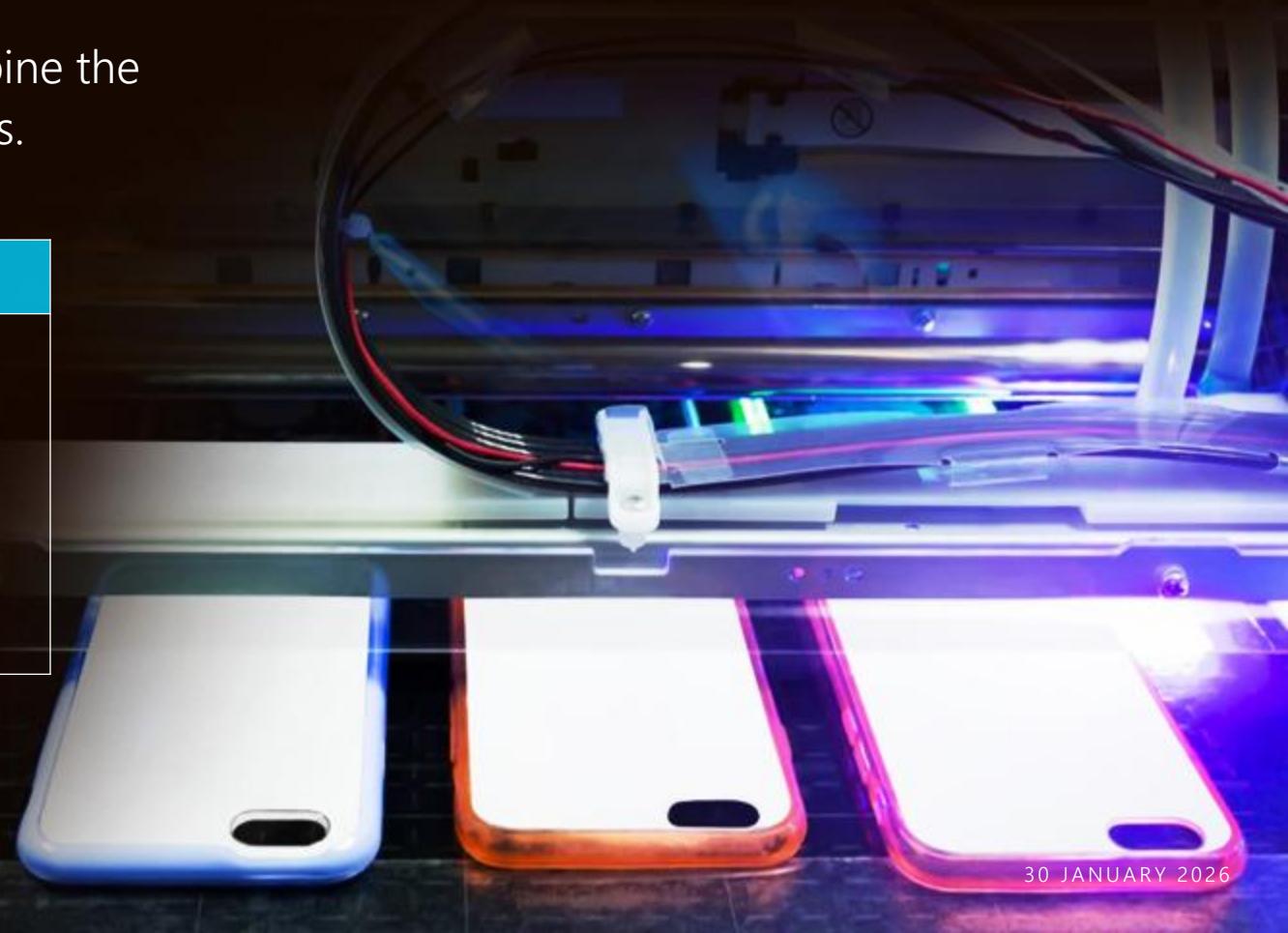


# Why use Cationic

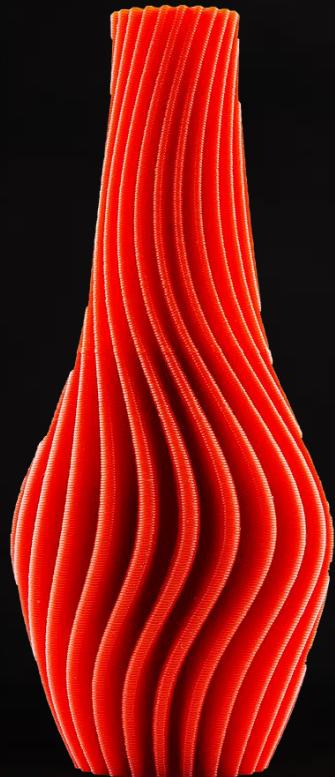
- Cationic technology is used when free radical/acrylates cannot meet the wanted properties.
- Hybrid systems can often be a solution to combine the benefits of cationic and free radical technologies.

## Advantages

- + Low shrinkage
- + Exceptional adhesion on difficult substrates
- + No O<sub>2</sub> inhibition
- + Exceptional flexibility
- + Low migration
- + Low levels of toxicity and irritation
- + Dark curing, offers complete curing



# Main applications Cationic UV curing



## 3D printing

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

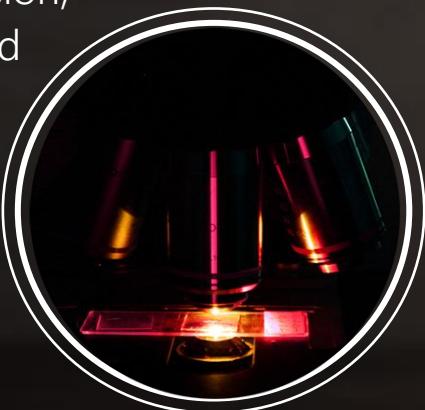


## Coatings

Good adhesion on challenging substrates like metal, glass and plastic

## Adhesives

Good adhesion, flexibility and toughness

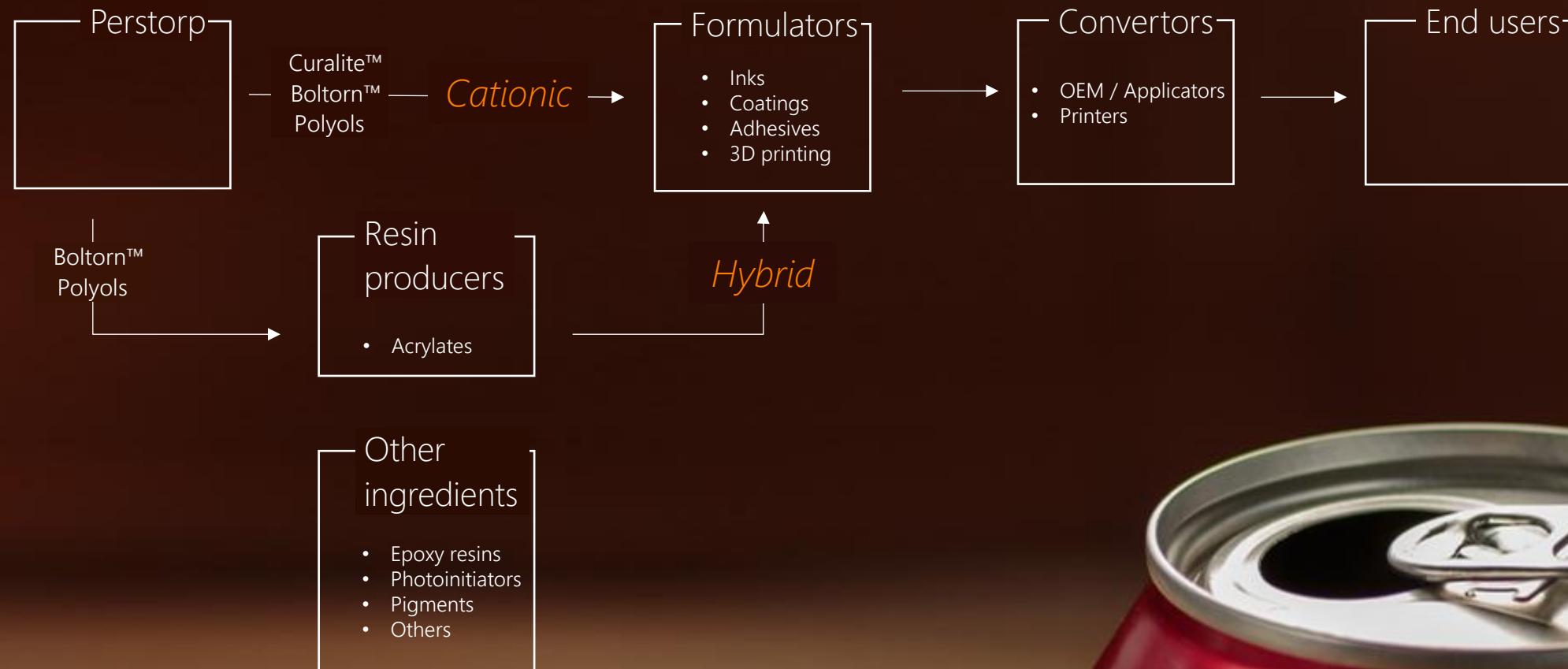


## Inks

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



# Where we support in the value chain

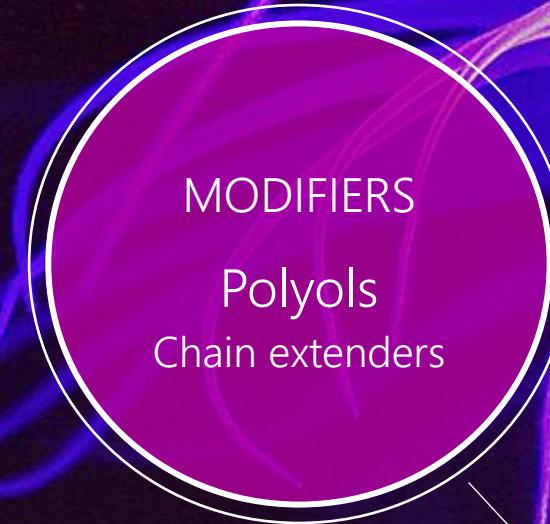


# Product offering for Cationic technology



Curalite™ Ox

Curalite™ OxPlus



Alkoxylates

High reactivity and safe polyethers

Boltorn™

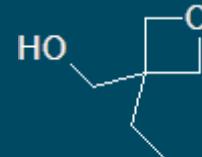
Multifunctional and highly branched dendrimers

# Curalite™

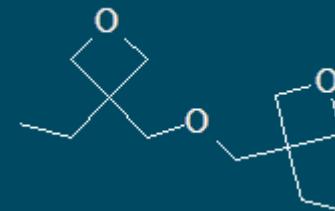
## Designed to enhance Cationic UV Curing

- 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

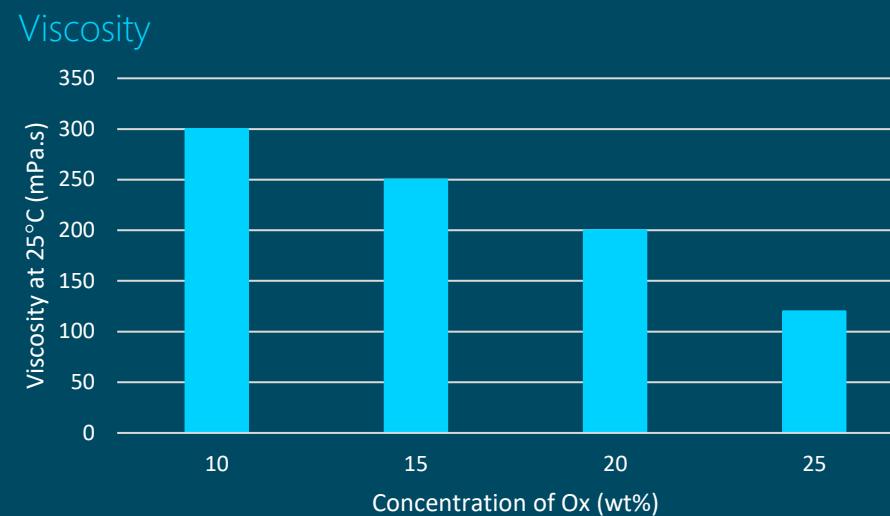
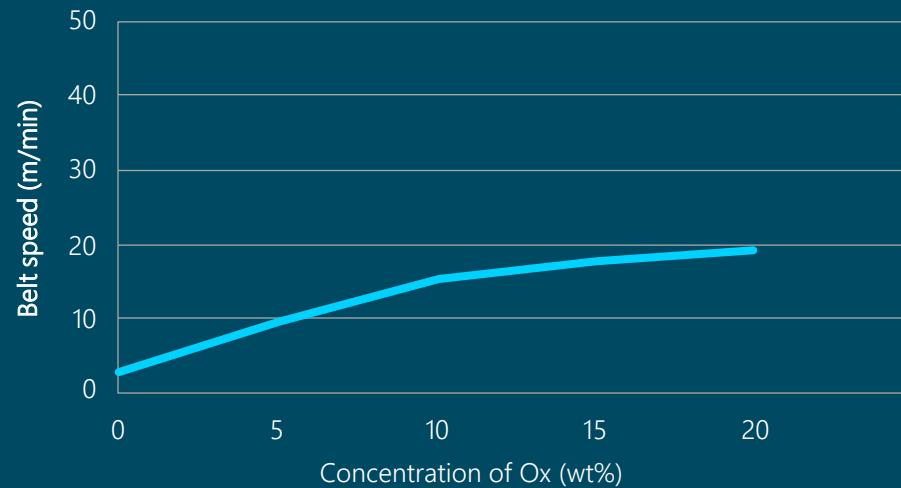


Typical properties	Curalite™ Ox	Curalite™ OxPlus
Appearance	Colorless liquid	Colorless liquid
Reactive groups	1 oxetane, 1 hydroxyl	2 oxetanes
Oxetane equivalent weight (g/eq)	116	107
Hydroxyl equivalent weight (g/eq)	116	-
Hydroxyl number (mg KOH/g)	485	-
Molecular weight (g/mol)	116	214
Viscosity at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

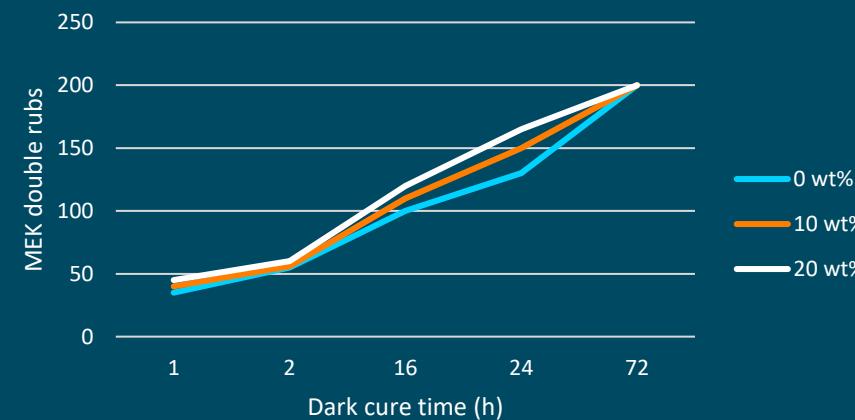
# Curalite™ Ox

- 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

## Surface cure (tack free)



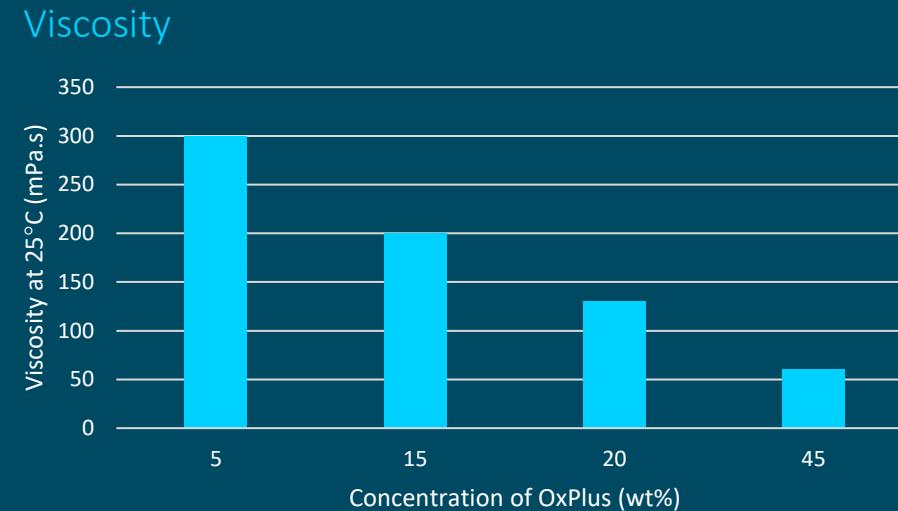
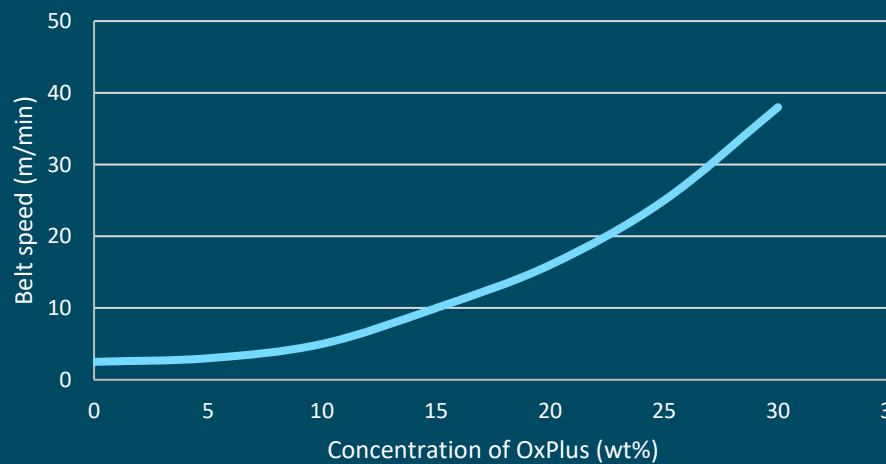
## Through cure (chemical resistance)



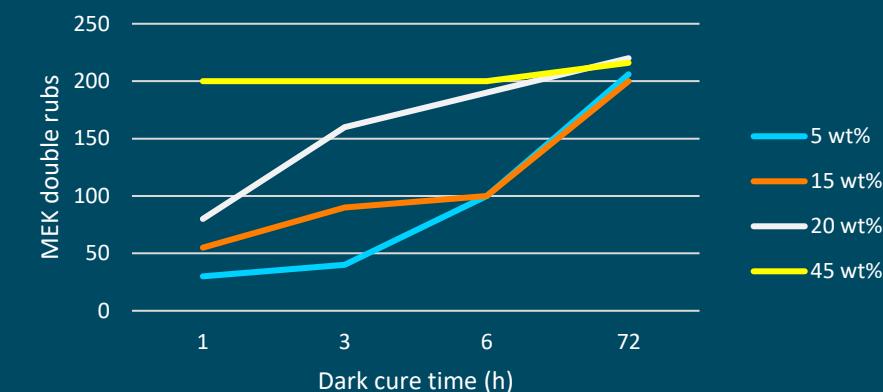
# Curalite™ OxPlus

- 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

## 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

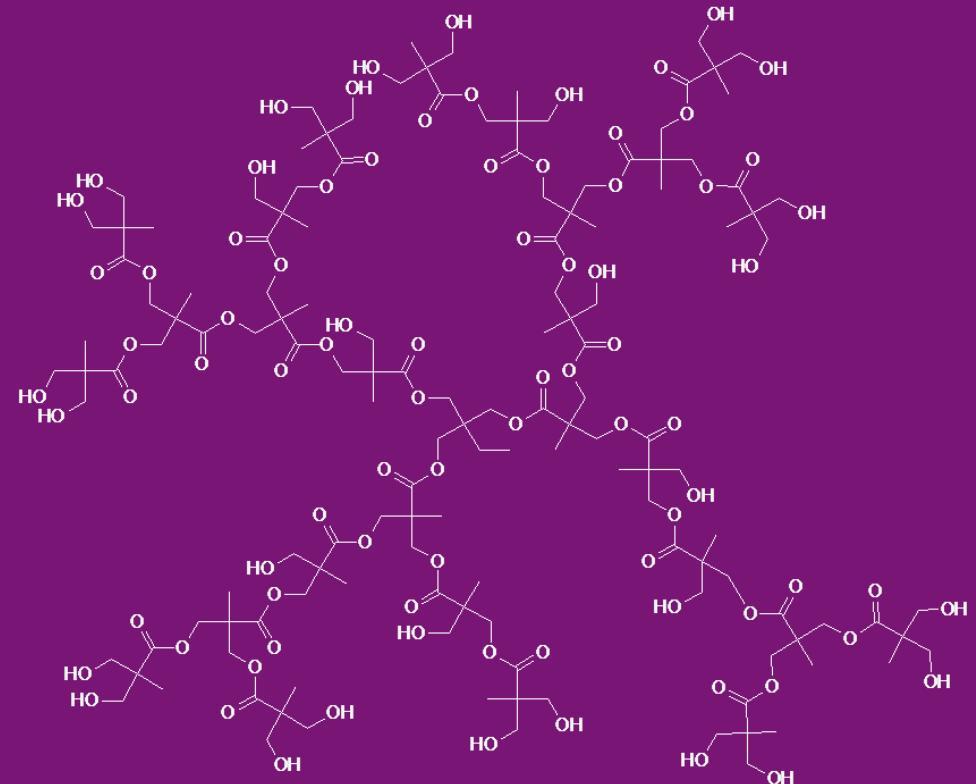
# Dendritic Polymers – Boltorn™

## 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

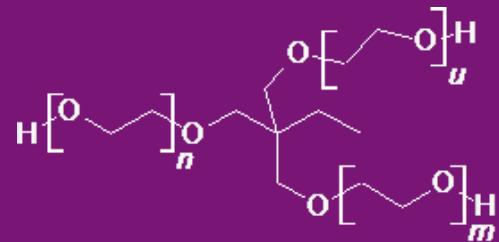
- Changing polyol and the ratio between epoxide/oxetane and polyol

Many grades allowing freedom to formulate

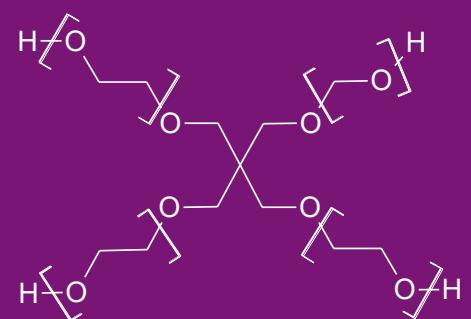
## Difunctional propoxylated polyol



## Trifunctional ethoxylated polyol



## Tetrafunctional ethoxylated polyol



# Other application areas

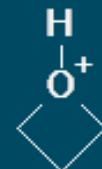
# Curalite™

## 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



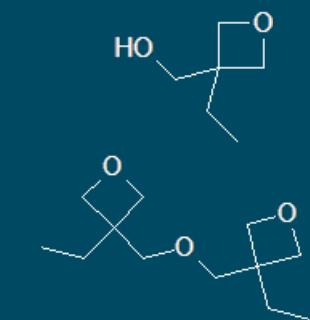
Allows easy ring opening

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



Stability vs epoxy

High thermal  
stability



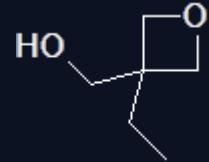
Multiple functionalities

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

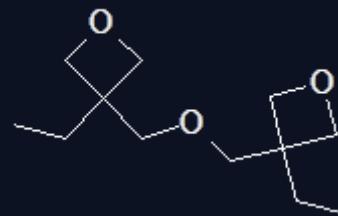
# Conclusions

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

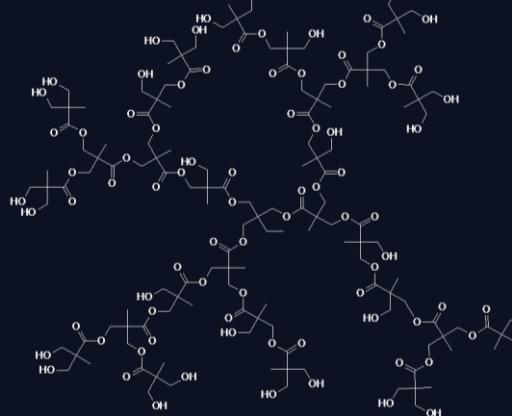
Curalite™ Ox



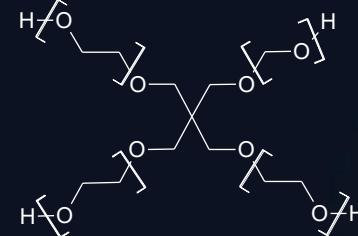
Curalite™ OxPlus



Boltorn™



Polyether polyols





# 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