



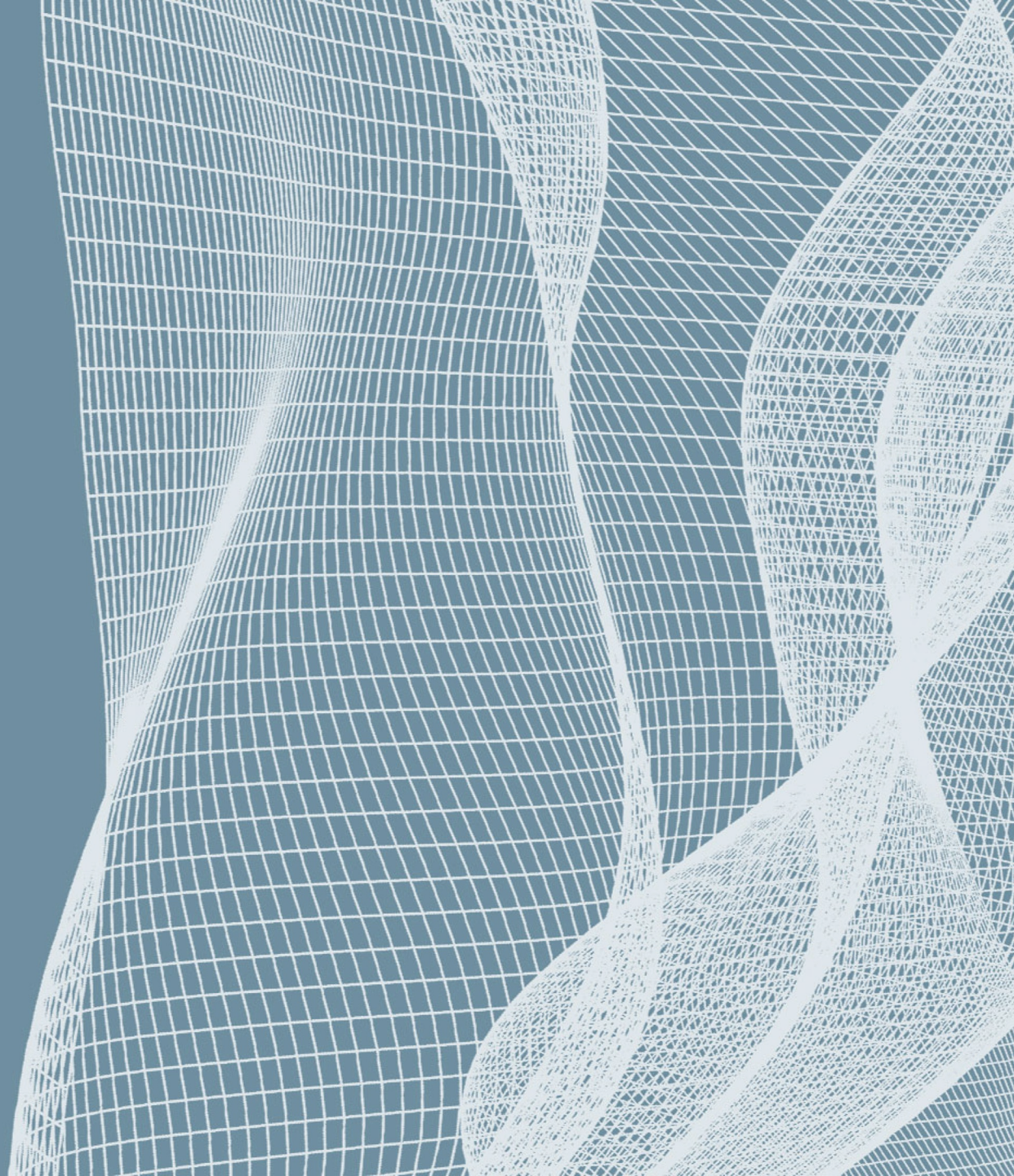
REMOVING HARMFUL FINISHES TO RECYCLE WASTE ACRYLIC TEXTILES

Brecht Tomme

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THE REACT PROJECT



THE REACT PROJECT



- Horizon 2020 project (European Commission)
- 7 partners from 4 European countries



- REcycling of waste ACrylic Textiles
 - Mechanical recycling down to the fibre level

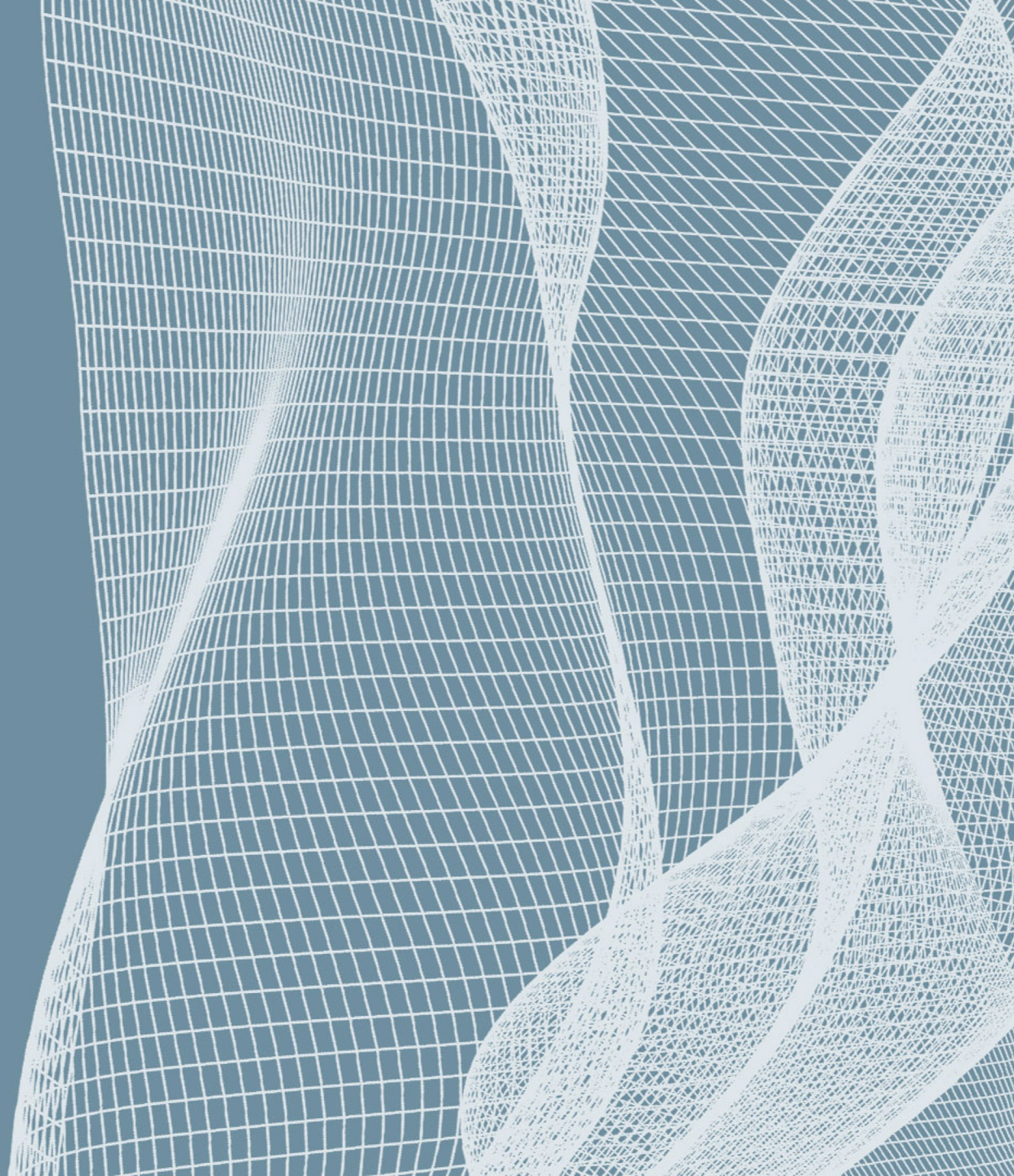
@project_react



company/react-project

WWW.REACT-PROJECT.NET

ACRYLIC FIBRES



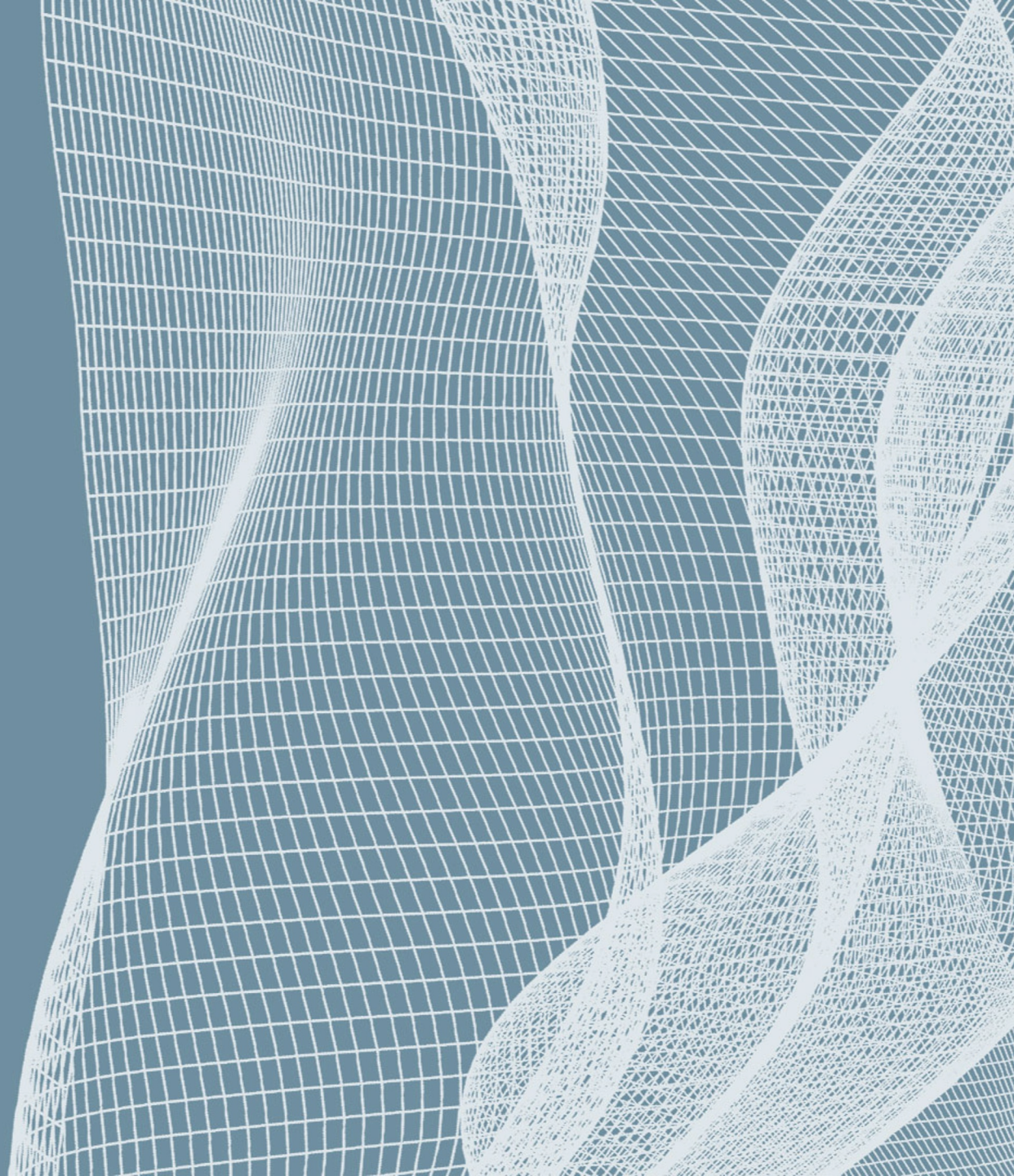
- Relatively small but not unimportant market
 - Production: 2 million tonnes per year (total synthetic fibres: 50 million tonnes) ^[1]
 - Market of €5 billion predicted by 2026 ^[2]
- Applications ^[3]
 - 75% apparel
 - 20% home furnishings
 - 5% industrial end uses



- Are the fibres worth recycling?
 - Energy yield/savings per kg is predicted to be 19.4 MJ vs. 2.4 MJ for incineration ^[4]
 - Acrylic fibres have the 4th highest Recycling Potential Index (after PET, PP, PE) ^[4]
- Mechanical recycling is ideal to avoid re-extrusion of the fibres
 - Solution spun using toxic and carcinogenic solvents such as DMF and DMAc
- Why does recycling not occur?
 - Finishes and coatings on the fabrics cause complications during the recycling process and reduce the quality of the recycled product



FINISH REMOVAL



IDENTIFICATION OF FINISHES & COATINGS



1. Awning finish
2. Coating
3. Furnishing finish

IDENTIFIED CHEMICAL FINISHING COMPOUNDS

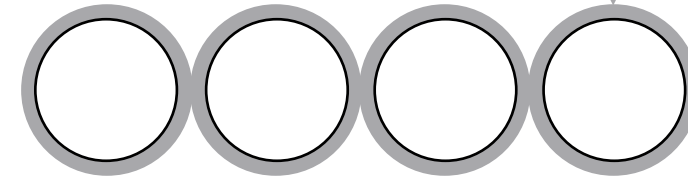
- Awning finish:

- Formaldehyde resin
- Fluorocarbon resin



- Furnishing finish:

- Fluorocarbon resin
- Softeners

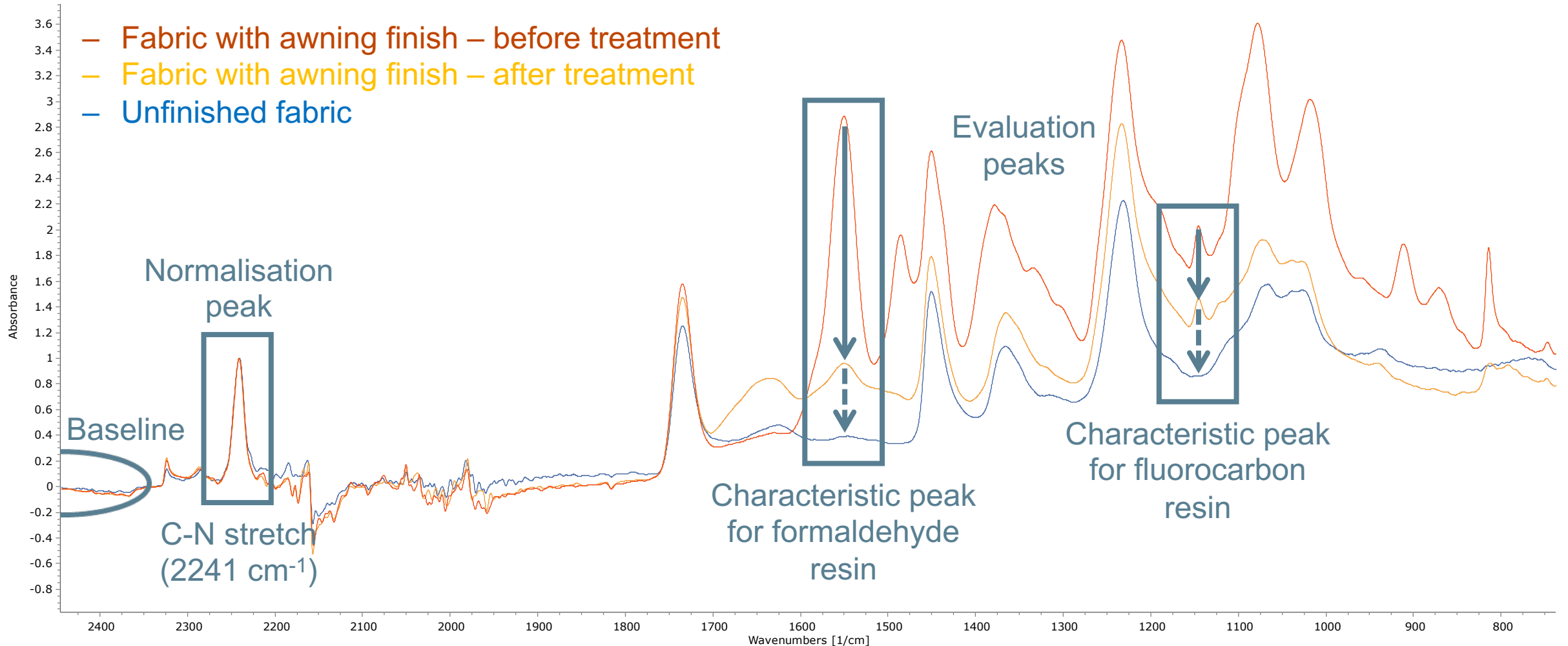


- Coating:

- Formaldehyde resin
- Fluorocarbon resin
- Acrylic resin

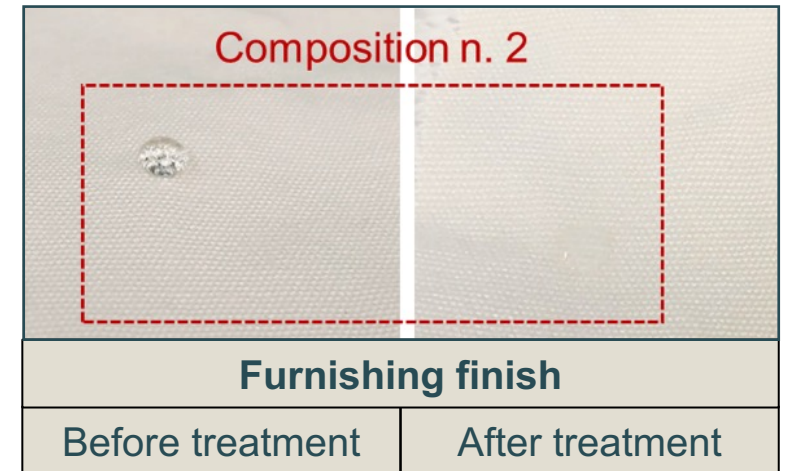
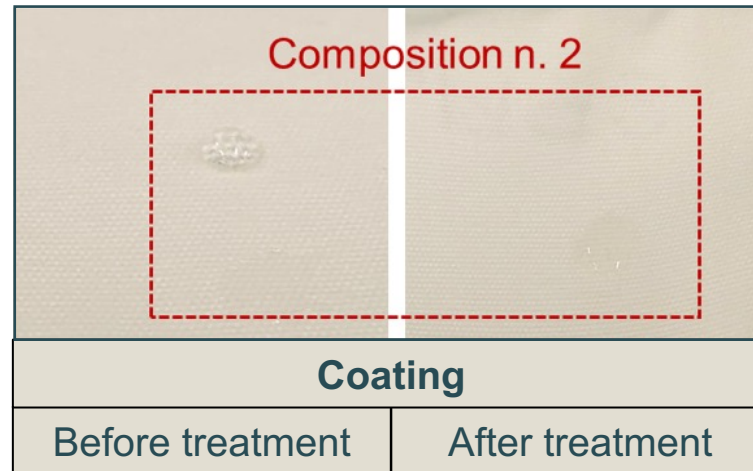
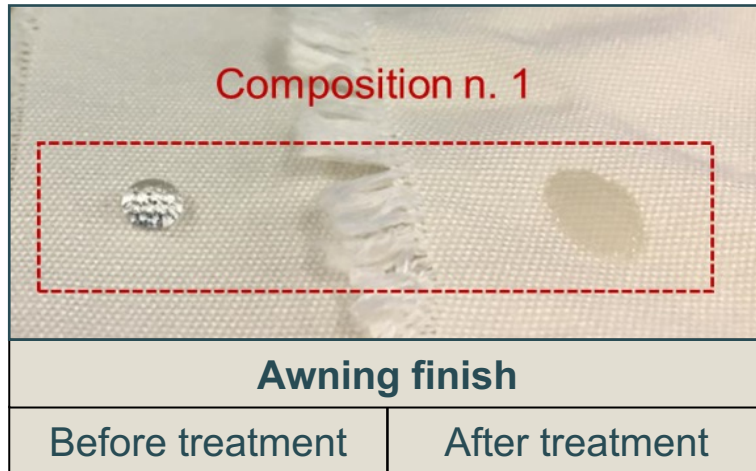


EVALUATING REMOVAL EFFECTIVENESS (FTIR-ATR)



EVALUATING REMOVAL EFFECTIVENESS (OIL-REPELLENCY)

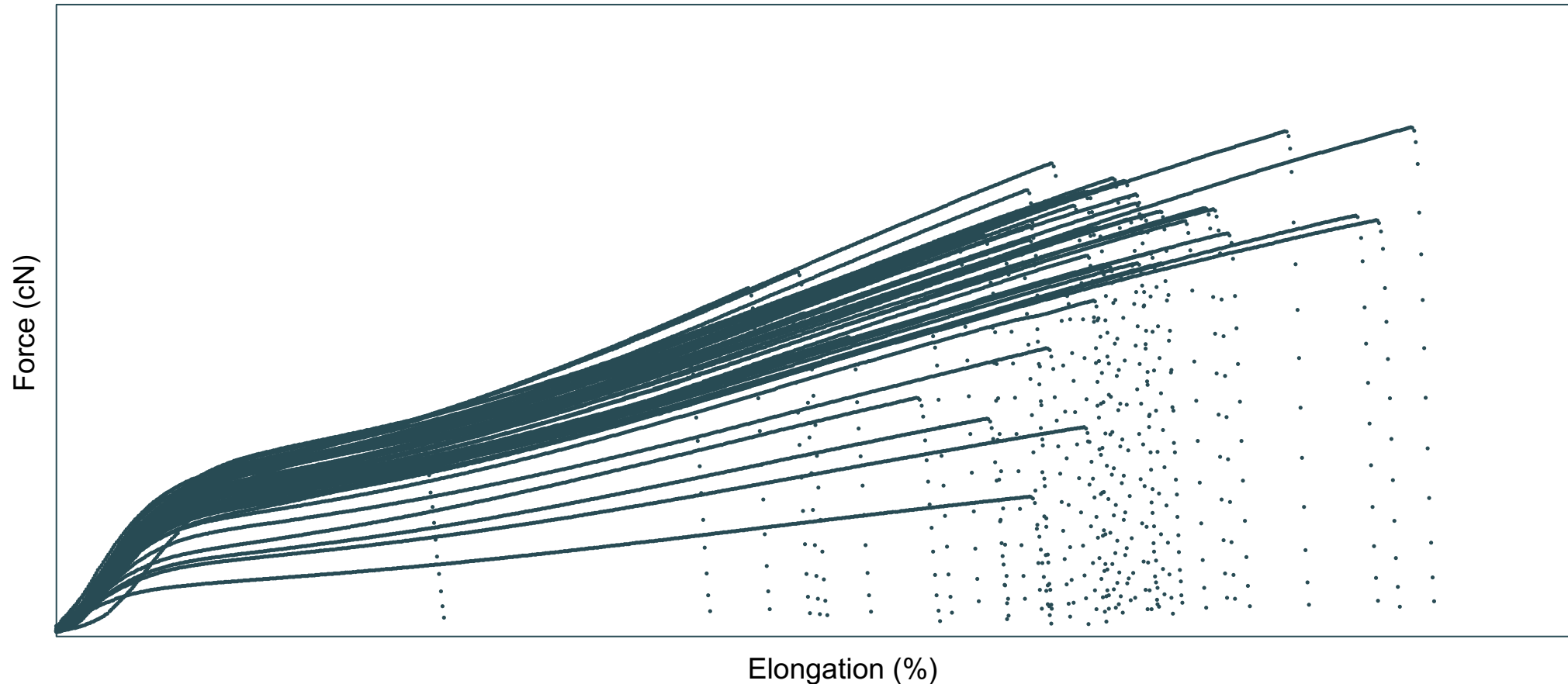
- Evaluation of fluorocarbon resin removal
- AATCC 118-2013



- More quantitative alternative: contact angle measurements

ARE OUR PROCESSES DAMAGING TO THE FIBRES?

- Fibre-level tensile tests (FAVIMAT+)



IDENTIFIED CHEMICAL FINISHING COMPOUNDS

- Awning finish:

- Formaldehyde resin

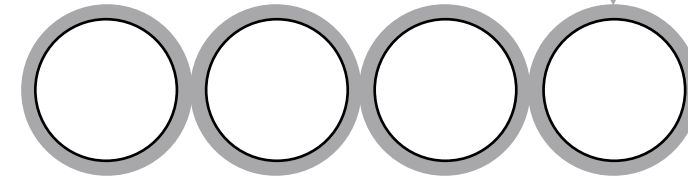
- Fluorocarbon resin



- Furnishing finish:

- Fluorocarbon resin

- Softeners



- Coating:

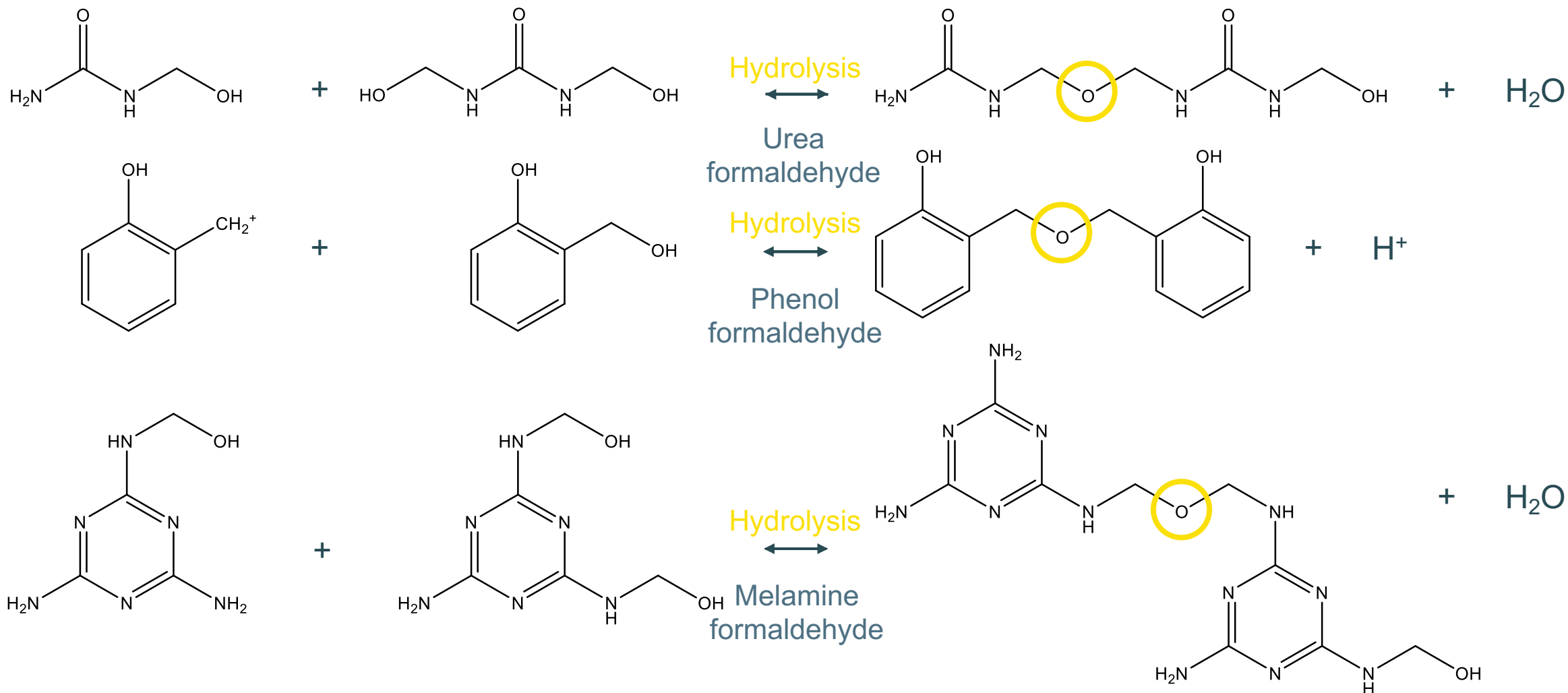
- Formaldehyde resin

- Fluorocarbon resin

- Acrylic resin



REMOVAL OF FORMALDEHYDE RESINS





	Formaldehyde resin removal (%)	Fluorocarbon resin removal (%)	Acrylic resin removal (%)	Softener removal (%)
Awning fabric	> 90	50 - 80	-	-
Coated fabric	< 30	< 30	< 30	-
Furnishing fabric	-	50 - 80	-	50 - 80

- Excellent removal of formaldehyde resin
- Coating and fluorocarbon resin are hard to remove
- Mechanical tests confirm there is no significant damage to the fibres

HYDROLYSIS 1 & 2 + WASHING



- Sequential treatments to improve removal of fluorocarbon and acrylic resins

	Formaldehyde resin removal (%)	Fluorocarbon resin removal (%)	Acrylic resin removal (%)	Softener removal (%)
Awning fabric	~ 100	50 – 80	-	-
Coated fabric	50 – 80	50 – 80	50 - 80	-
Furnishing fabric	-	50 - 80	-	~ 100

- Better removal of acrylic resin and softeners
- **Fluorocarbon resin** is still difficult to remove (validated by oil-repellency tests)
- Mechanical tests confirm there is **no significant damage** to the fibres

HYDROLYSIS 1 & 2 + WASHING + PHYSICAL TREATMENT



- Extra physical treatment to improve removal of fluorocarbon resin

	Formaldehyde resin removal (%)	Fluorocarbon resin removal (%)	Acrylic resin removal (%)	Softener removal (%)
Awning fabric	~ 100	> 90	-	-
Coated fabric	~ 100	~ 100	~ 100	-
Furnishing fabric	-	> 90	-	~ 100

- Near complete removal of all finishing components
- Fabric is no longer water- or oil-repellent, as proven by oil-repellency tests
- Some issues with **upscalability** of the physical treatment, and mechanical tests show increase in **elongation** and loss of **stiffness**

HYDROLYSIS 1 & 2 AT HIGHER T + WASHING

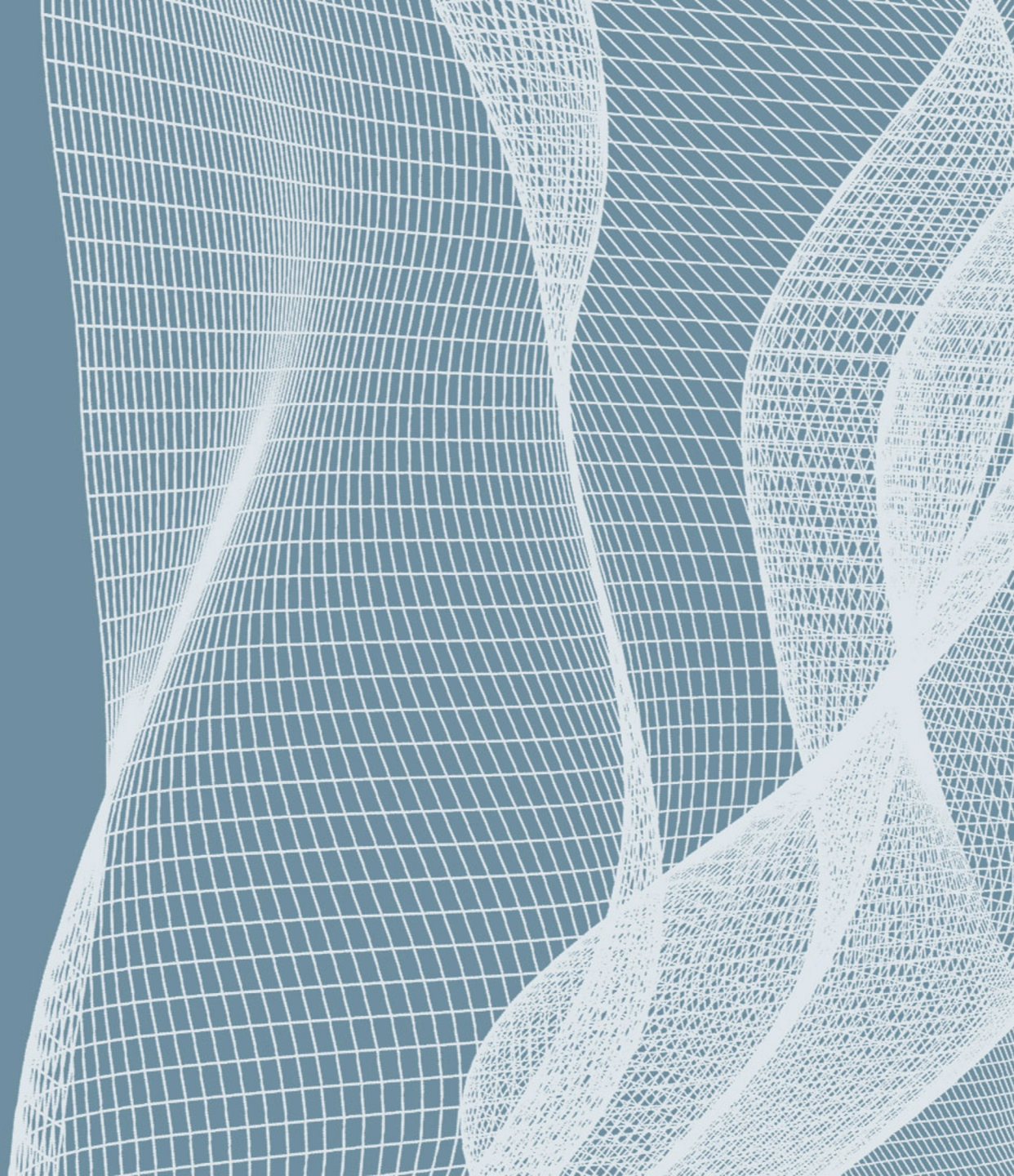


- Higher temperature hydrolysis decreases the surface tension of the solution → easier penetration of fluorocarbon and acrylic resins

	Formaldehyde resin removal (%)	Fluorocarbon resin removal (%)	Acrylic resin removal (%)	Softener removal (%)
Awning fabric	~ 100	~ 100	-	-
Coated fabric	~ 100	> 90	> 90	-
Furnishing fabric	-	~ 100	-	~ 100

- Better removal of acrylic resin and softeners
- Fluorocarbon resin is still difficult to remove (validated by oil-repellency tests)
- Mechanical tests confirm there is no significant damage to the fibres

CONCLUSION



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- Acrylic fibres for outdoor applications are not yet recycled even though they have a high recycling potential, due to finishing chemicals on the fibre surface
- Hydrolysis 1 & 2 at higher temperature + washing is an optimised, lab-scale series of treatments that can remove over 90% of all finish components from outdoor acrylic textiles
- First pre-industrial scale trials are successful and have led to umbrellas, pillows and a seat made of 100% recycled fibres





THANK YOU FOR YOUR ATTENTION

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