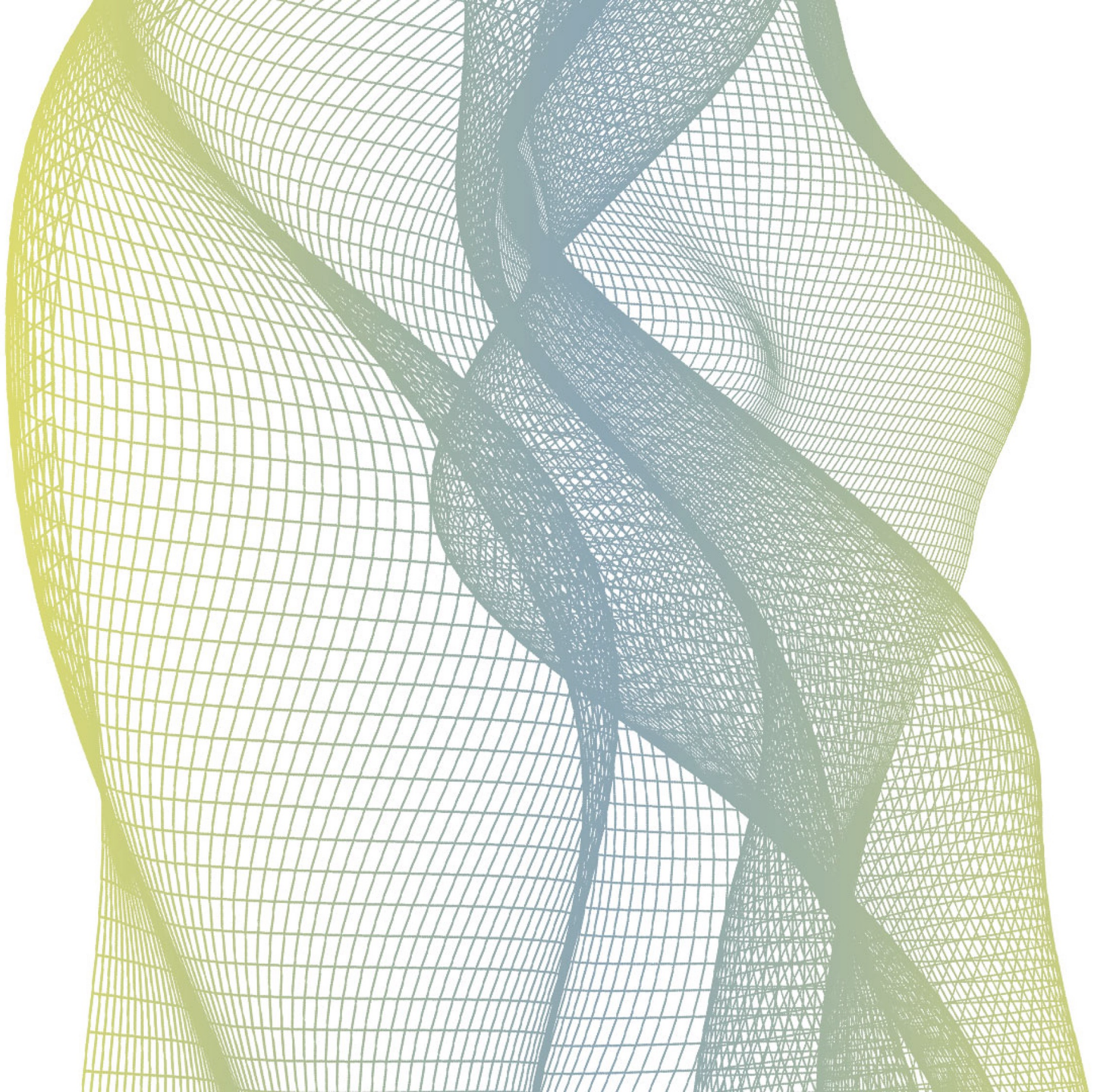

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REACT

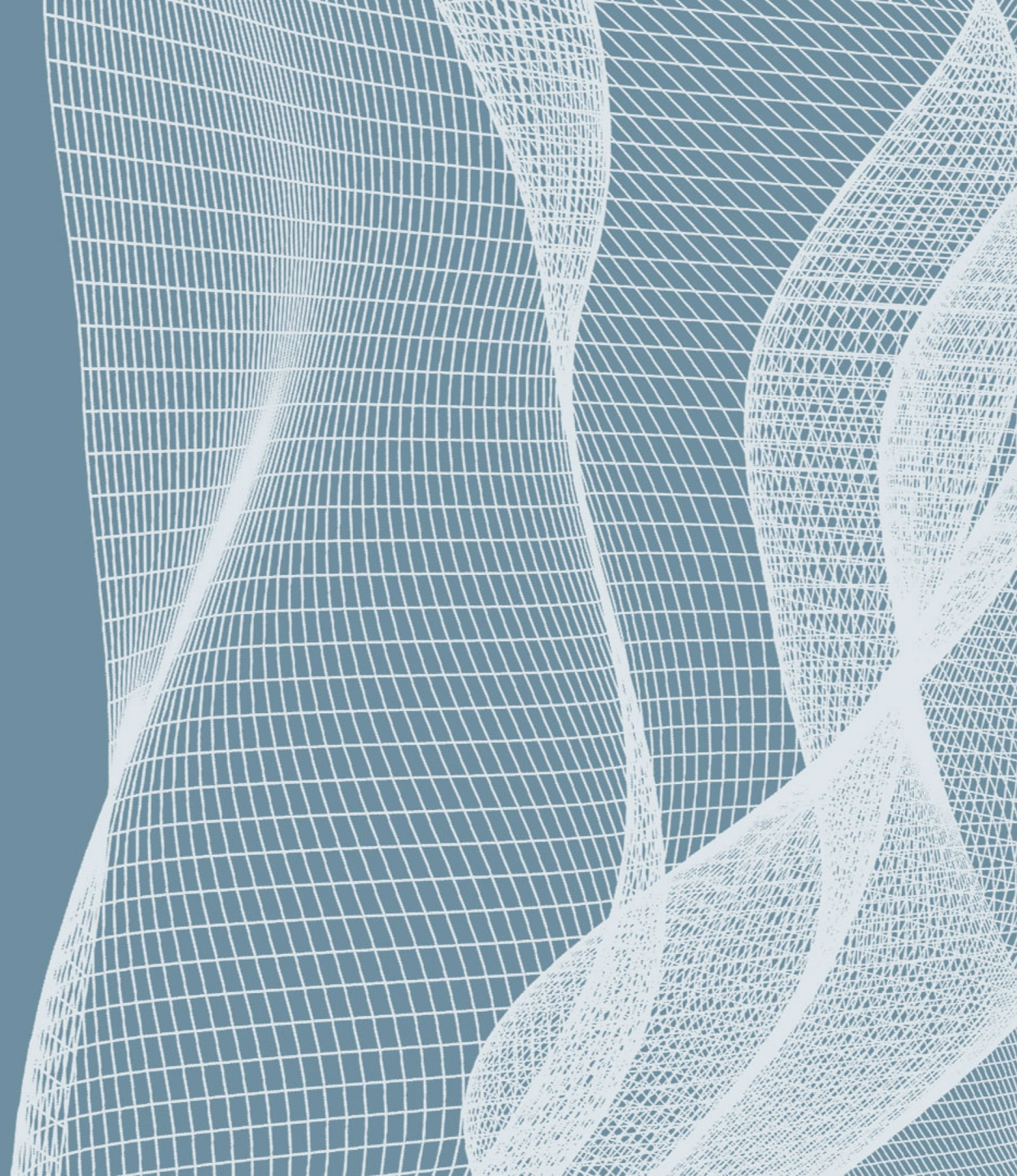
REMOVING FINISHING CHEMICALS FROM OUTDOOR ACRYLIC TEXTILES

Brecht Tomme

Valentina Trovato, Jozefien Geltmeyer, Giuseppe Rosace, Daniele Piga, Barbara Ferrari, Andrea Cataldi, Steven De Meester, Karen De Clerck

NanoInnovation Workshop, 23/09/2021

THE REACT PROJECT



THE REACT PROJECT

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

CENTROCOT Innovation experience

CETI CENTRE EUROPÉEN DES TEXTILES INNOVANTS

TEMPOTEST ITALIAN PERFORMANCE FABRICS

GHENT UNIVERSITY

soft chemicals

Ják Spinning

MARTEL innovate

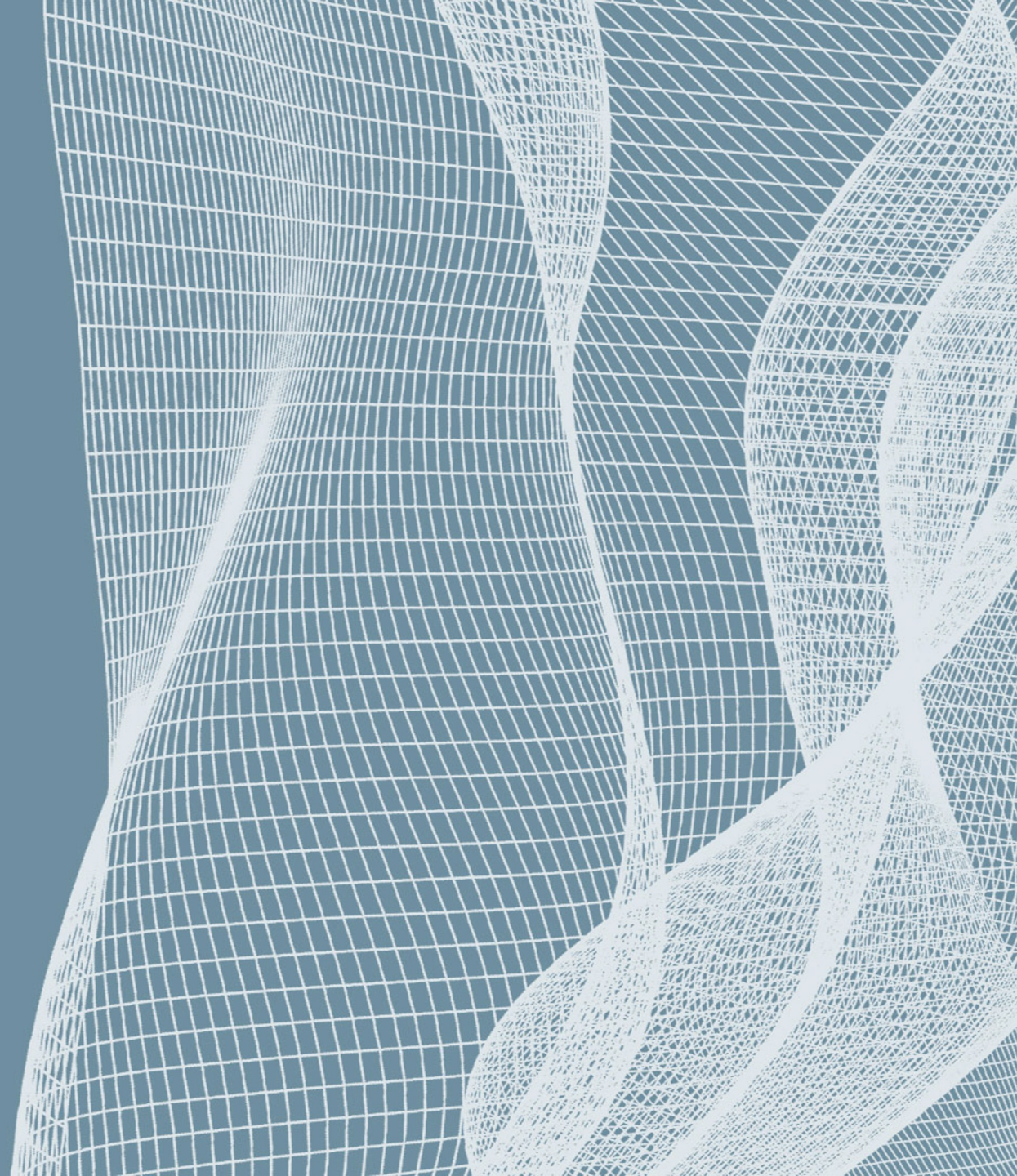
- REcycling of waste ACrylic Textiles
  - Mechanical recycling down to the fibre level

@project_react

company/react-project

WWW.REACT-PROJECT.NET

ACRYLIC FIBRES



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

[1] M. Yang Qin, "Global fibres overview", Pattaya, May 2014.
[2] Future Market Insights, "Acrylic fibre market: Global industry analysis and opportunity assessment", Oct 2013.
[3] M. Niaounakis, Management of marine plastic debris. Amsterdam: Elsevier, 2017, pp. 1-55.

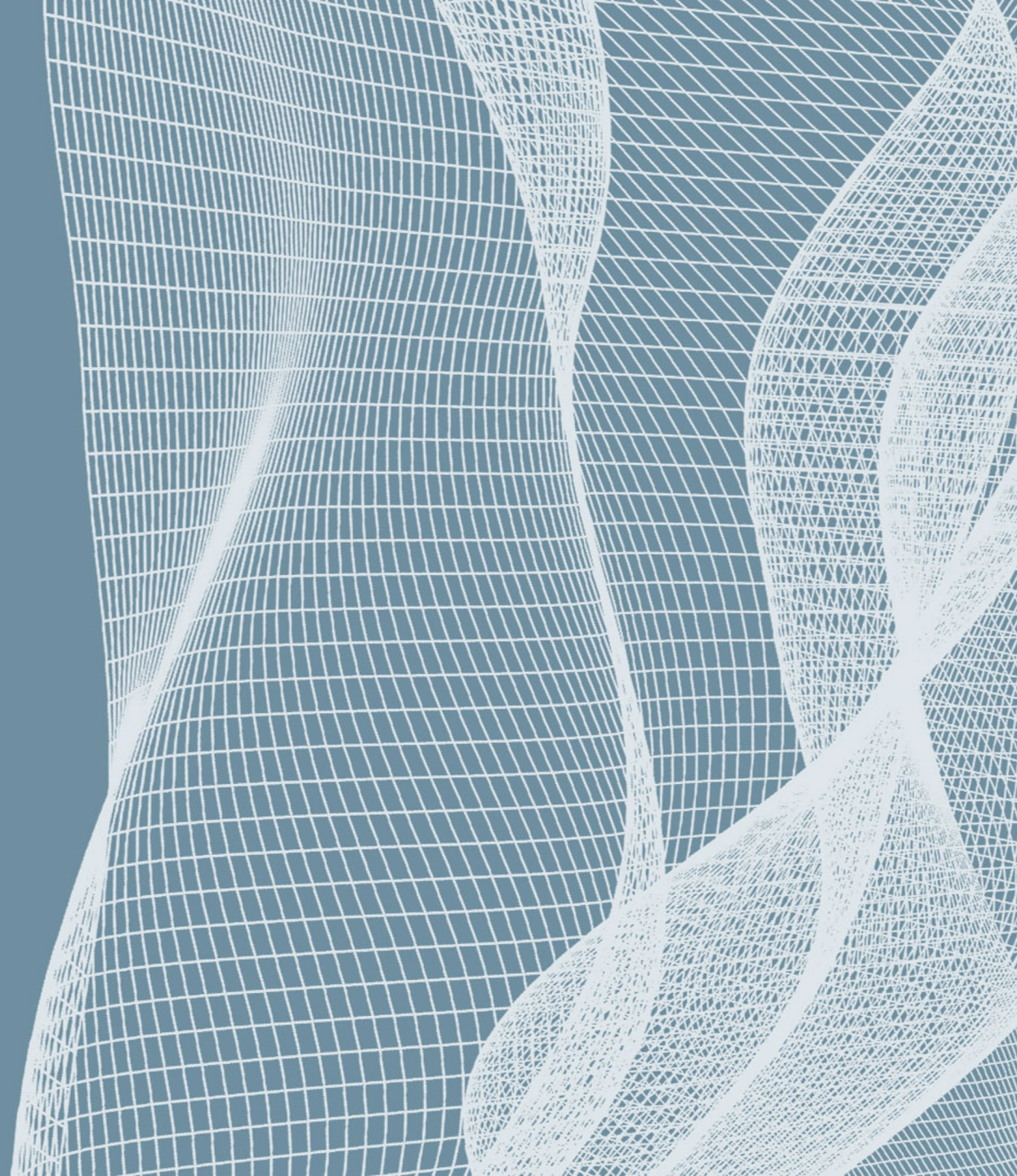
RECYCLING WASTE ACRYLIC TEXTILES

- 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

[4] S. Muthu, Y. Li, J. Hu and P. Mok, "Recyclability Potential Index (RPI): The concept and quantification of RPI for textile fibres", Ecological Indicators, vol. 18, pp. 58-62, 2012.

FINISH REMOVAL



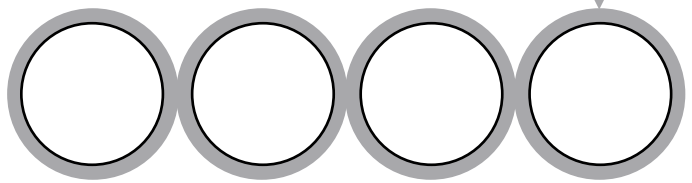
IDENTIFICATION OF FINISHES & COATINGS

1. Awning finish
2. Coating
3. Furnishing finish

IDENTIFIED CHEMICAL FINISHING COMPOUNDS

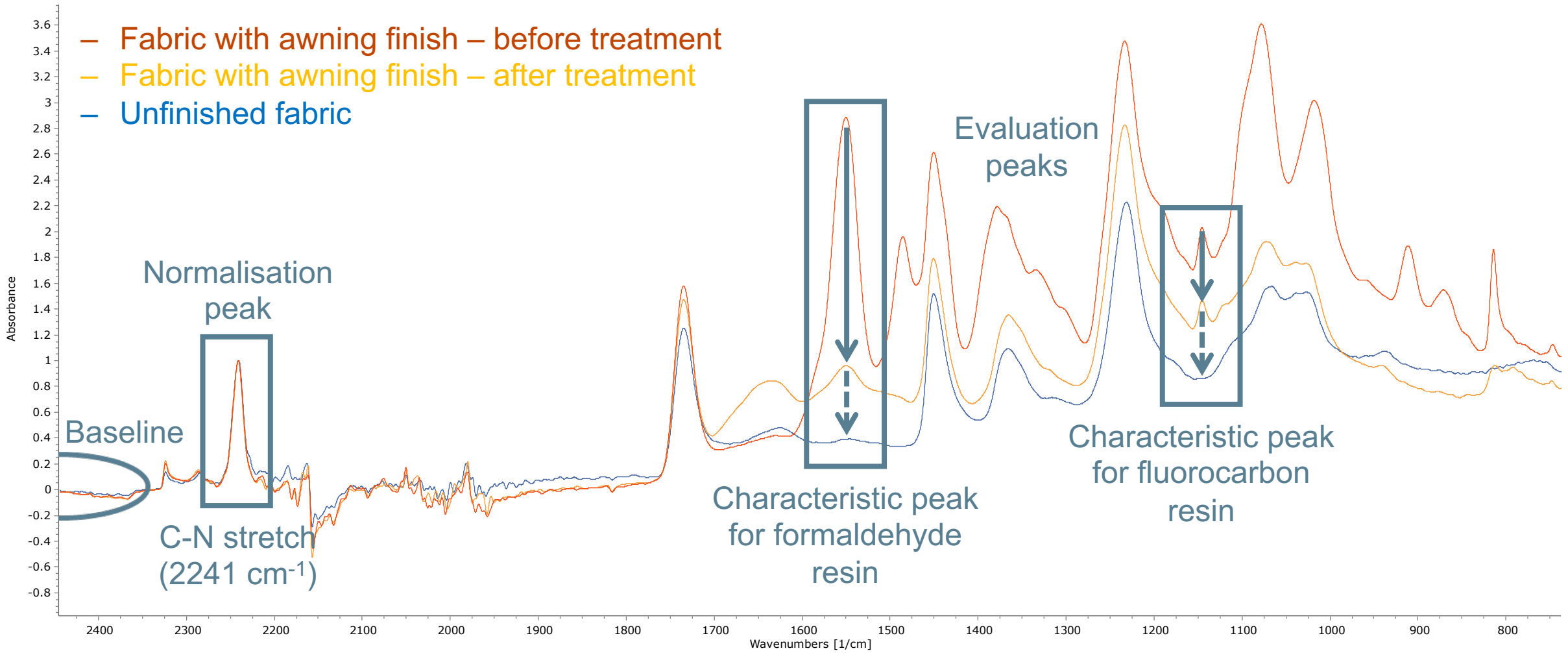
- Awning finish:
  - Formaldehyde resin
  - Fluorocarbon resin

- Furnishing finish:
  - Fluorocarbon resin
  - Softeners



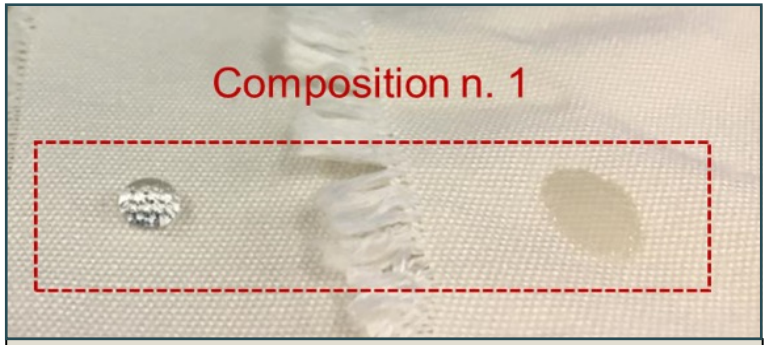
- Coating:
  - Formaldehyde resin
  - Fluorocarbon resin
  - Acrylic resin

EVALUATING REMOVAL EFFECTIVENESS (FTIR-ATR)

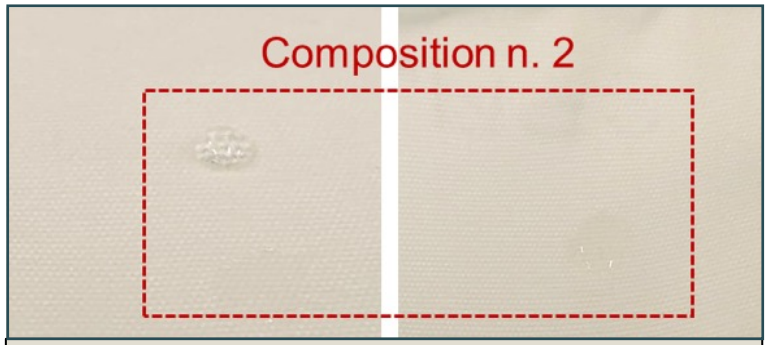


EVALUATING REMOVAL EFFECTIVENESS (OIL-REPELLENCY)

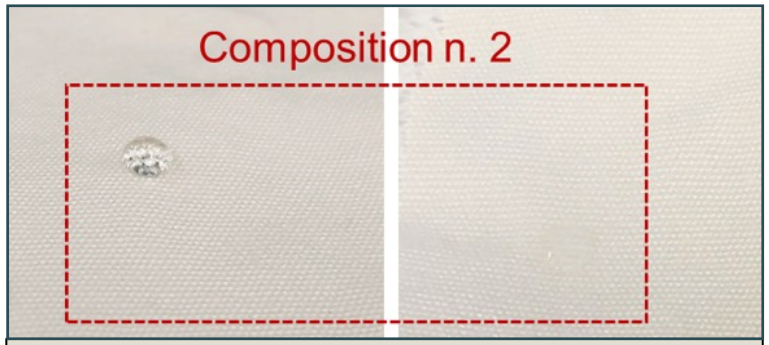
- Evaluation of fluorocarbon resin removal
- AATCC 118-2013



Awning finish	
Before treatment	After treatment



Coating	
Before treatment	After treatment

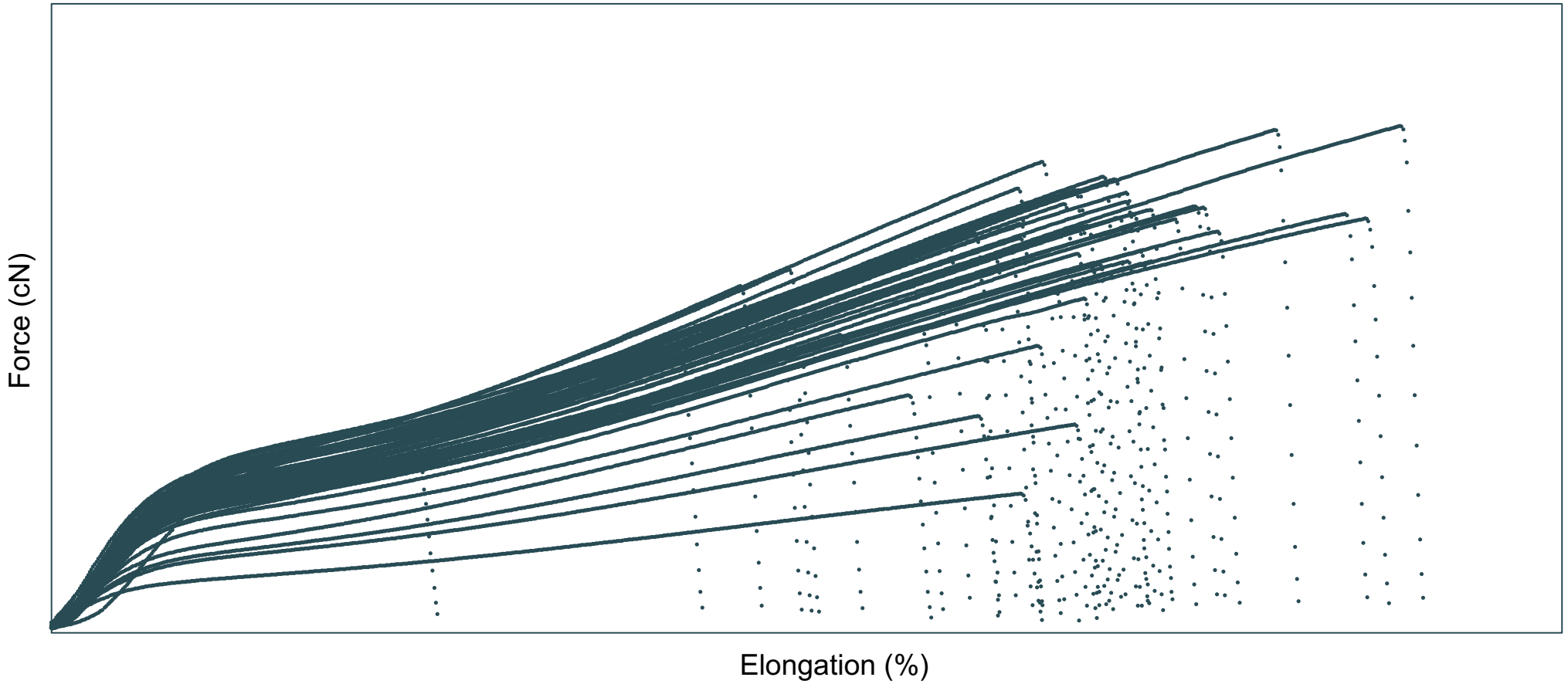


Furnishing finish	
Before treatment	After treatment

[2] M. Yang Qin, "Global fibres overview", Pattaya, May 2014.

ARE OUR PROCESSES DAMAGING TO THE FIBRES?

- Fibre-level tensile tests (FAVIMAT+)



IDENTIFIED CHEMICAL FINISHING COMPOUNDS

- Awning finish:
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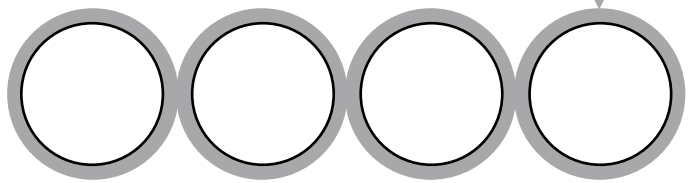
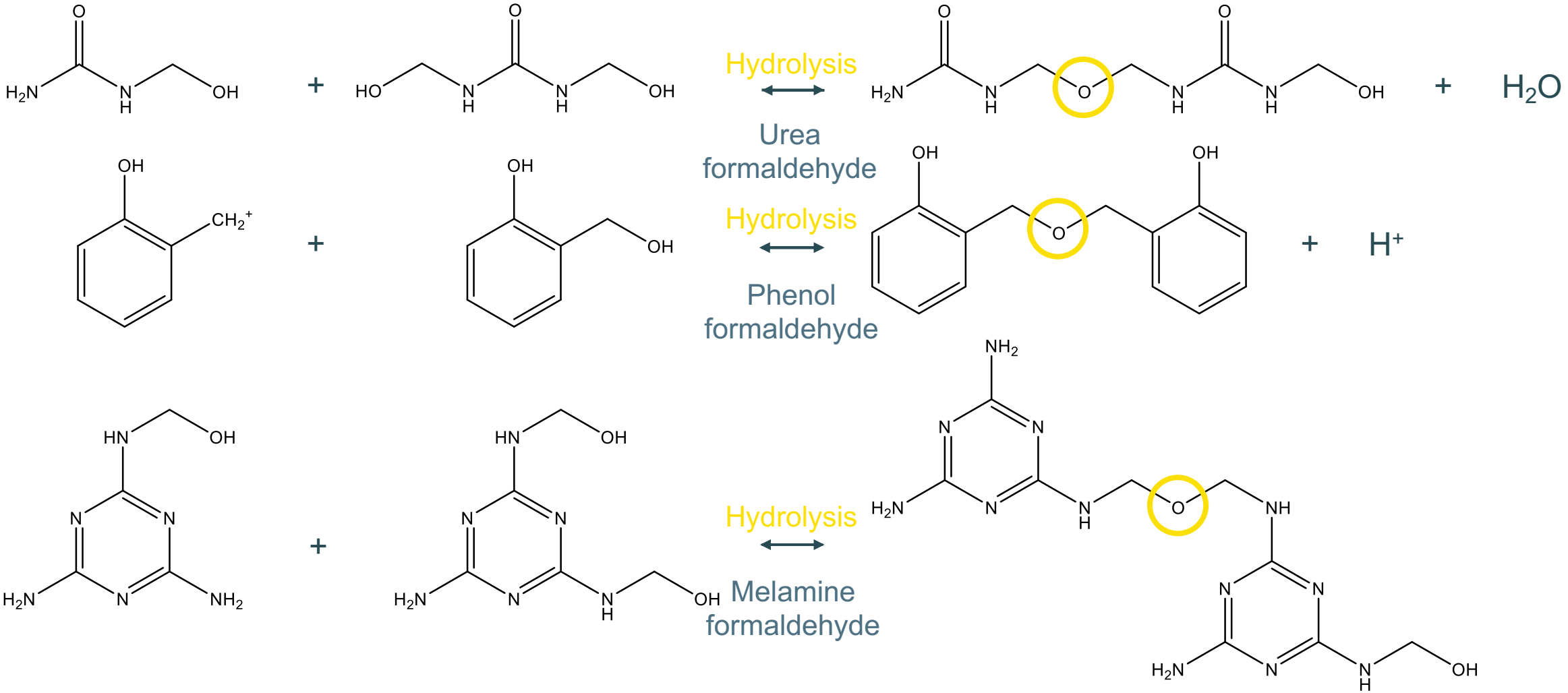
  - Fluorocarbon resin

- Furnishing finish:
  - Fluorocarbon resin
  - Softeners



- Coating:
  - Formaldehyde resin
  - Fluorocarbon resin
  - Acrylic resin

REMOVAL OF FORMALDEHYDE RESINS



HYDROLYSIS 1

Design of experiments → Statistical model → Optimised parameters

	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

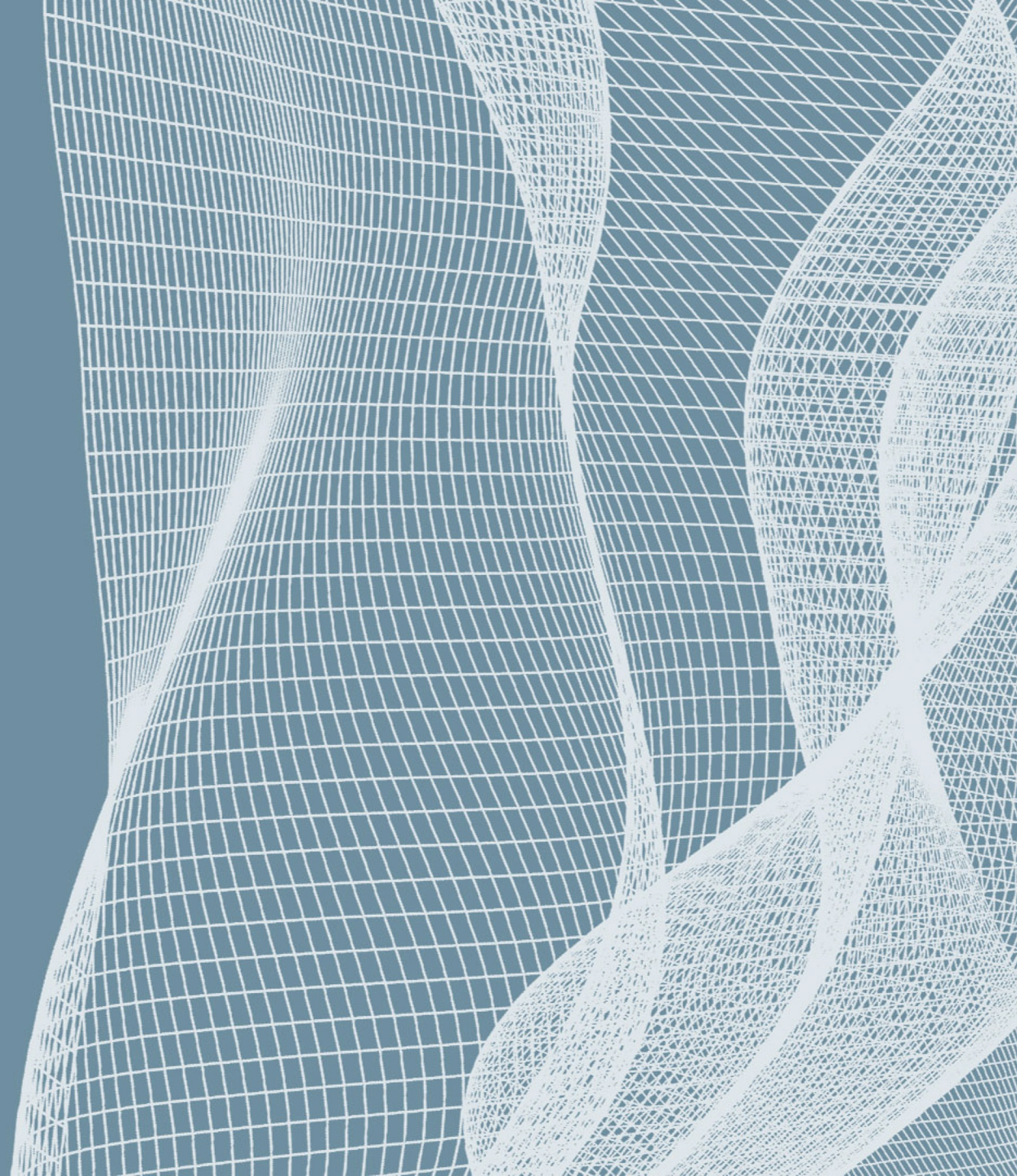
HYDROLYSIS 1 & 2 + WASHING + PHYSICAL TREATMENT

- 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 mechanical damage to the fibres and upscalability of the physical treatment → further investigation required

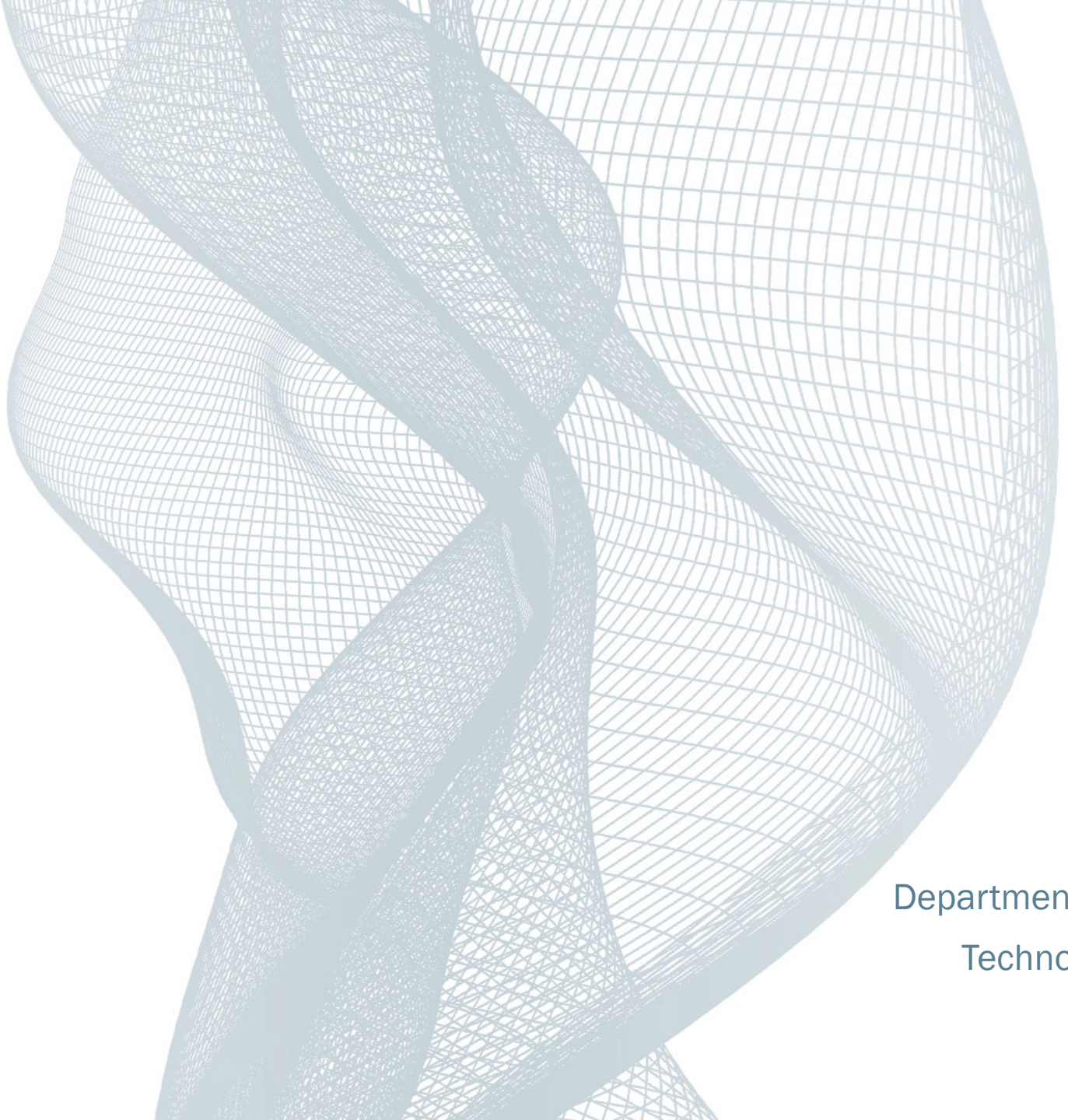
CONCLUSION



CONCLUSION

- 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 + washing + physical treatment is an optimised, lab-scale series of treatments that can remove over 90% of all finish components from outdoor acrylic textiles

- More research necessary to ensure physical treatment does not damage the fibres and is upscalable in industry
  - Optimise parameters
  - Find alternative treatment



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REACT

THANK YOU FOR YOUR ATTENTION

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 820869