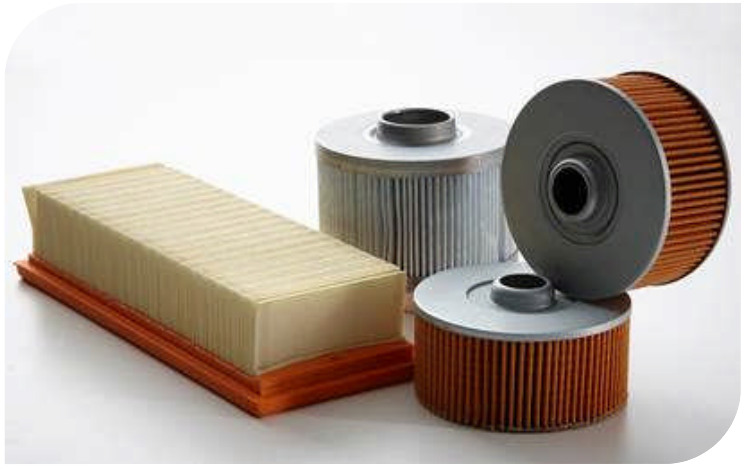
Automotive filtration – fibrillation makes the difference



A Slater

Lenzing Fibers

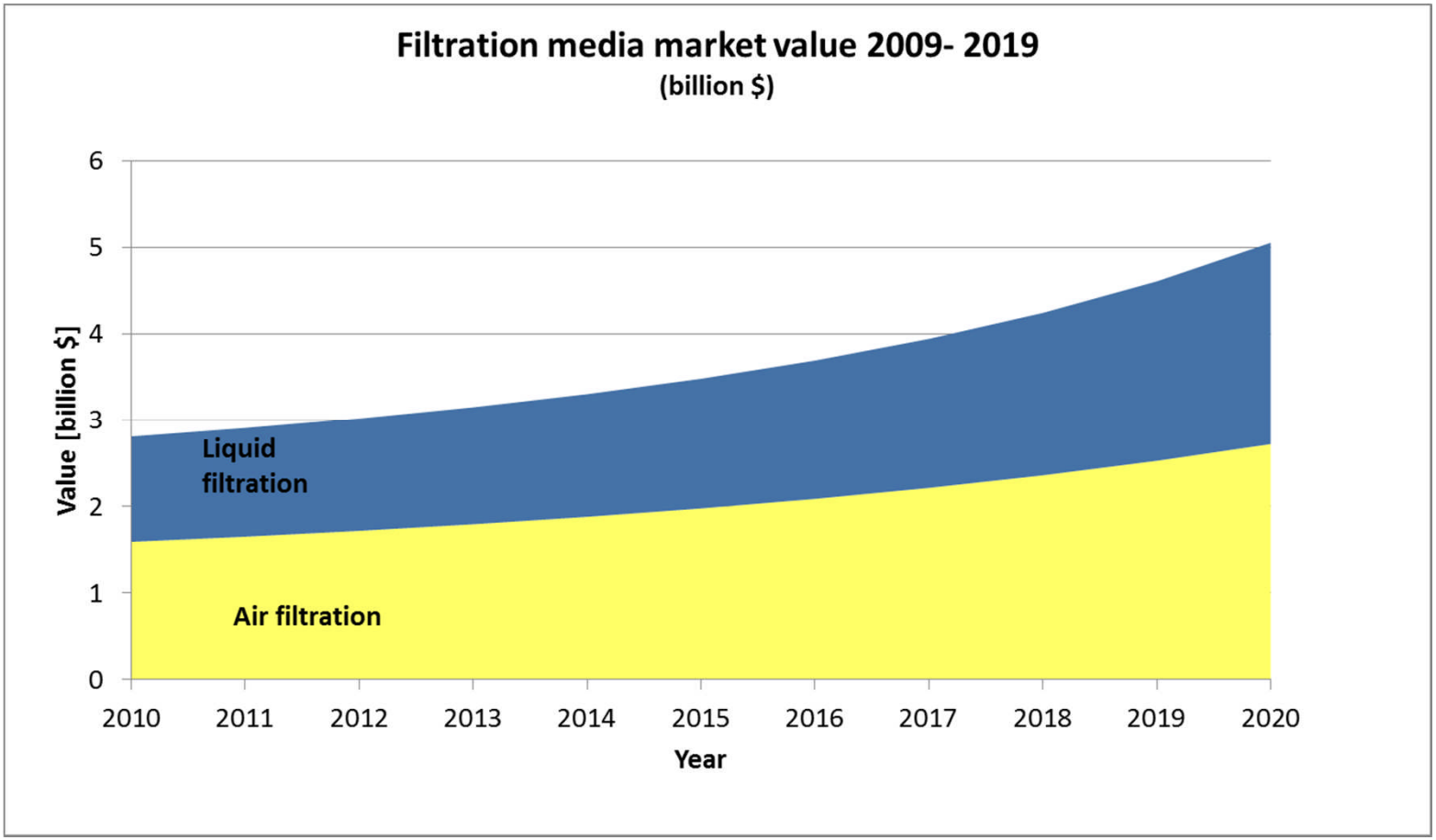
Stefan Rief & Konrad Steiner, Fraunhofer ITWM, Kaiserslautern

55th Dornbirn man-made fibres Congress

September 2016

a.slater@lenzing.com

Filtration media market growth



Source: Lenzing estimates

Filter media requirements

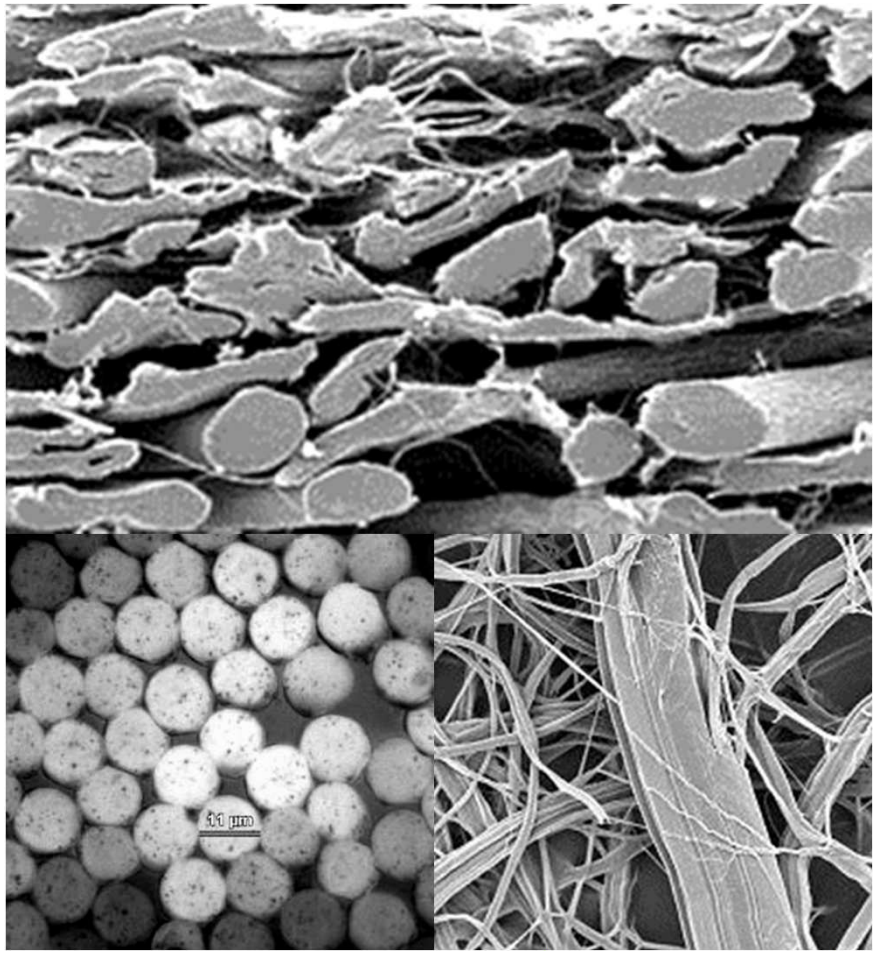
Functions:

- Filtration efficiency
- Dust holding capacity
- Mechanical stability
- Thermal stability
- Chemical resistance
- Lifetime cost…….

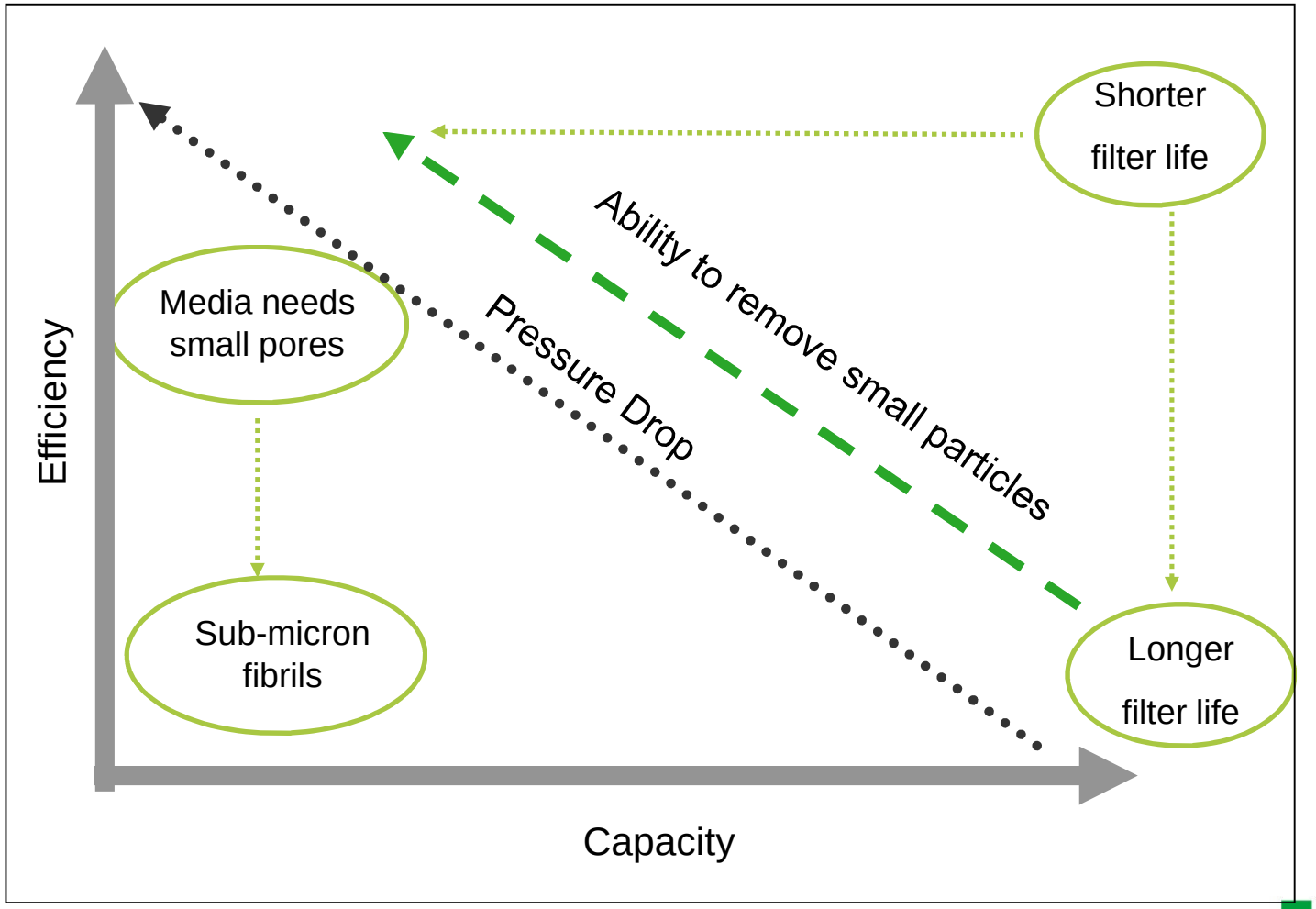
Fibers in filtration

Variables:

- Natural or Synthetic
- Chemical type
- Diameter
- Length
- Electrostatic function
- Ionic function
- Media production process



High performance filters require fine fibres



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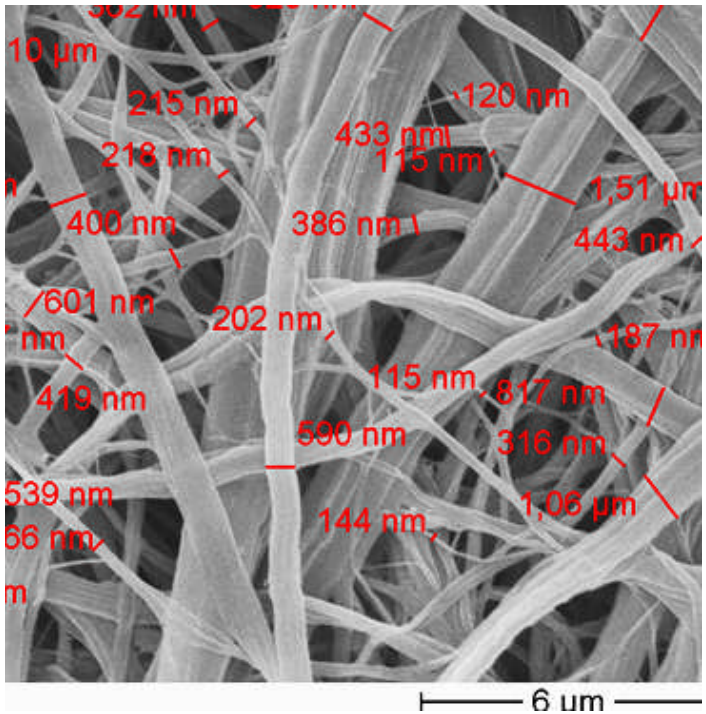
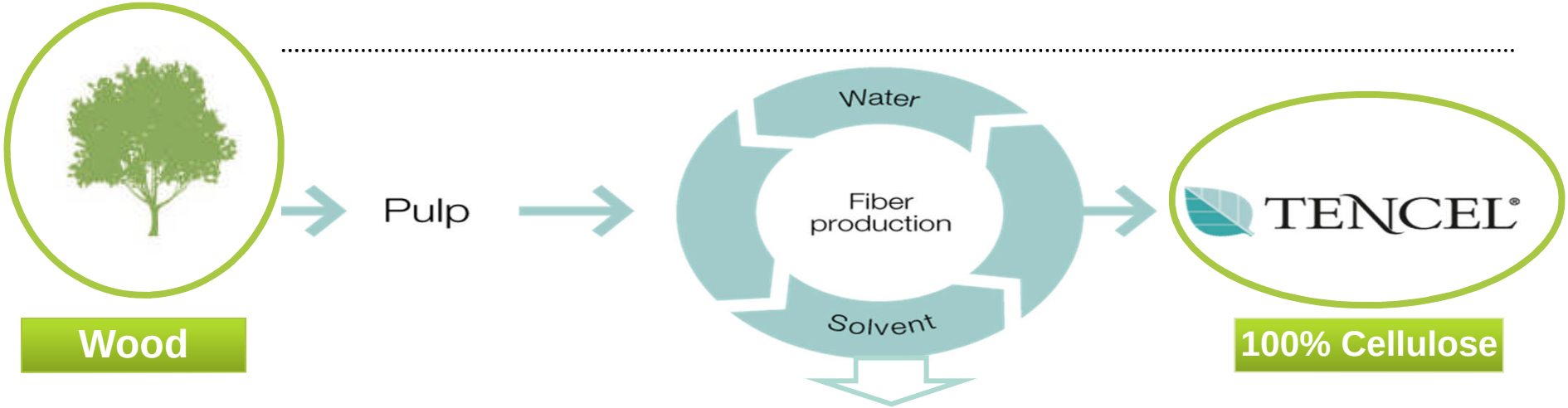
Commercial routes to micro-fibres

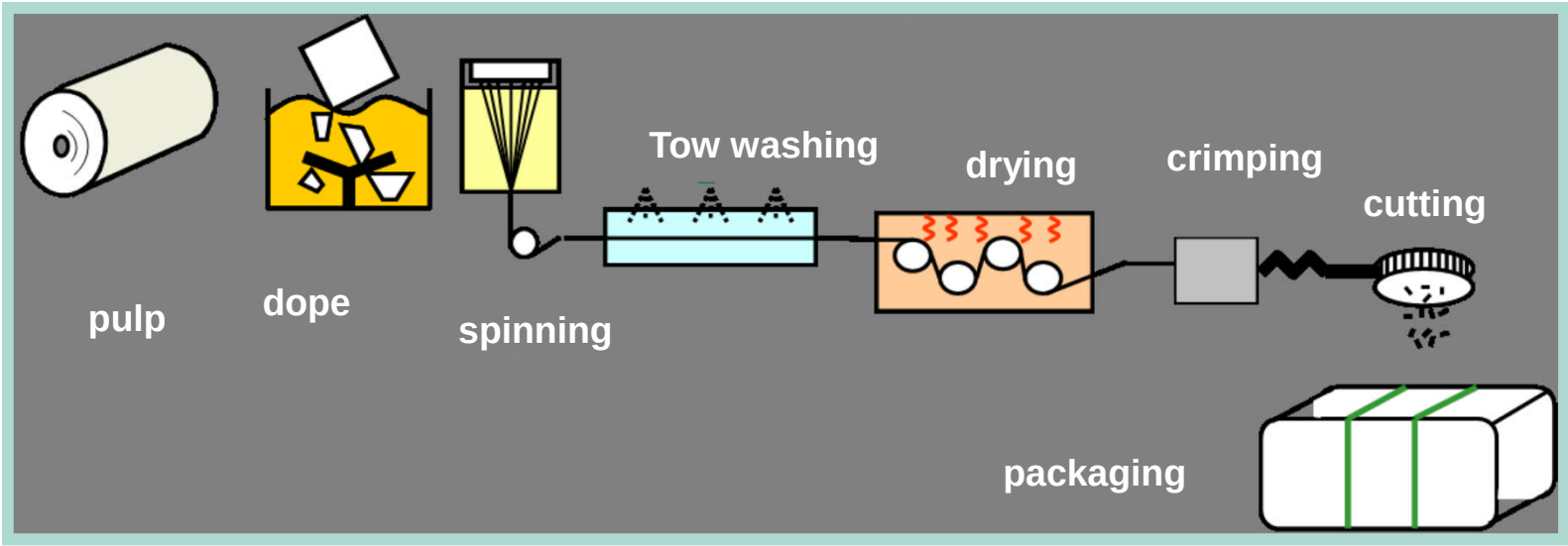
- Fine dtex melt spinning
  - E.g. 0.7 micron polyester[1]
- Meltblown fibres
  - E.g. 0.26 micron glass fibres[2]
- Splittable fibres

  E.g. 1 micron polyamde[3]
- Electrospinning
  - E.g. 80 - 500 nm polymer fibres [4]
- **Fibrillation** – microfibrillated TENCEL® - 100nm -10µm cellulose



TENCEL® is a lyocell fibre produced from wood

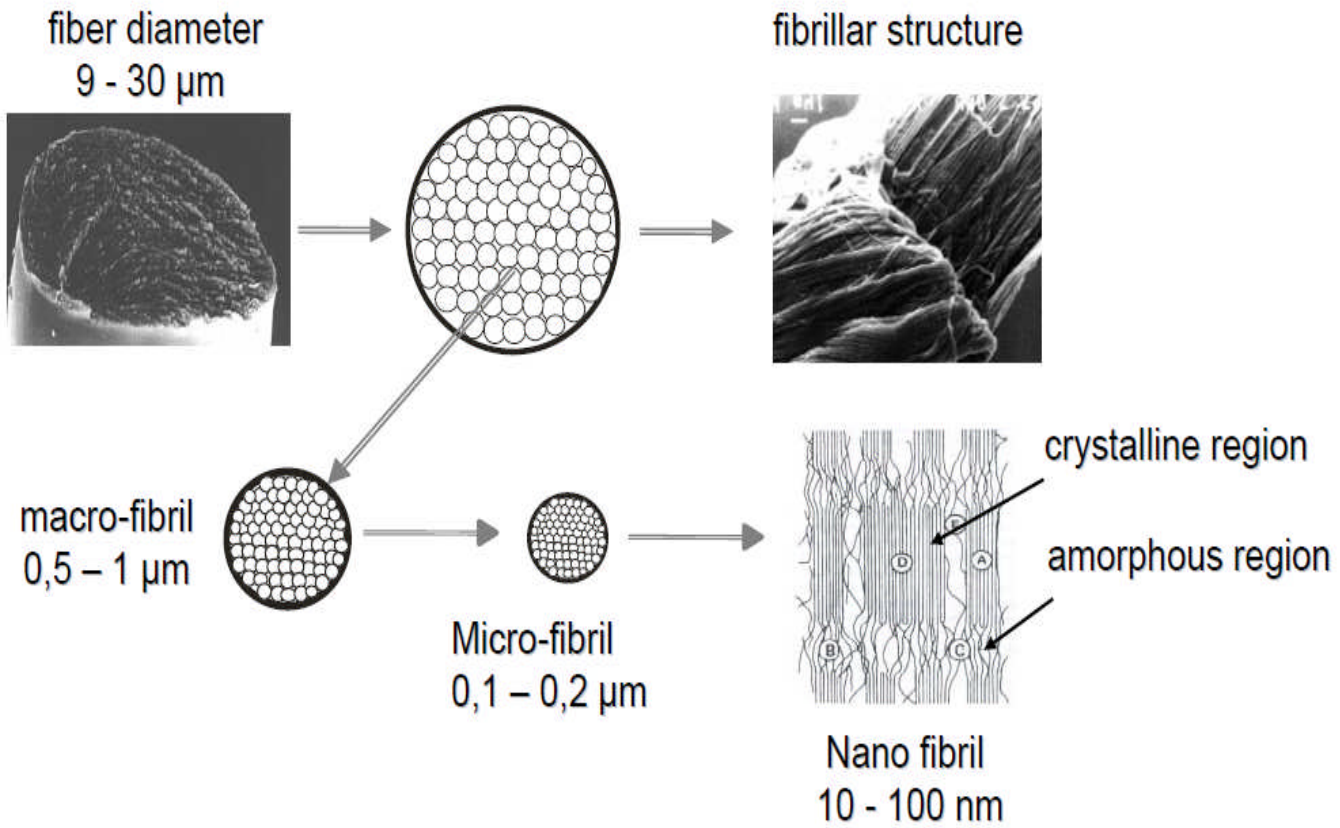




TENCEL® unique structure..

Fiber Morphology

- Smooth Surface
- Round Cross Section



Structural Properties

- Fibrillar Structure
- High Crystallinity
- High Orientation
- High Purity

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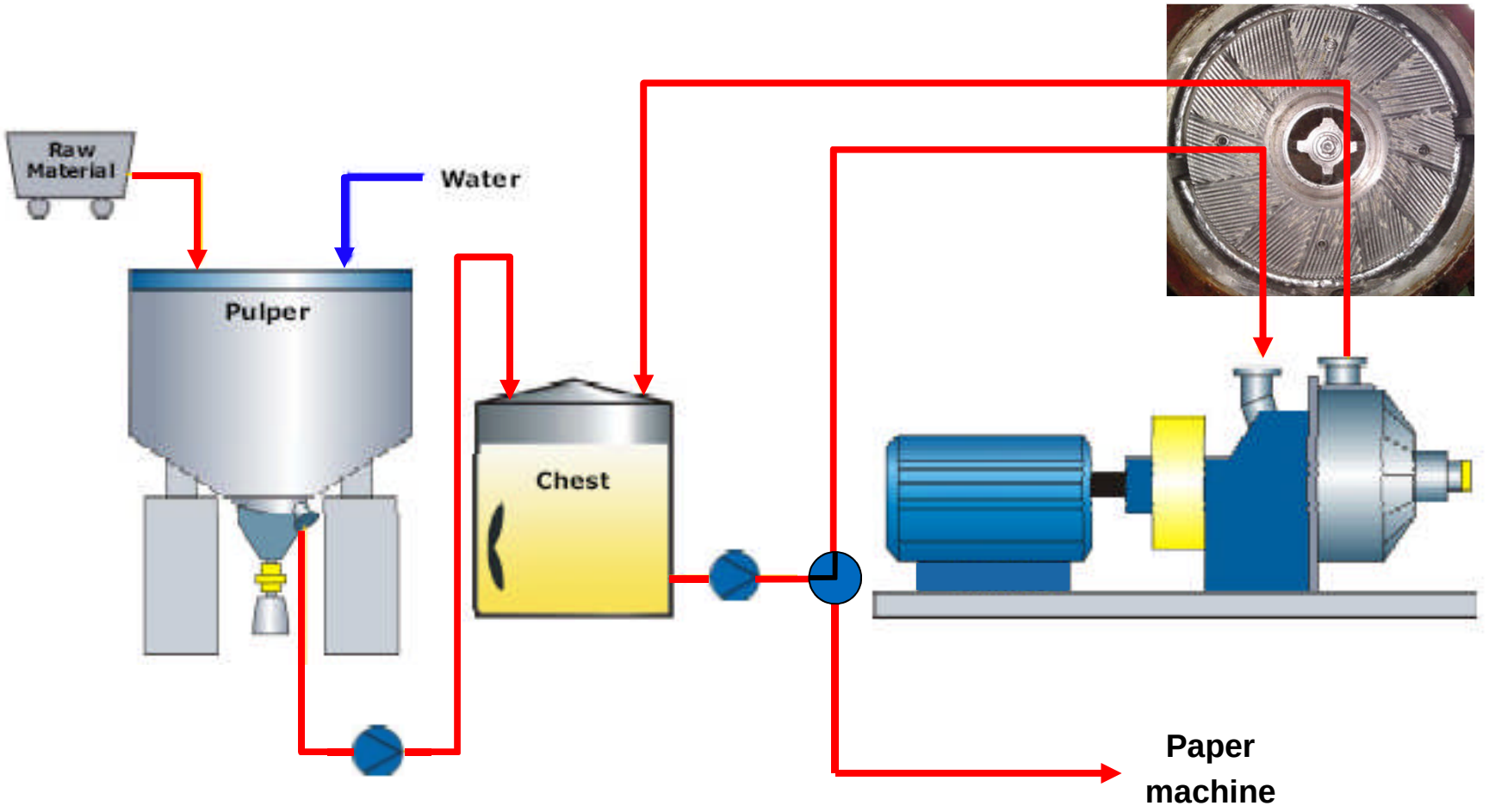
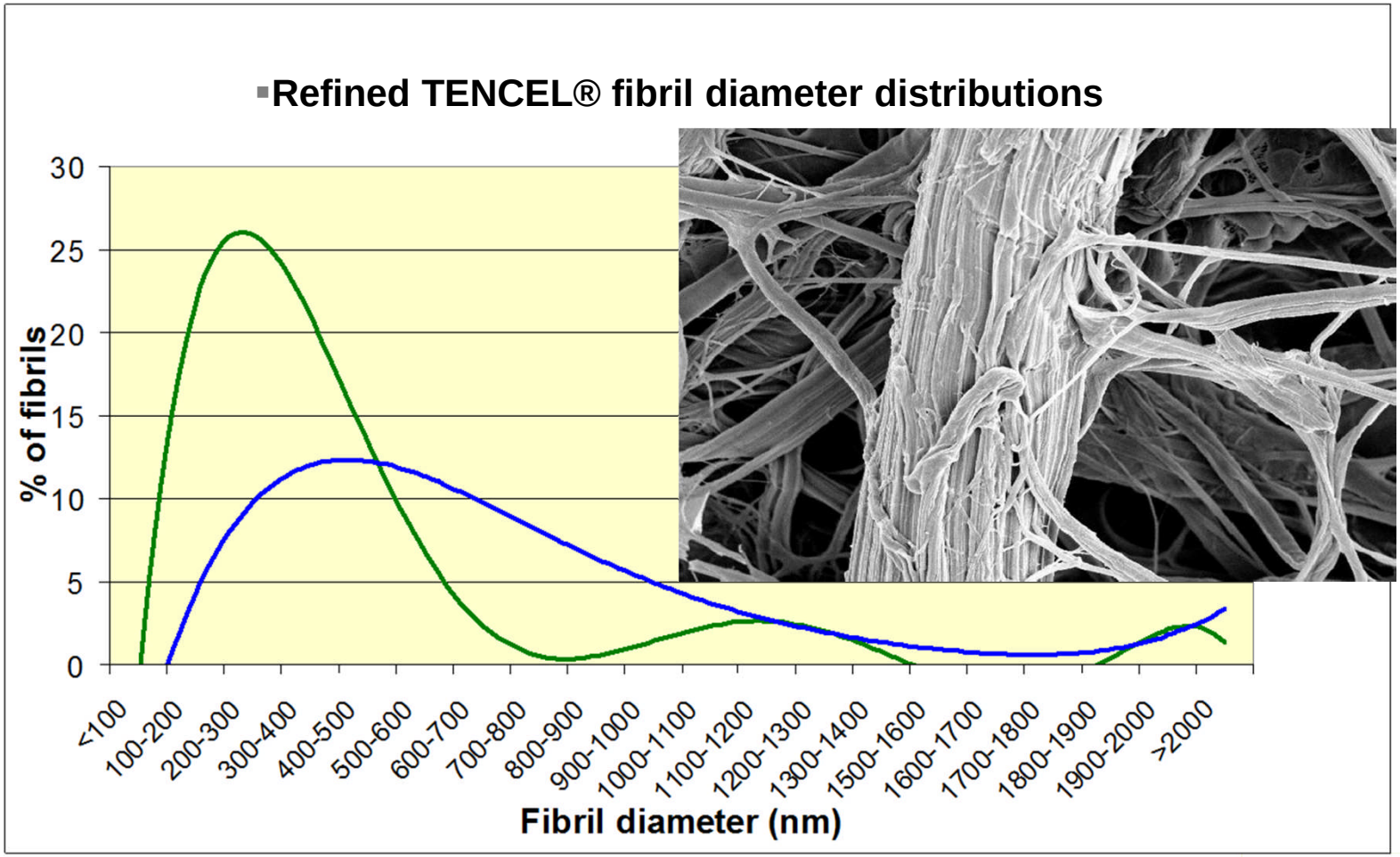
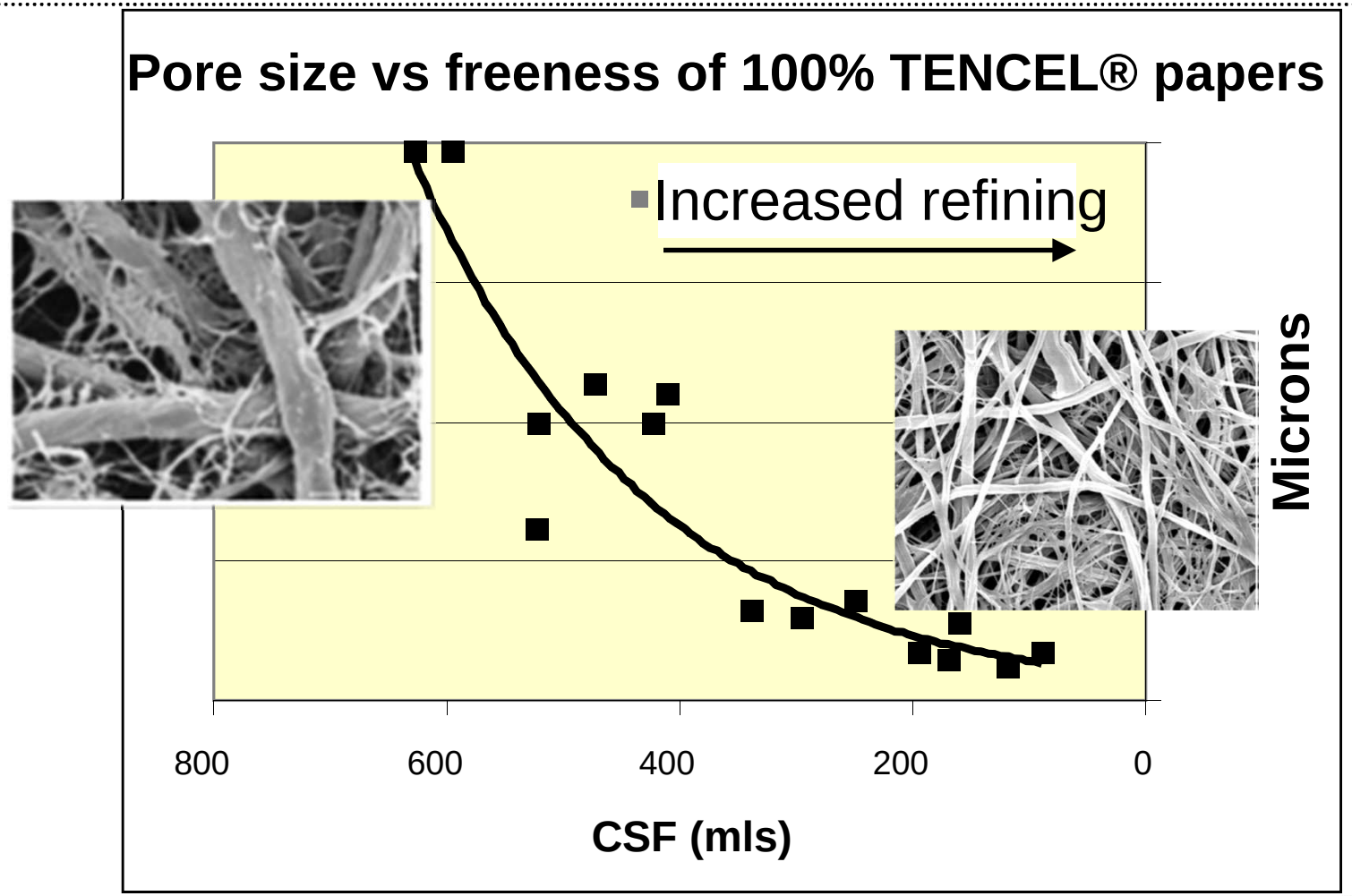
Refiner set-up



TENCEL® Microfibrillated fibril diameter distribution

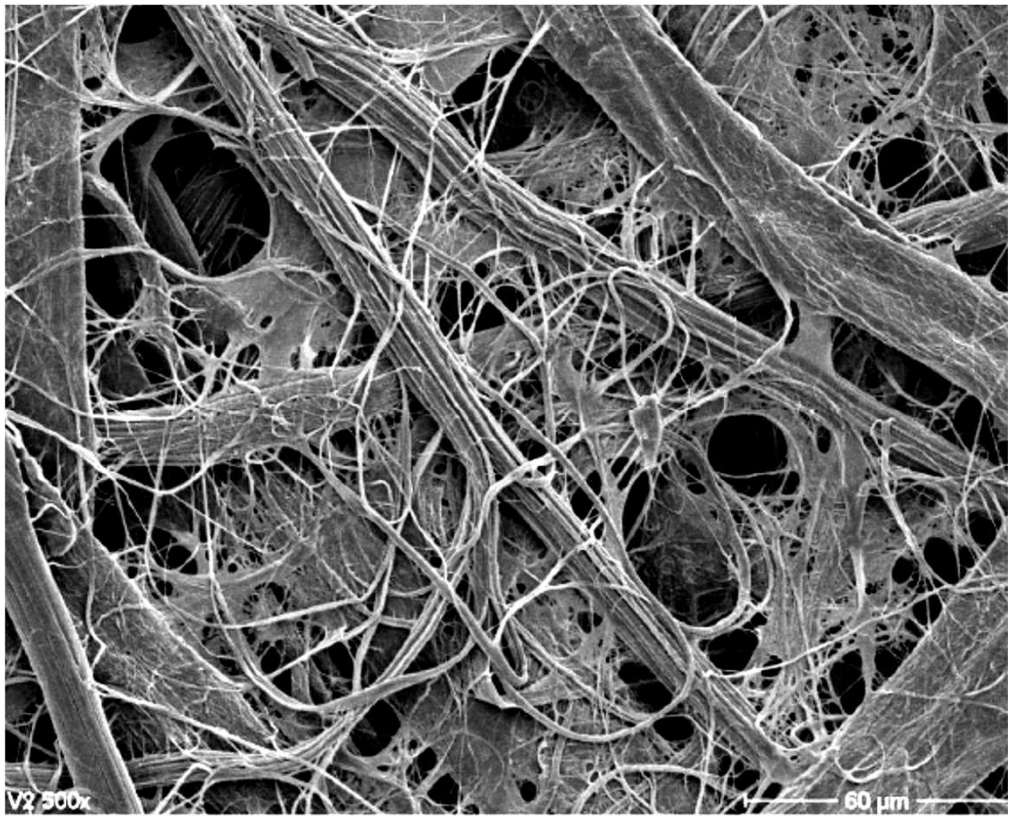


Pore size

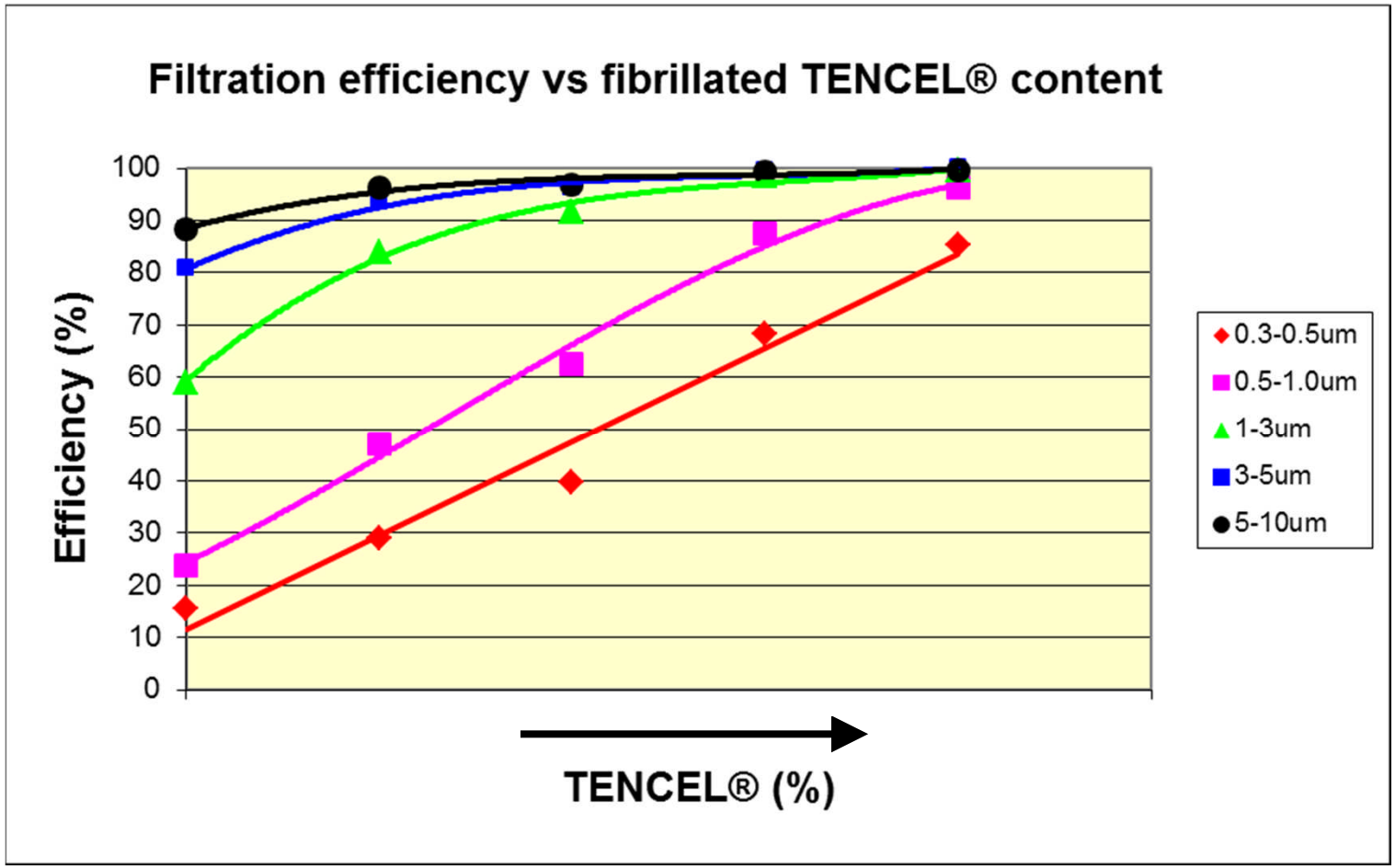

Pore size vs freeness of 100% TENCEL® papers
Increased refining
Microns
800
600
400
200
0
CSF (mls)

Formulated media

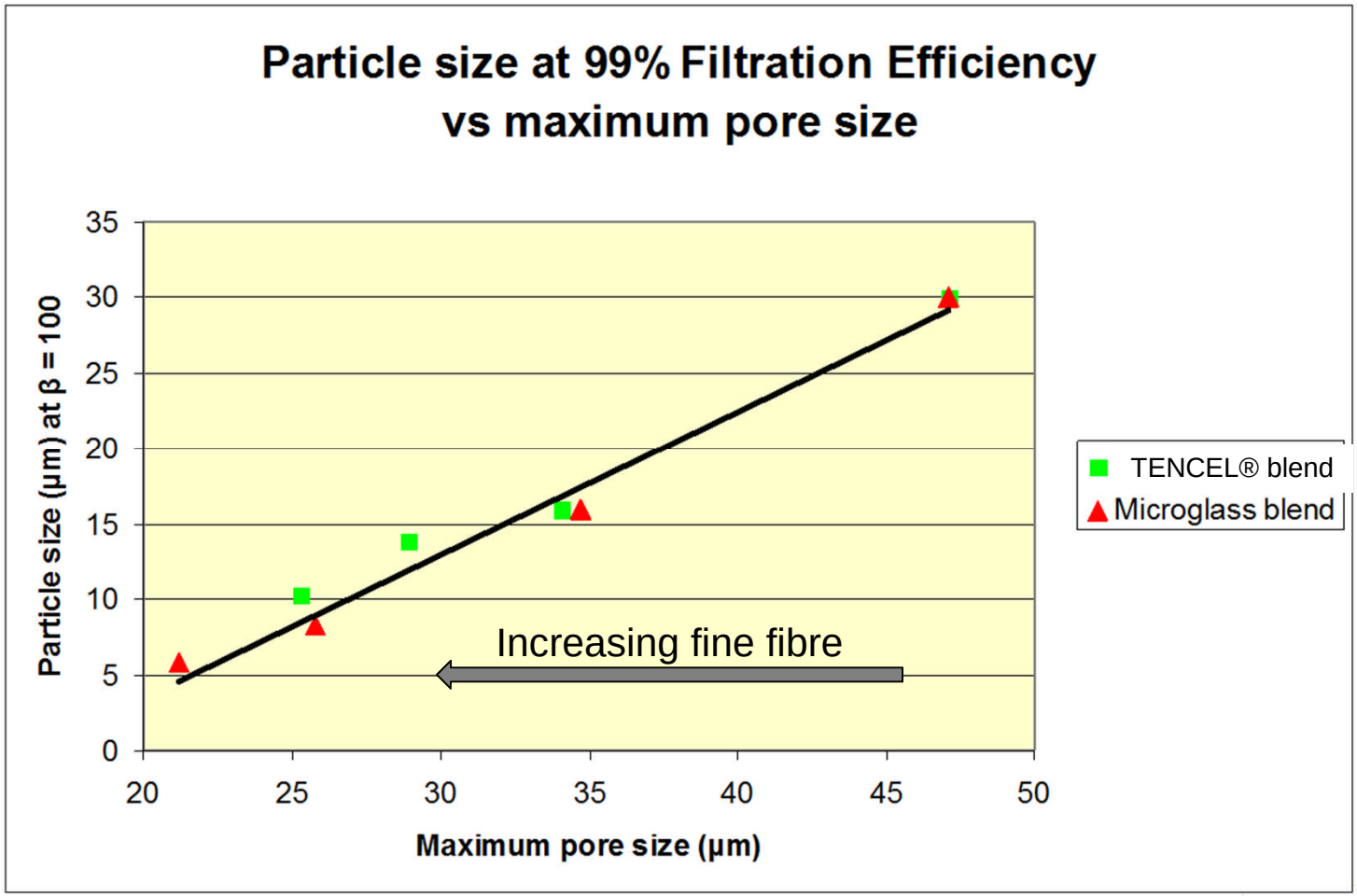
Microfibrillated TENCEL® is used as a blend component within a media formulation to enhance filtration efficiency



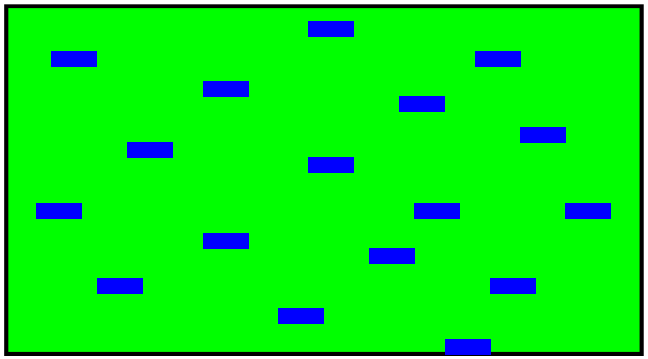
Increasing particle filtration efficiency



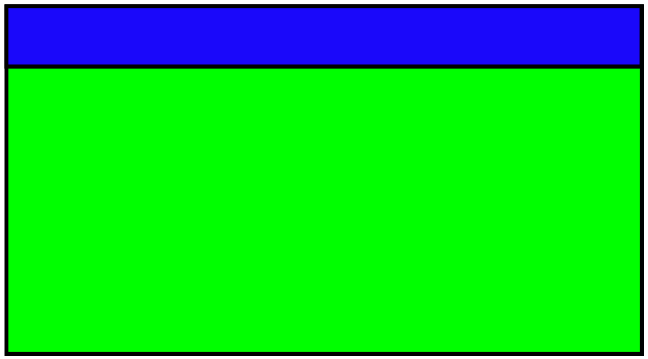
Glass-free media formulations



Engineered media structures



Blended media



Layered media

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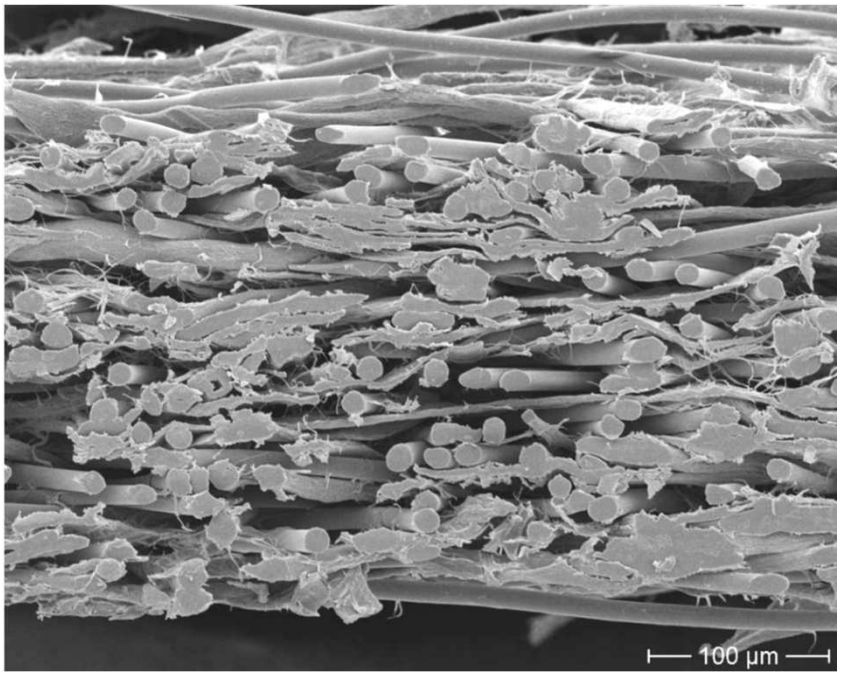
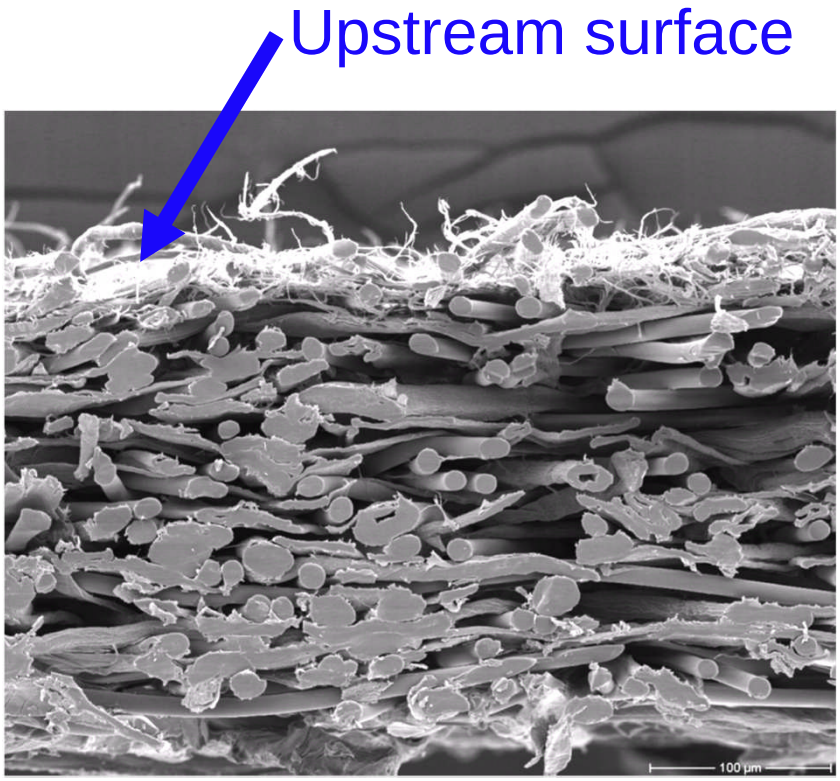
Media cross-sections

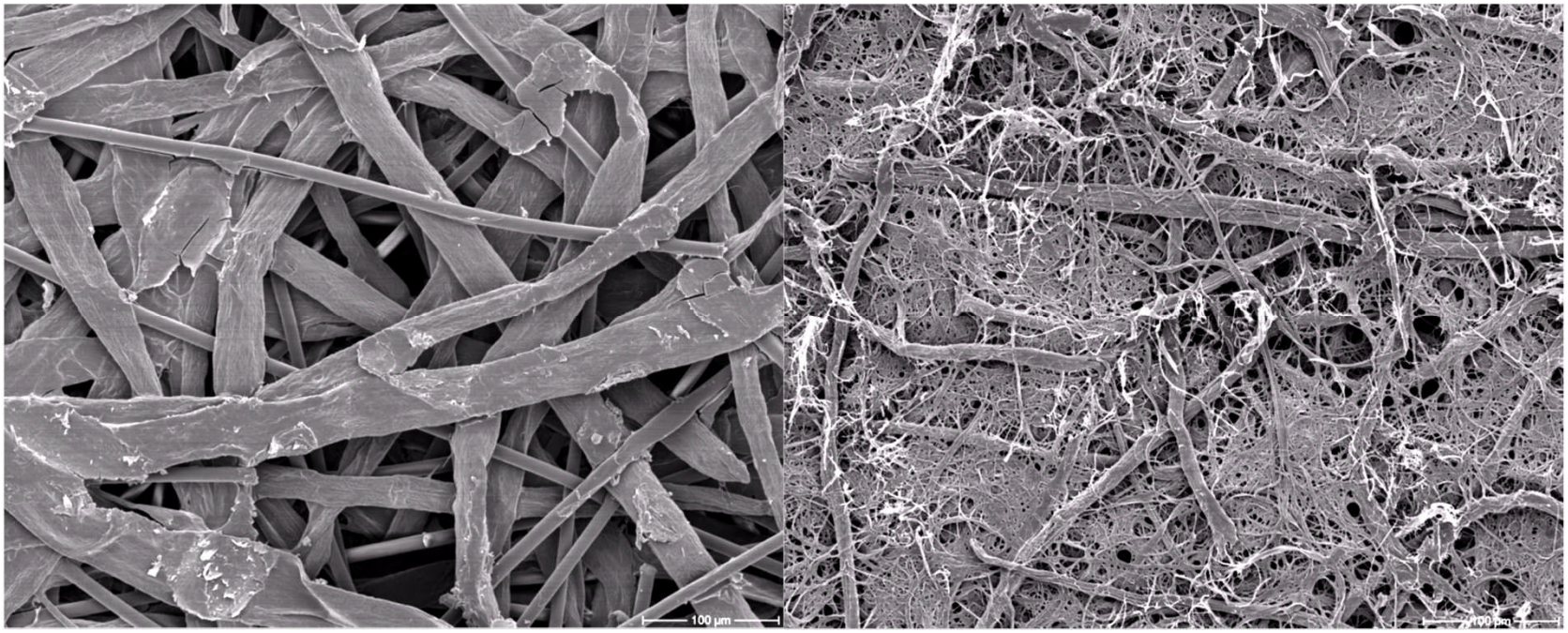


Blended media



Layered media

Actual layered media structures



Downstream surface

Upstream surface

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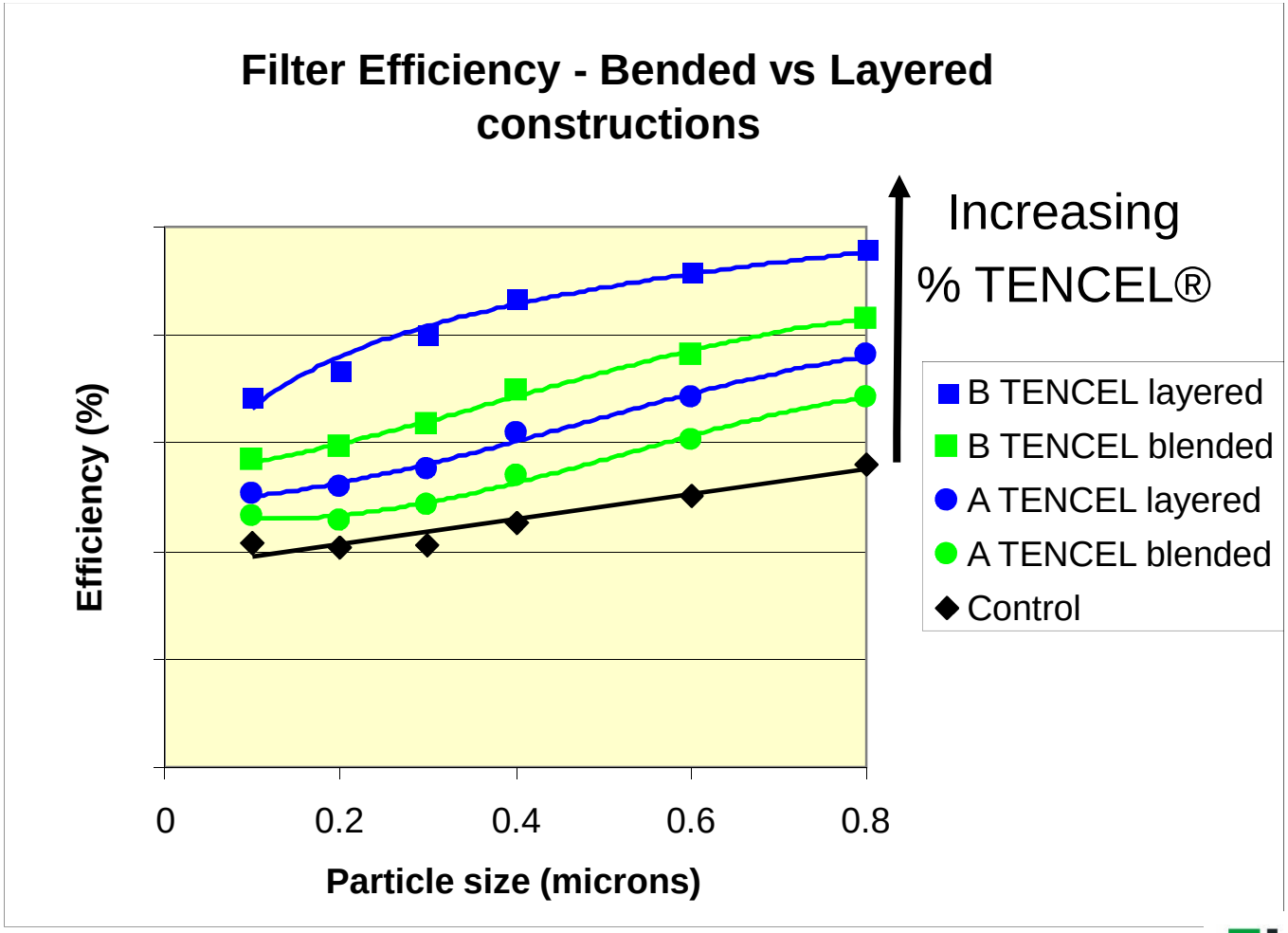
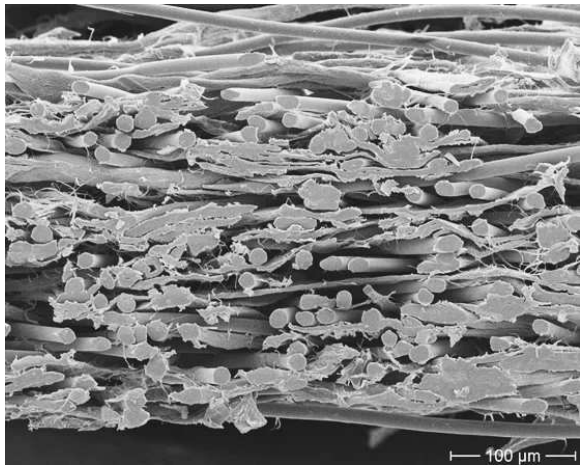
Filtration efficiency

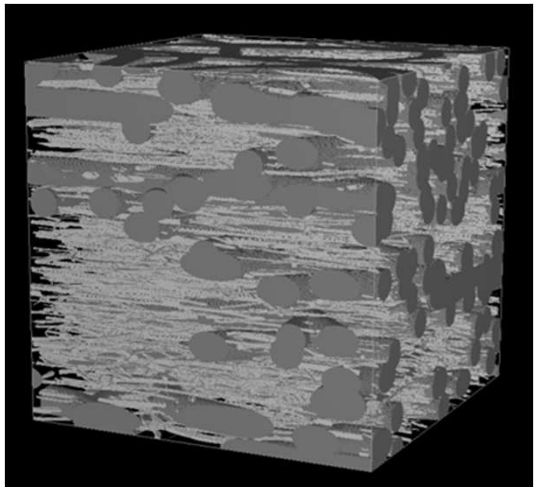


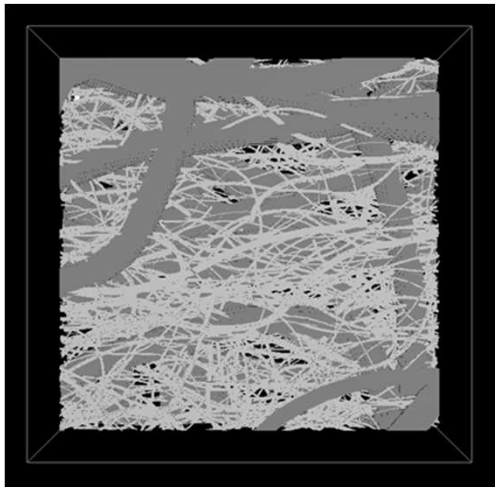
Mathematical simulation

Model definition

- Fibre diameter & density, + binder density
- Fibril diameter distribution & fibre types
- Random filament placement, 100nm voxel size
- Sheet thickness, basis weight, composition
- Fibre volume fraction, binder volume fraction
- Percentage fibrillation of TENCEL® fibres







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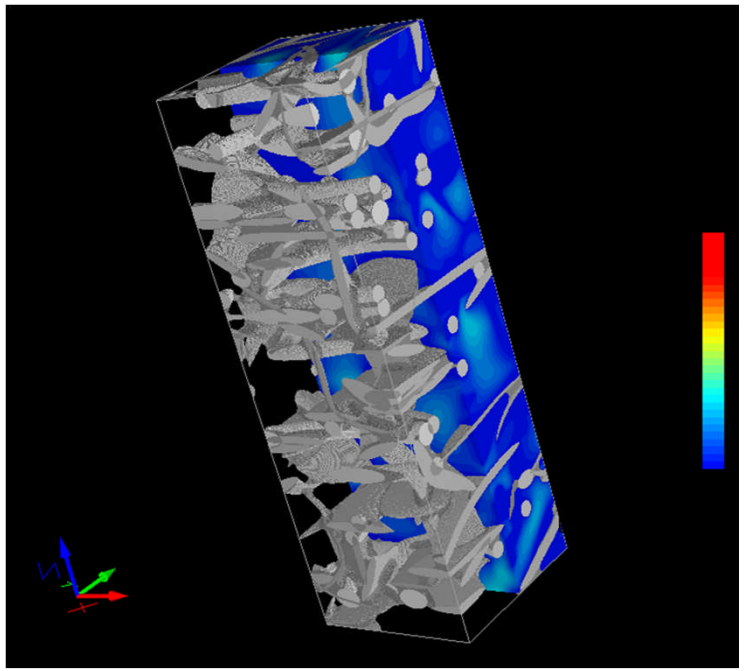
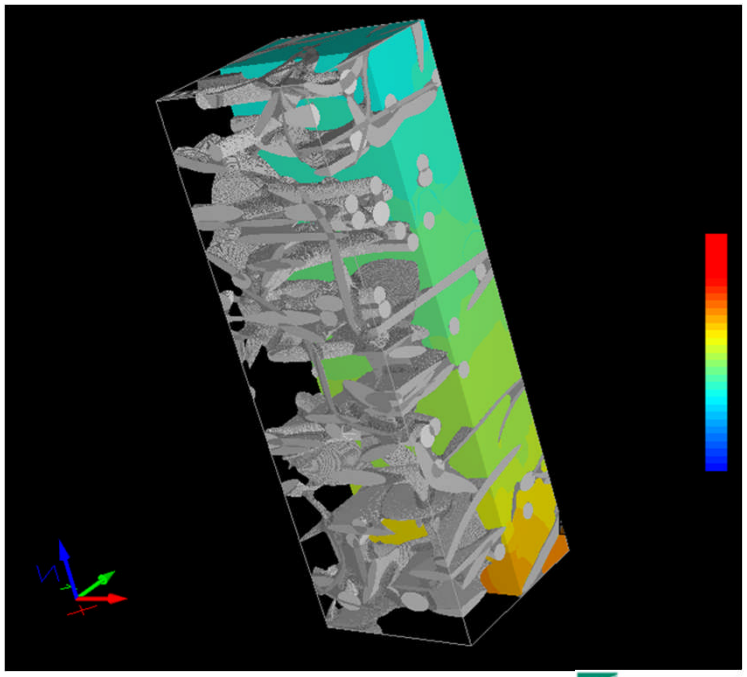
Model simulation

- CFD simulation of flow velocity through media and calculation of permeability and pressure drop using Darcy's law



Flow velocity



Pressure drop

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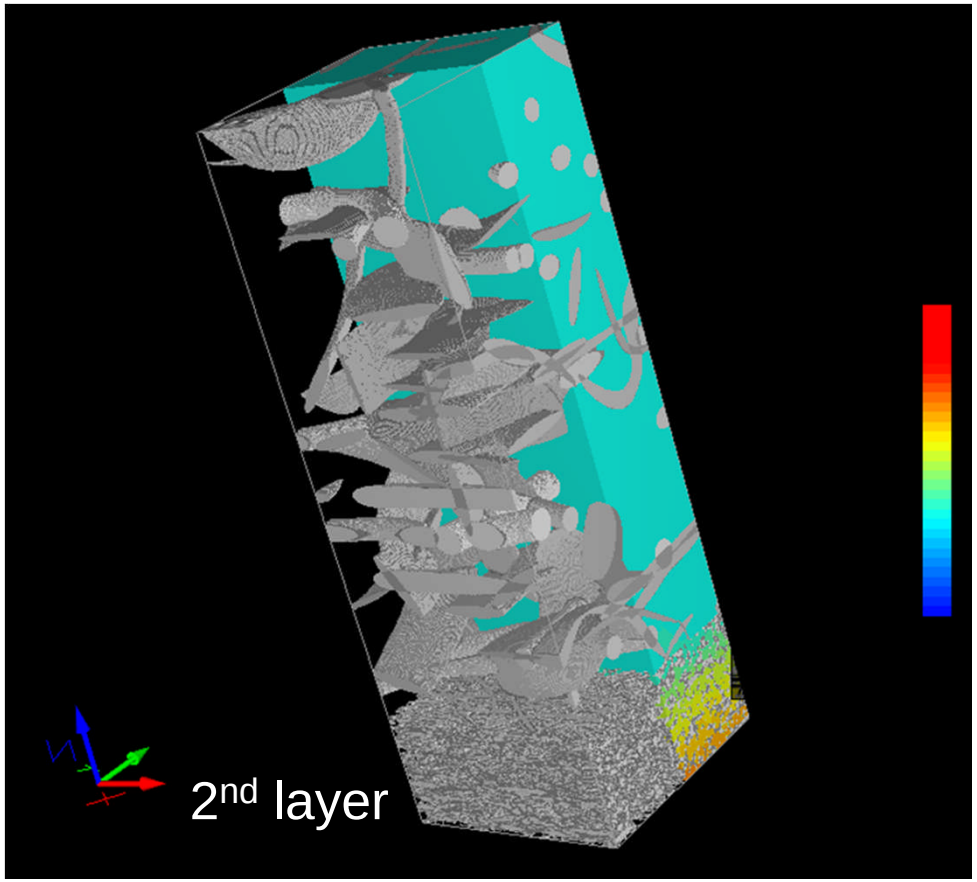
Two-layer structures

Pressure simulation through two-layer media thickness



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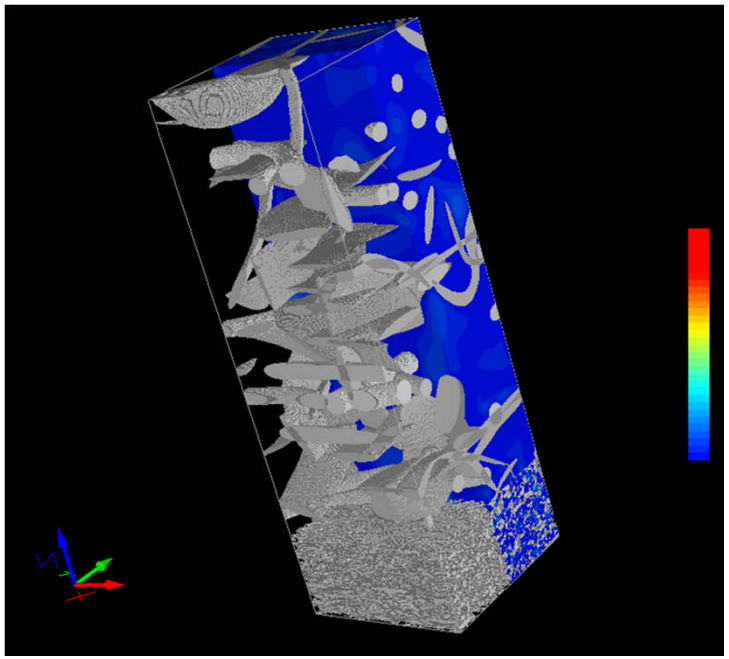
Filtration efficiency

- Simulation of particle capture efficiency through media thickness
- Simulation of media blocking as a function of time
- Simulation of 2-layer, gradient porosity, media designs



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Summary

- Filtration market continues to exhibit growth across major segments
- Incorporation of microfibrillated TENCEL® within a media formulation increases fine particle filtration efficiency of sheet filters
- Microfibrillated TENCEL® is used as a formulation component of glass-free filter media
- Gradient pore structures utilising multilayer constructions maximise filter efficiency and capacity
- Mathematical simulation provides a tool to assess the effects of fibre and formulation variables on the performance of filter media

Acknowledgements

Stefan Rief and Konrad Steiner – Fraunhofer ITWM

References

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2 W A Goddard et al, Handbook of nanoscience, engineering & technology, 2nd Ed. CRC Press

3 Lausche Fiber International, datasheet U-805EN, Jul 2013

4 S Petrik, EDANA International Nonwovens Symposium, May 2009

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In harmony with nature