

# Microscopic Analyses of Filtering Media

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# Context

## EU Single Use Plastic Directive

### Ban as of 2021



# Microscopic Analyses of Filtering Media



Optical microscopy <sup>1</sup>

Leica MZ6  
iScope Euromex



Scanning electron microscopy <sup>2</sup>

JEOL, JSM-IT500HR



X-Ray 3D microscopy (tomography) <sup>3</sup>

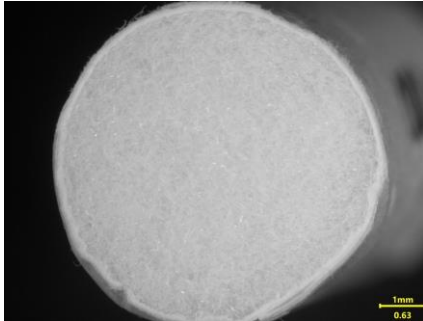
Xradia Versa 620 (Zeiss)

# Optical Microscopy

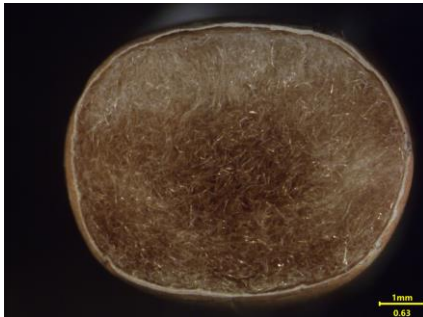
Allows to visualize the filter appearance



Cellulose acetate filter

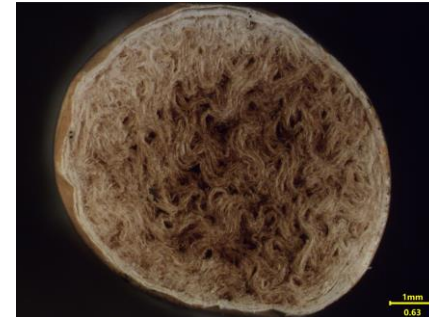
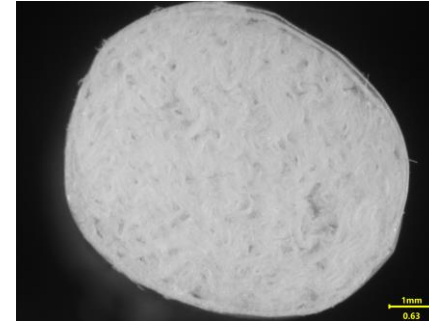


Before consumption

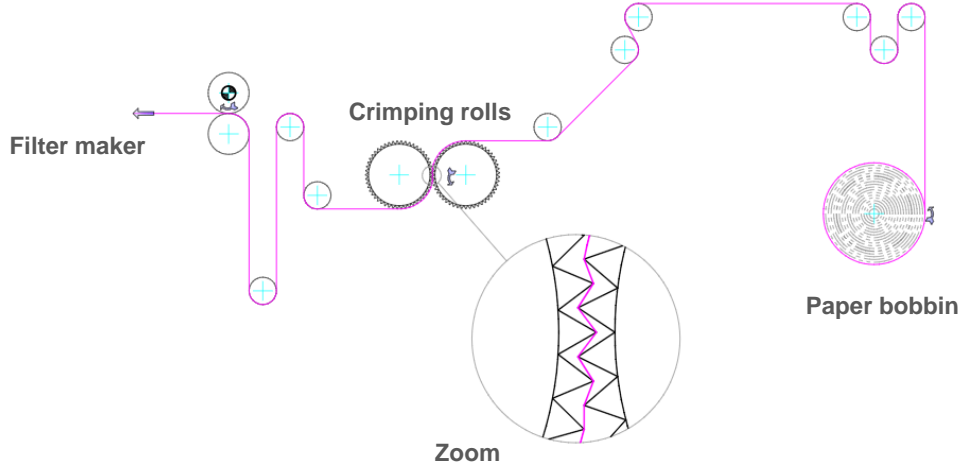


After consumption

Crimped paper filter

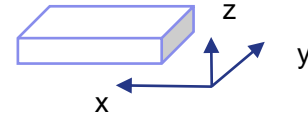
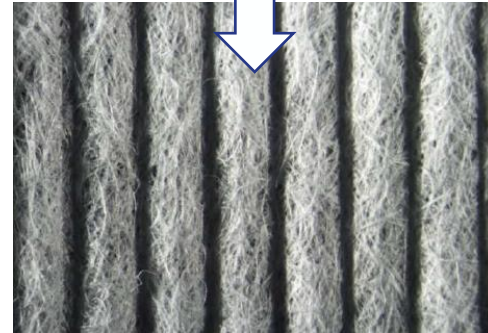
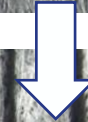
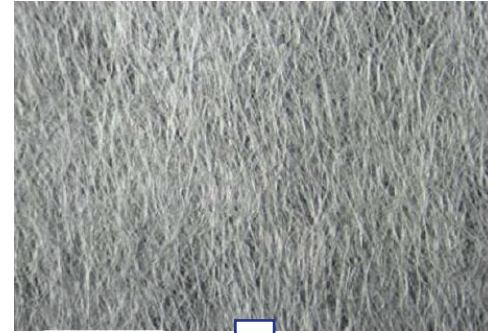


# Paper Filter – Crimping Process



Crimping parameters:

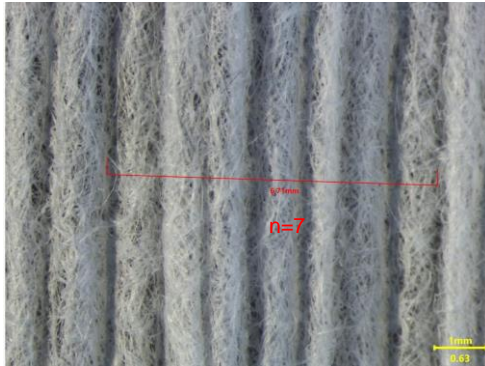
- Teeth penetration
- Pitch (distance between two teeth)
- Teeth design



Crimping expands the paper in X and Z directions, which changes its apparent density

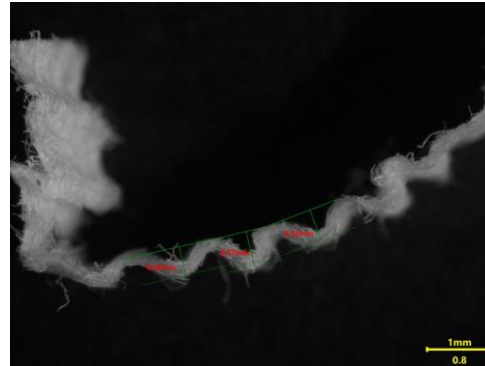
# Optical Microscopy

Allows to estimate crimping influence on paper

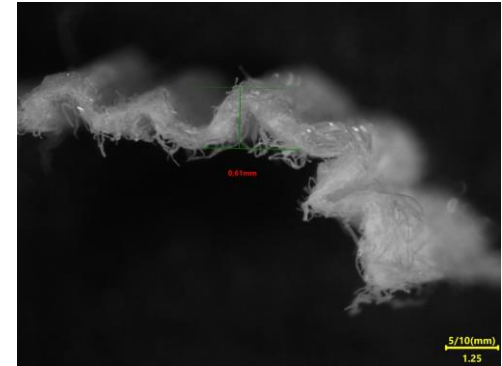


Pitch estimation

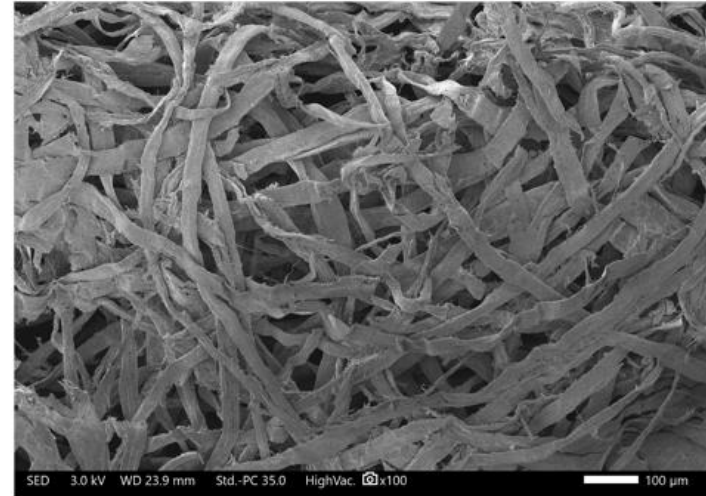
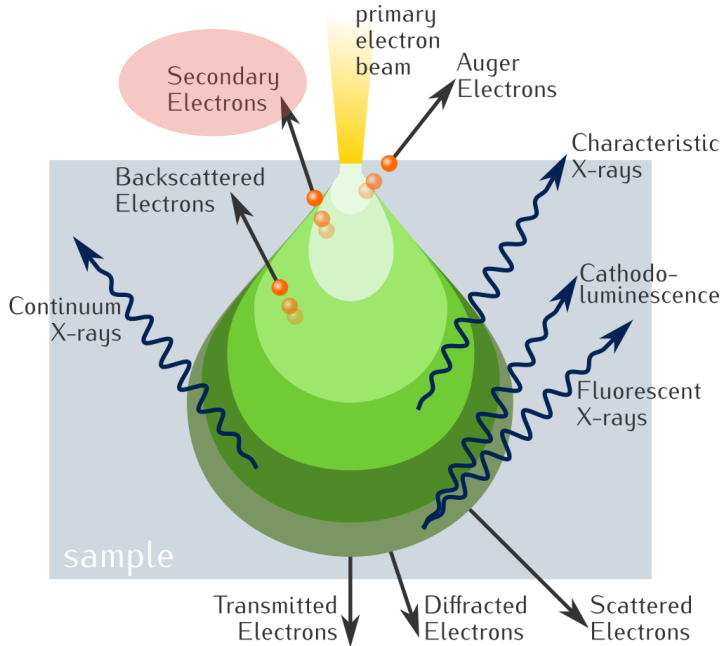
Pitch =  $6,7/7 = 0,95$  mm



Z-directional expansion estimation



# Scanning Electron Microscopy (SEM)



# Scanning Electron Microscopy

Nanometric resolution allowing to visualize fibres

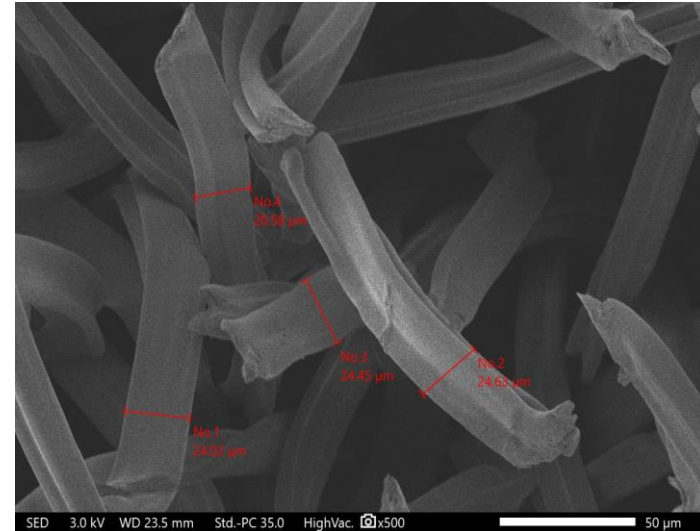


Paper x 100



Fibres shape and organization inside  
the filtering media

Cellulose acetate x 500



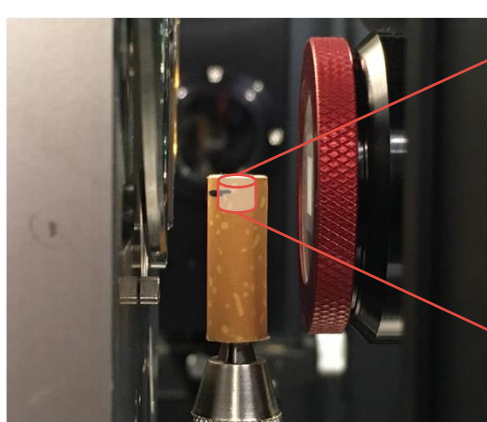
Fibre width estimation



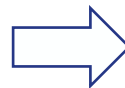
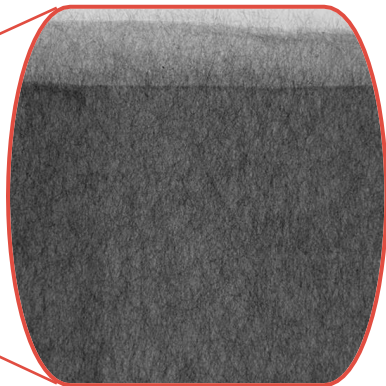
# X-Ray Tomography

3D imaging

X-Ray



360°



3 mm

4 mm

Voxel size = 2.5  $\mu\text{m}$

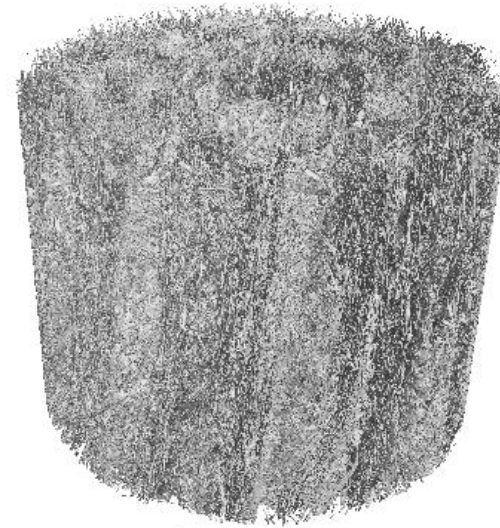


# X-Ray Tomography

3D imaging



Cellulose acetate filter



Paper filter



1 mm

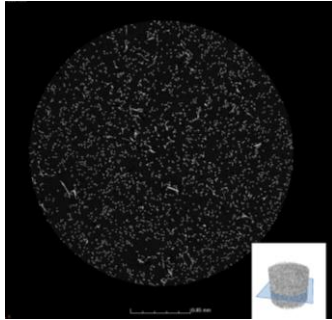


# X-Ray Tomography

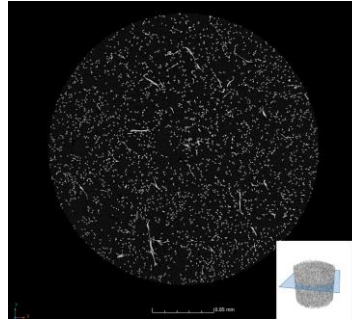


↑  
z

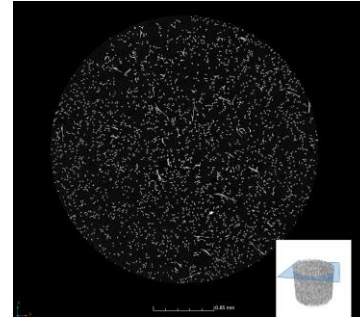
Cellulose acetate



Void fraction  
90 %

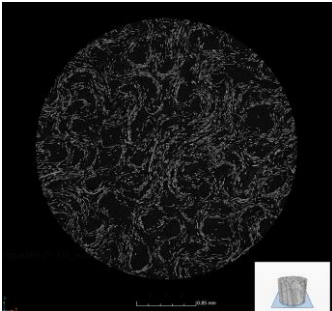


90 %



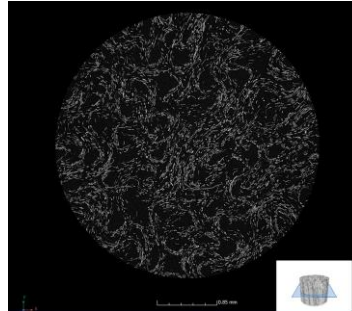
89 %

Paper

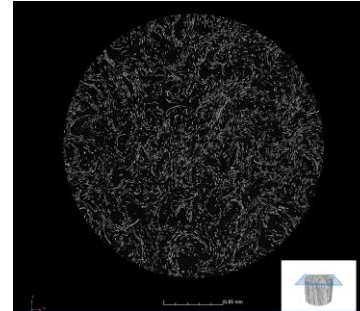


Void fraction

80 %



81 %



83 %

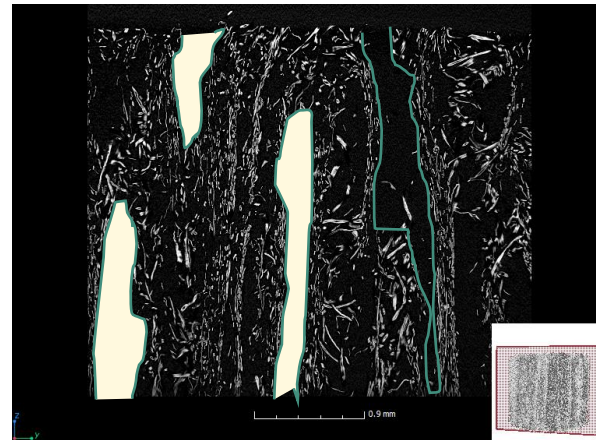
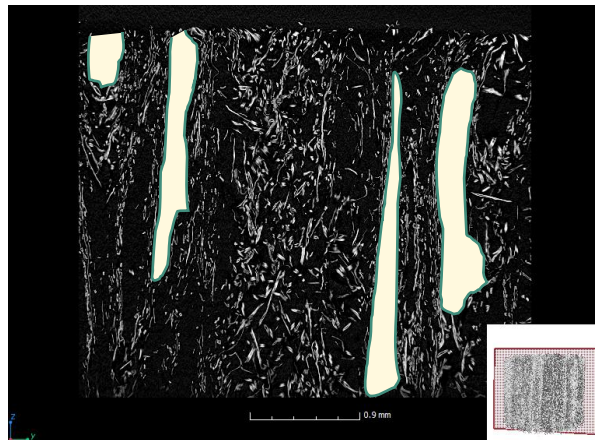
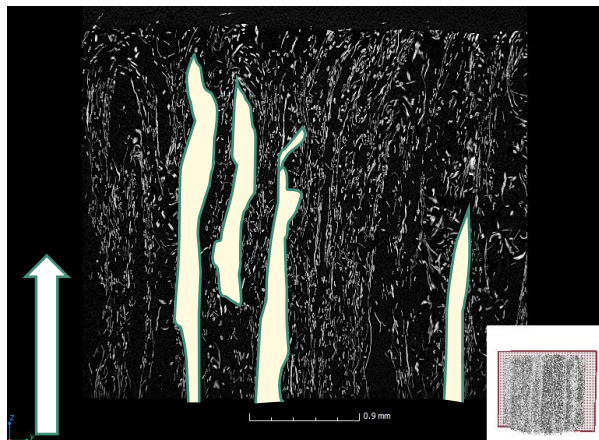
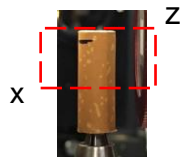


- Void fraction is stable across the filter
- Paper filter has lower void fraction than cellulose acetate

—  
0,85 mm

# X-Ray Tomography

Allows to visualize paper filter channels



Smoke  
flow

- Channels are not continuous across the filter
- Some fibers are present inside the channels

→ Increase of the filtration efficiency

0,9 mm

# Conclusions



## Low resolution microscopy<sup>1</sup>

- Visualize filter appearance
- Estimate crimping parameters



## High resolution microscopy/SEM<sup>2</sup>

- Fibres organisation observation
- Fibres width analysis



## 3D microscopy<sup>3</sup>

- 3D observation of filter structure
- Void fraction analysis
- Channeling analysis

## Perspective: filtration efficiency dynamic simulation

# Thank you



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