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Imaging aerosol deposition and filtration with advanced x-ray microscopies

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diamond

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Transmission factors under study:

- Content of respiratory droplets
- Filtration effectiveness of face masks (model particulate)

Why x-ray microscopy?

- Short wavelength → resolution ~ virus
- Image through substrates / filters
- 3D + (potentially) nondestructive

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1. Respiratory droplet content

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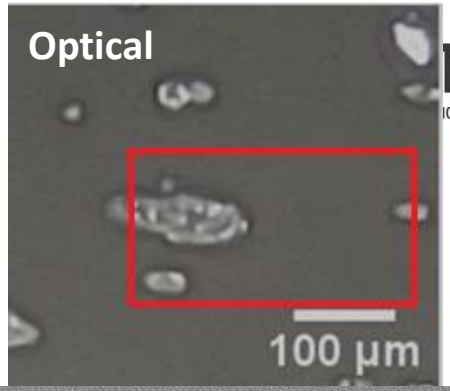
Respiratory droplet generation: HSE Cough Simulator

Respiratory droplet content



X-ray ptychography
Phi6 + UV stain in
artificial saliva

Saliva residues

Small particulates <100 nm

10 µm

Particulates outside
droplet

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2. Face mask / covering filtration

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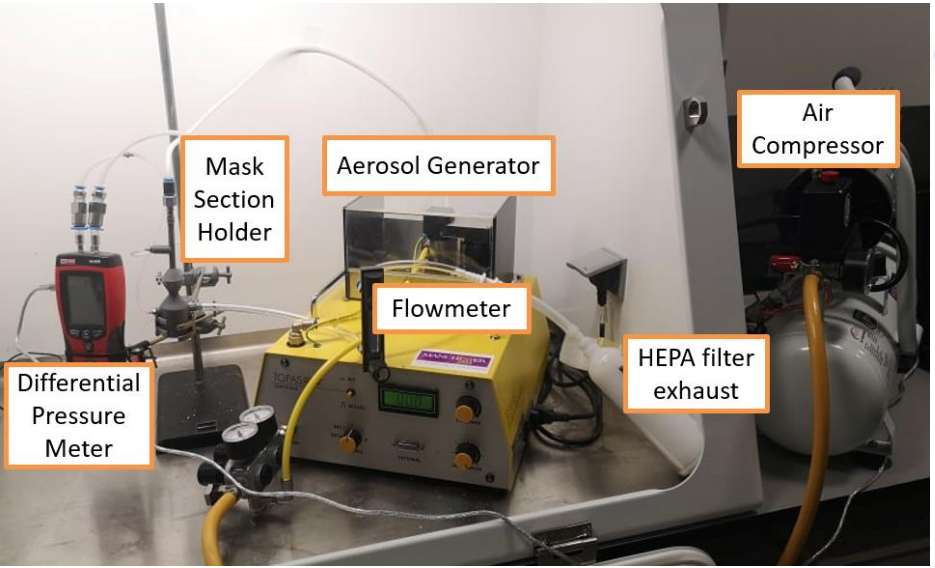
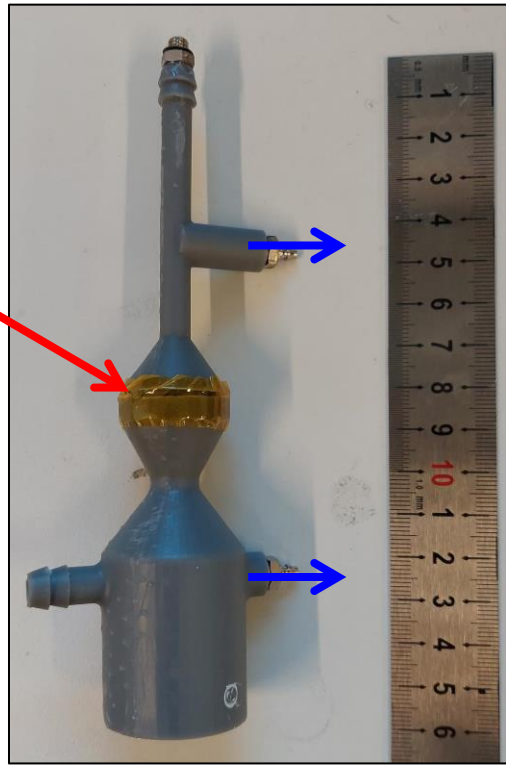
Filter measurement





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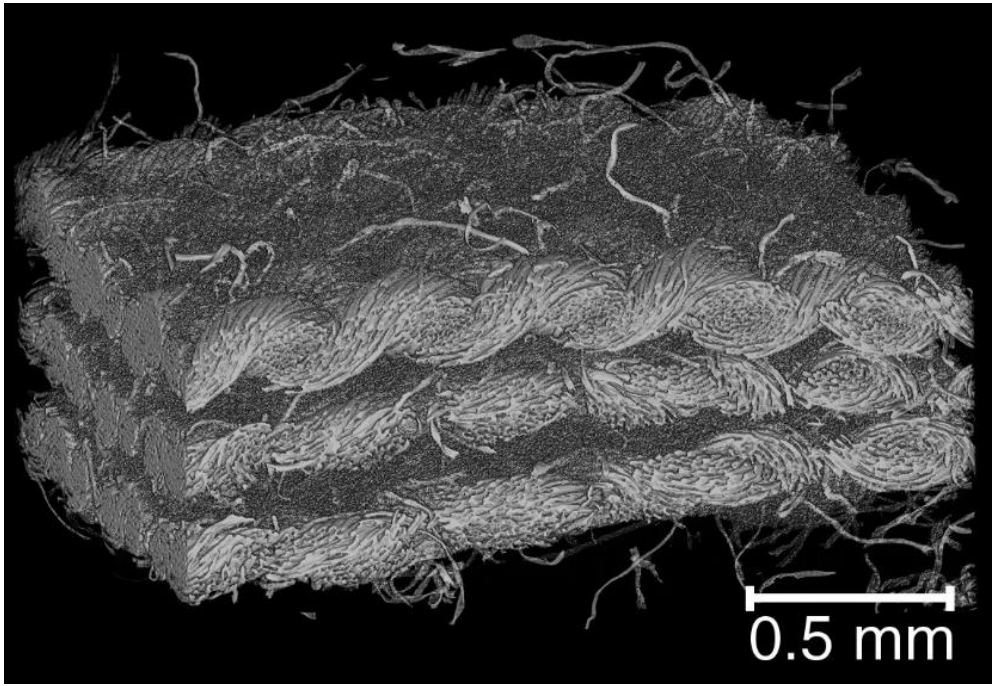
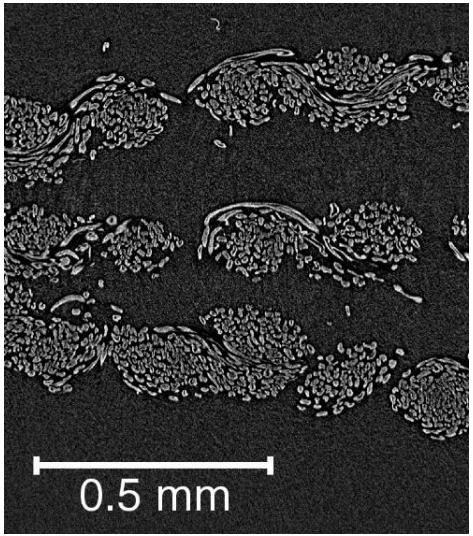
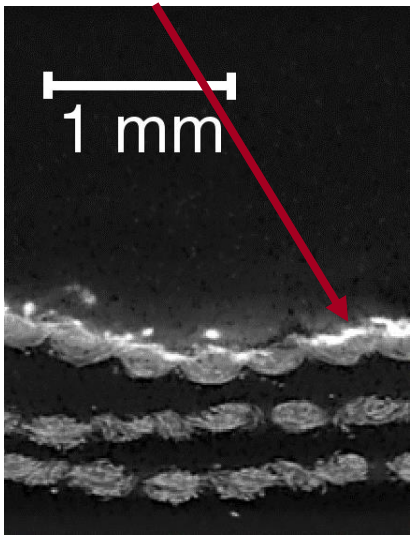
Woven trilayer face covering

< 1 µm diameter aerosolized TiO_2



X-ray tomography: 3D rendering





- Large voids in weave
- Second and third layers: no filtration

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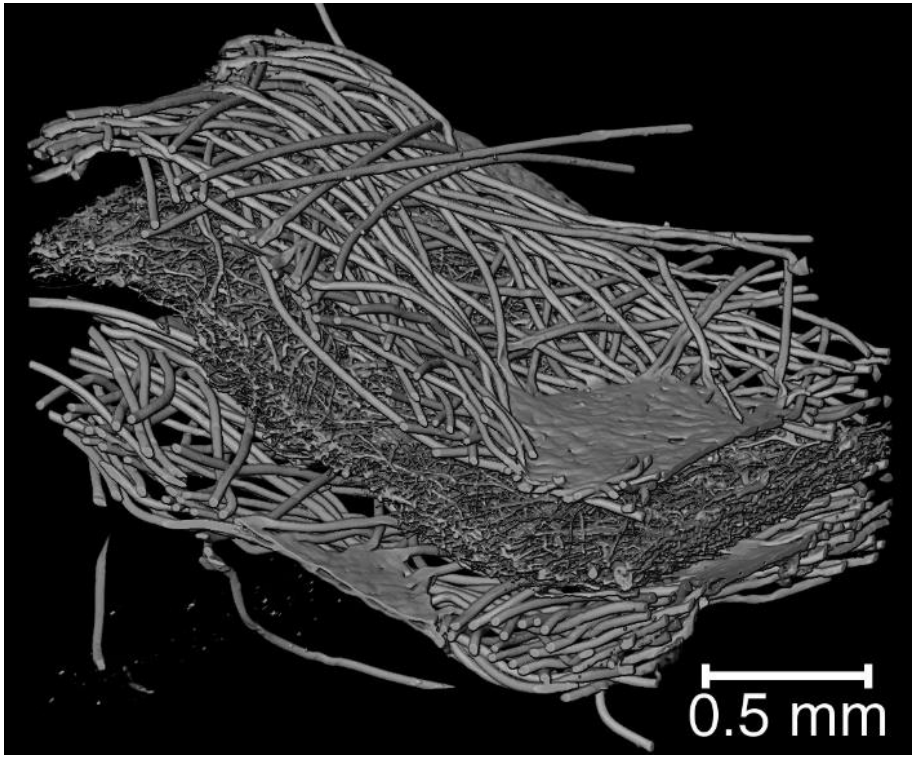
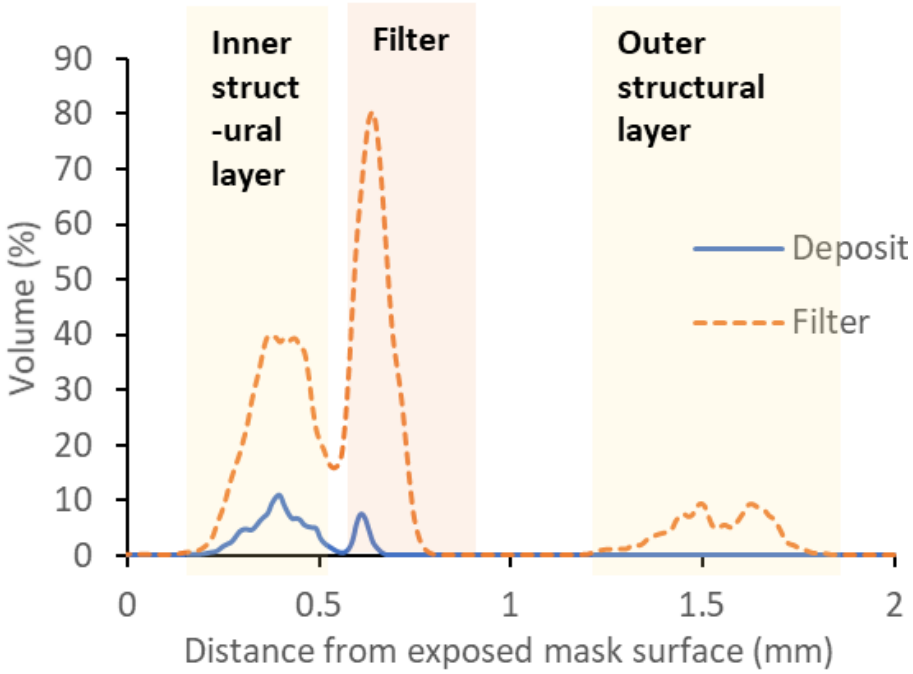
Surgical mask





- Inner electrostatic filter effective

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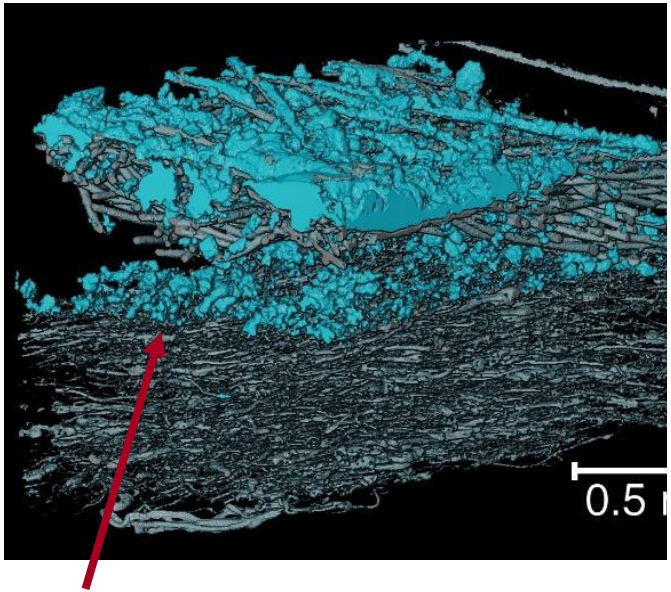
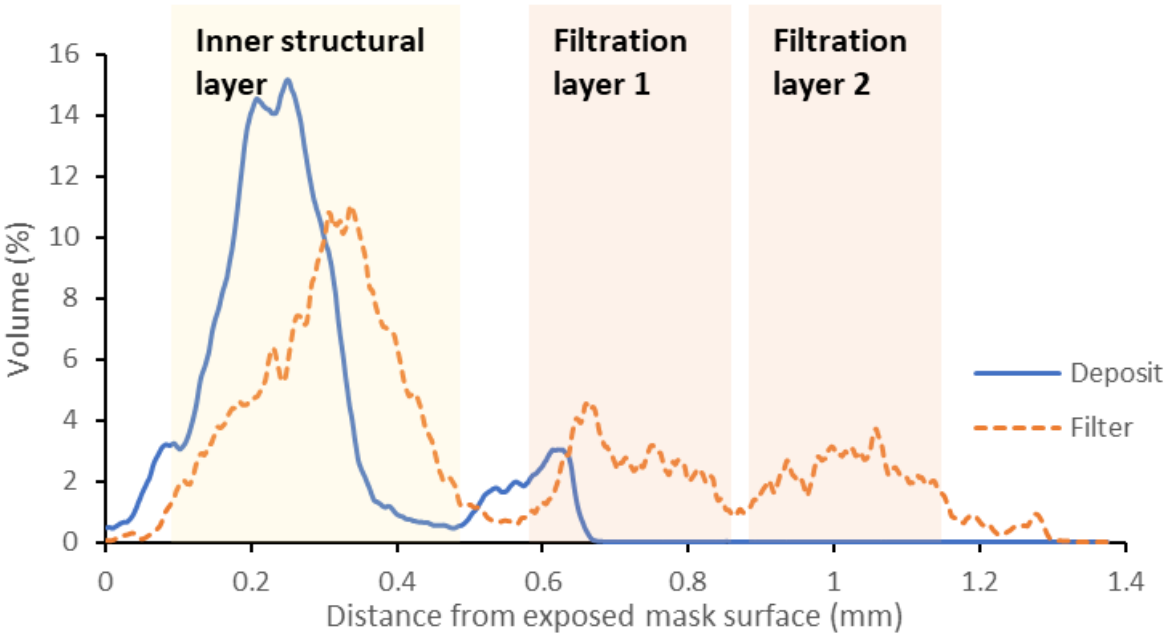
FFP3 Half mask (Easimask FSM16 NR Duckbilled)



< 1 µm diameter aerosolized TiO_2



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Summary

X-ray microscopies provide fast, penetrative, high resolution imaging, showing:

- 2D x-ray imaging of ~50 nm structures in respiratory droplets
- 3D x-ray imaging at <1 µm resolution of masks and deposits, of filters in operation
- Generally non-destructive, but radiation damage occurs

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