Biodegradable Nanofibrous Filters for Air Filtration

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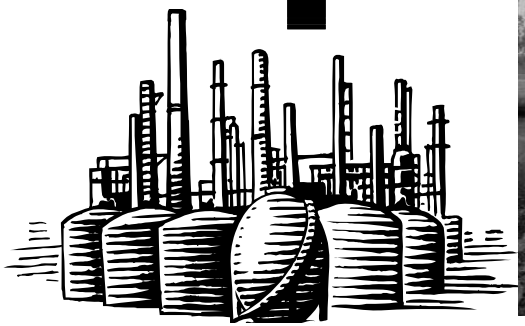
Indirect formulation of PM

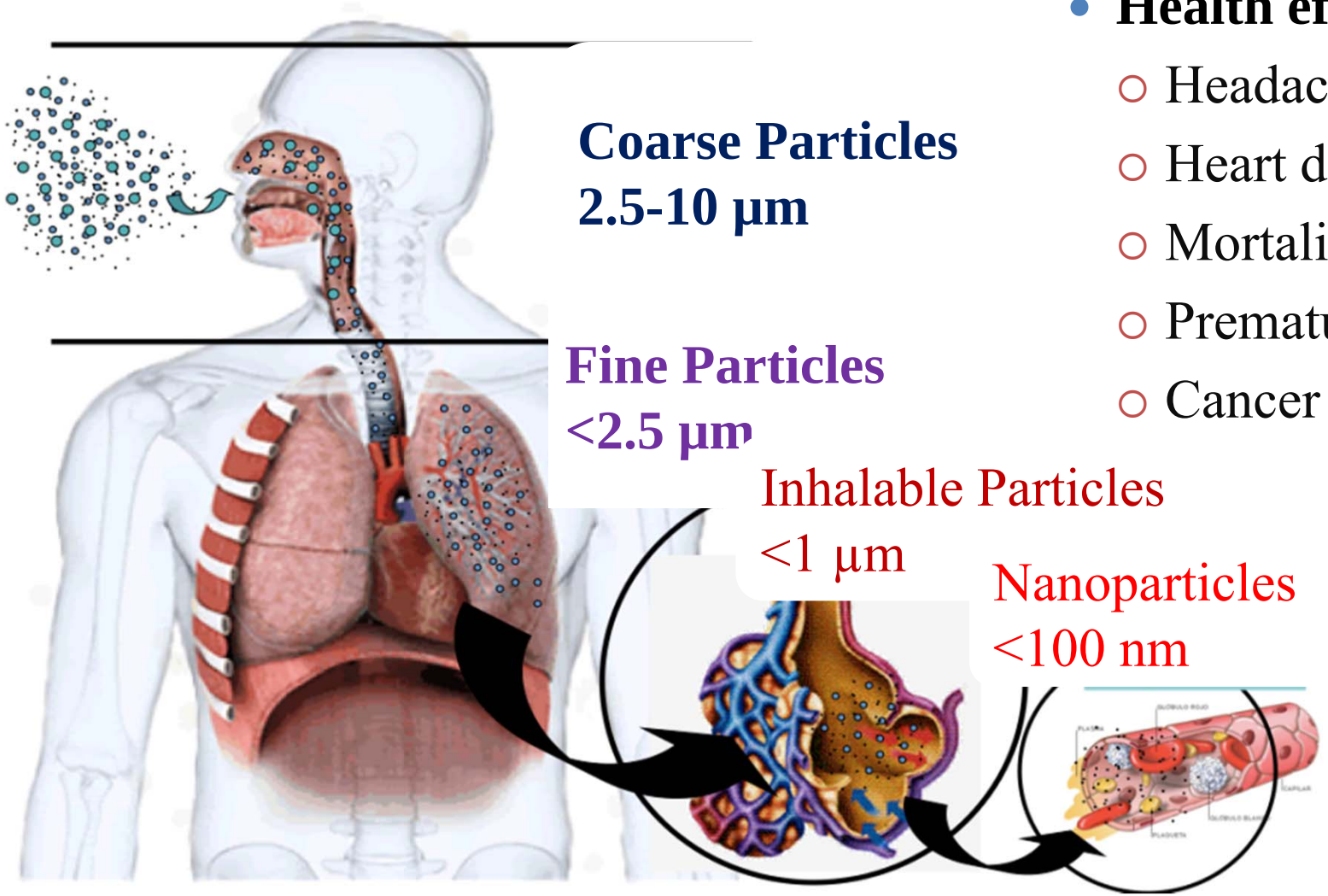
Product of Fuel Combustion+ Ammonia+ Solvents

Environmental Impact

- Low visibility (smog/fog)
- Climate change
- thermal radiation
- Adsorption
- Reflection
- Water and soil pollution through precipitation

Direct release of PM





- **Health effects**
  - Headache
  - Heart diseases
  - Mortality
  - Premature death
  - Cancer

Solution…

Wear a respiratory mask to protect the respiratory system from inhalation of airborne PM.

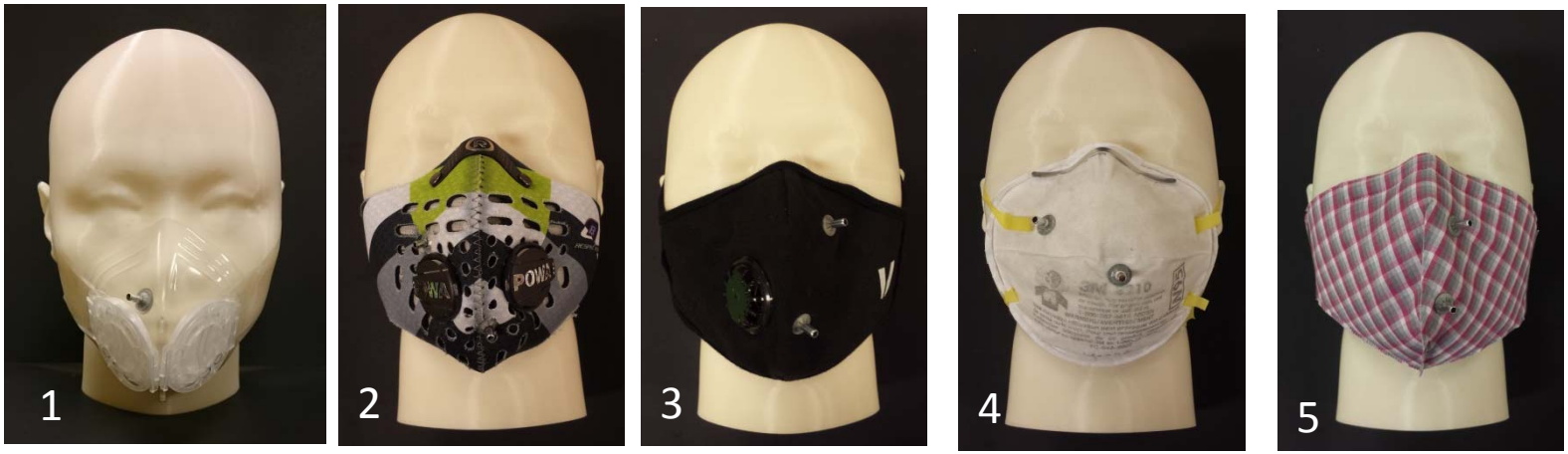
Knowledge gap:

Performance of nanofibrous filters in respiratory mask

The **objectives** of this study are:

- ✓ Determine the filtration efficiency of nanofibrous filter media for capturing PM10.
- ✓ Determine the filtration efficiency of nanofibrous filter media in respiratory mask for protection
- ✓ Comparing the filtration efficiency of nanofibrous filter respiratory mask with commercial ones

Commercial Respiratory Masks



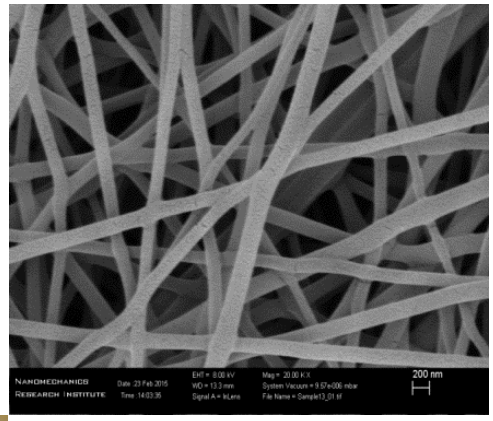
Nanofibrous Filter mounted in mask 1

Replace the filter of the commercial mask with the fabricate nanofibrous filter

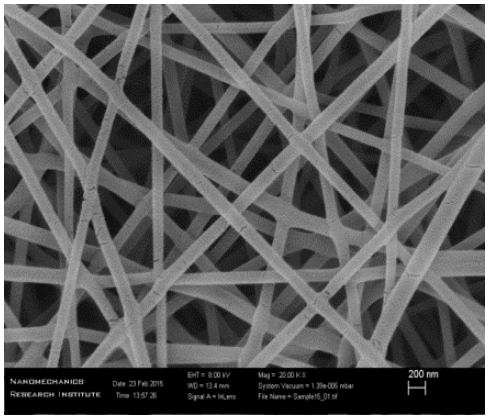
Employing two circular filter media with a diameter of 25 mm

Electrospinning Setup for Filter Fabrication

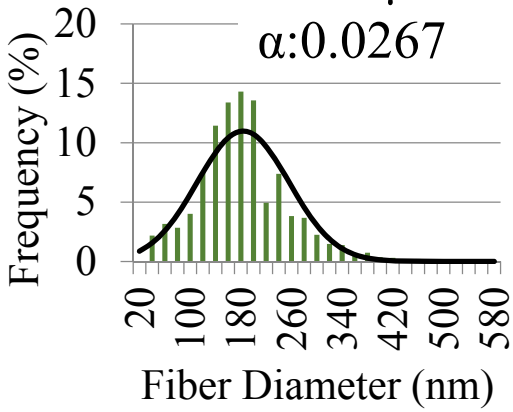
Polyvinyl alcohol (PVA),
10% w/w
V=15 kV
d=10 , 15 cm
Deposition times:
5 , 15, 30 min

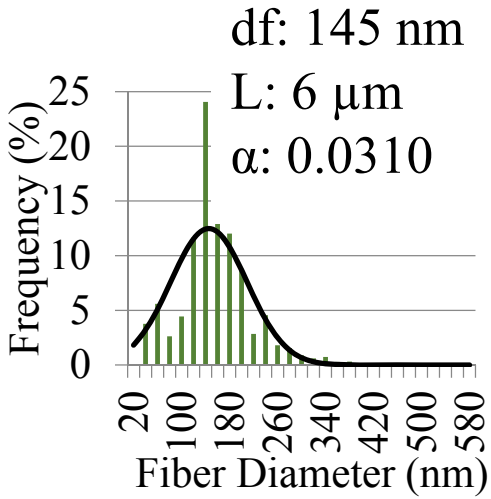


NF1, d=10 cm

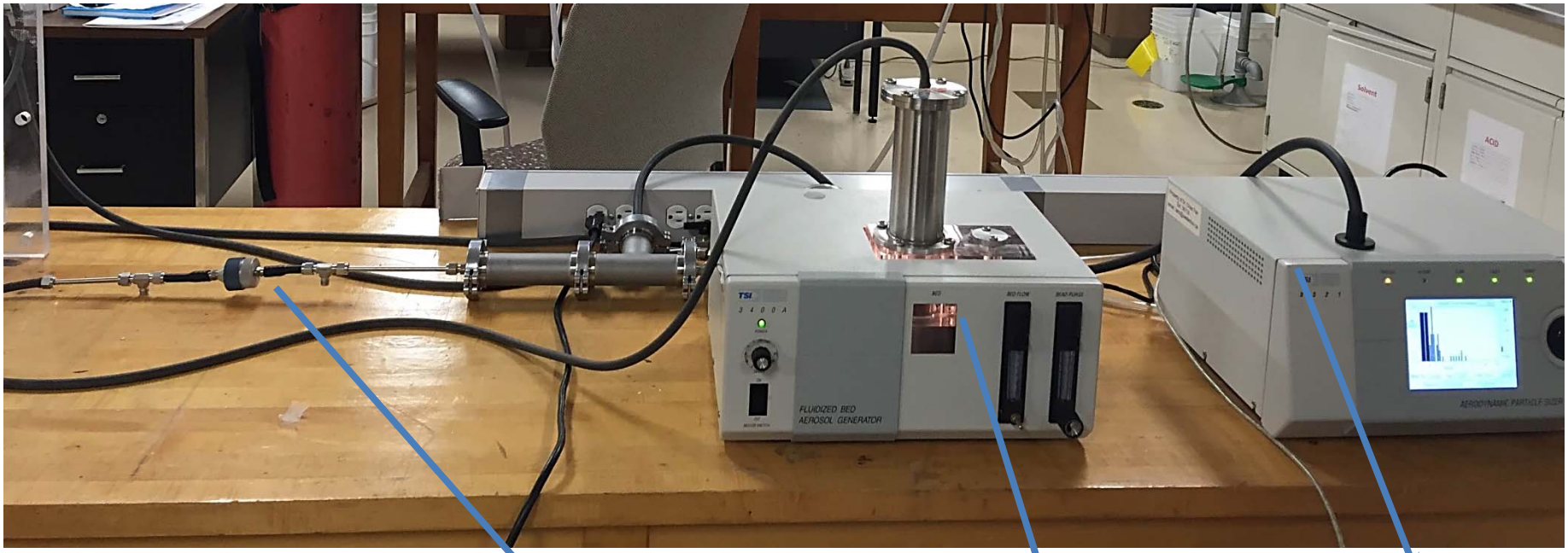


NF2, d=15 cm





1) Experimental Setup to test filter media



Filtration efficiency

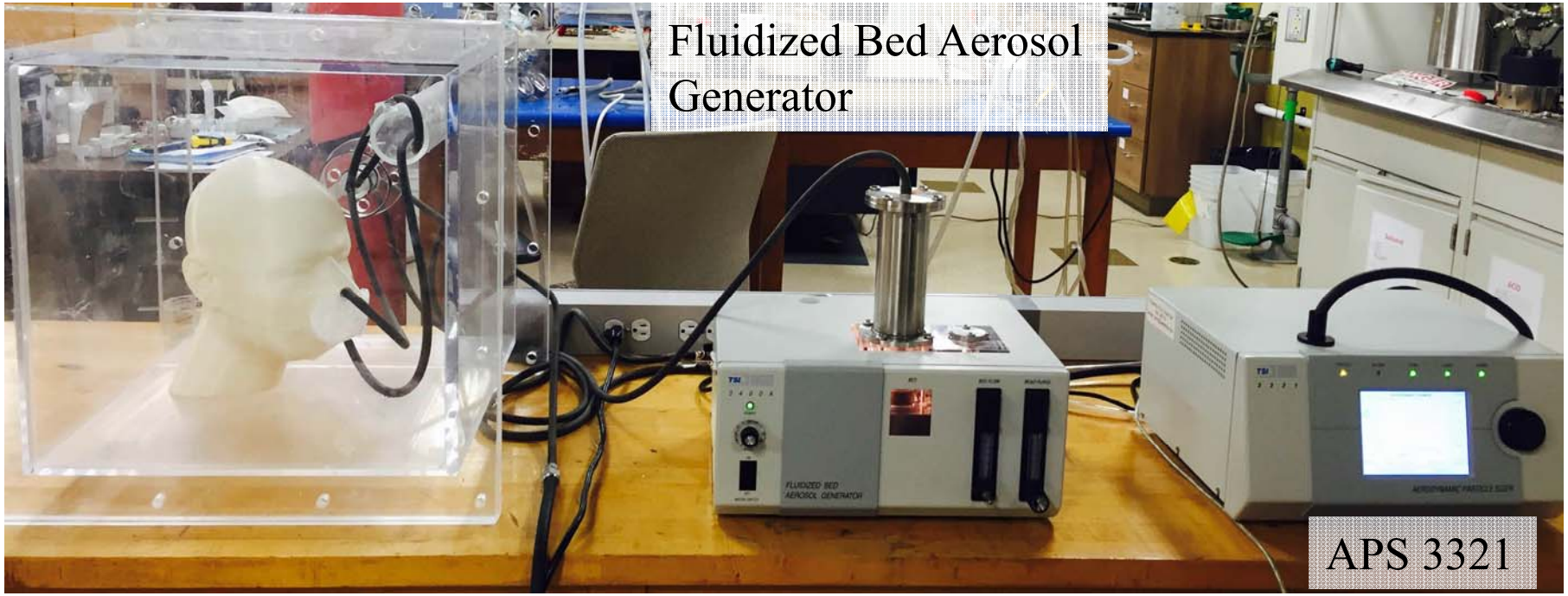
$$\eta = 1 - \frac{C_{down}}{C_{up}}$$

Filter media holder

Fluidized Bed Generator (TSI 3400A)

APS (TSI 3321)

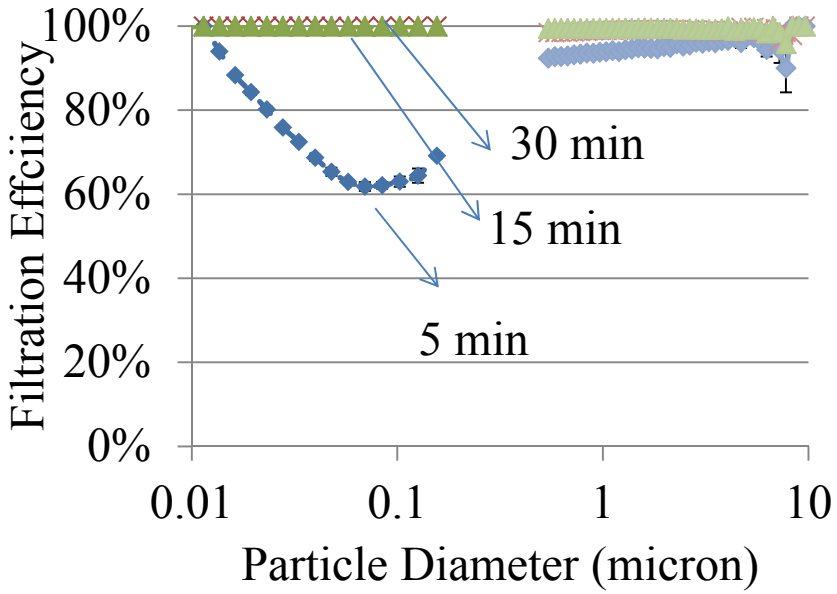
2) Experimental Setup to test respiratory mask



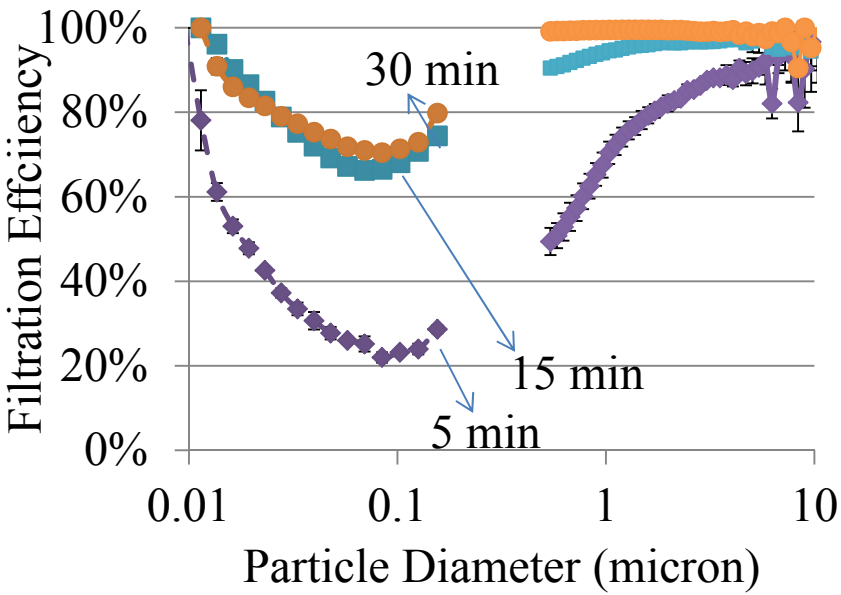
Due to anthropometric differences, no respirator can be guaranteed to fit all users

PVA Filtration Efficiency

NF1, prepared at d=10 cm

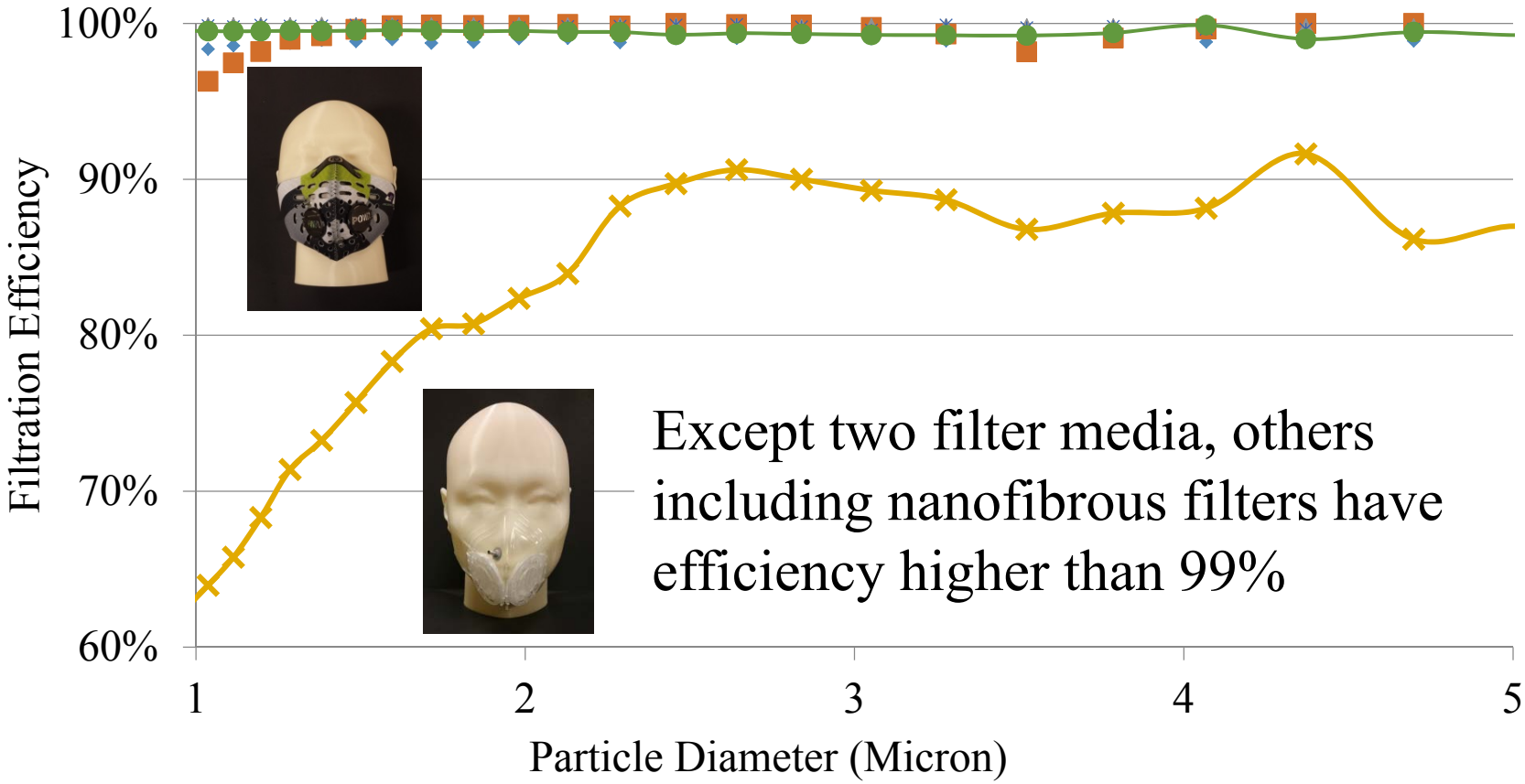


NF2, prepared at d=15 cm



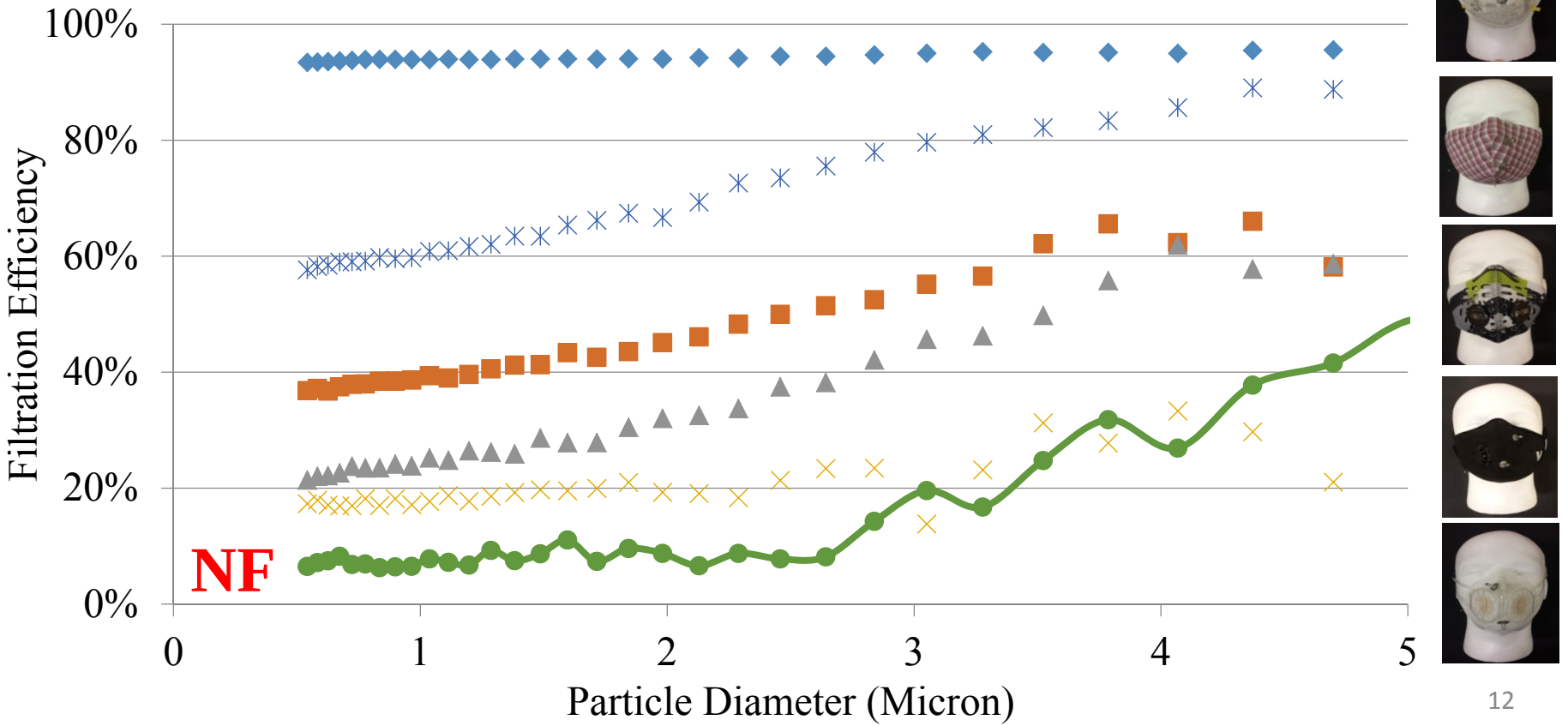
Although NF2 has the lower mean fiber diameter, it does not have the highest efficiency, due to the smaller thickness.

Comparison between the performance of commercialized filter media with nanofibrous filter



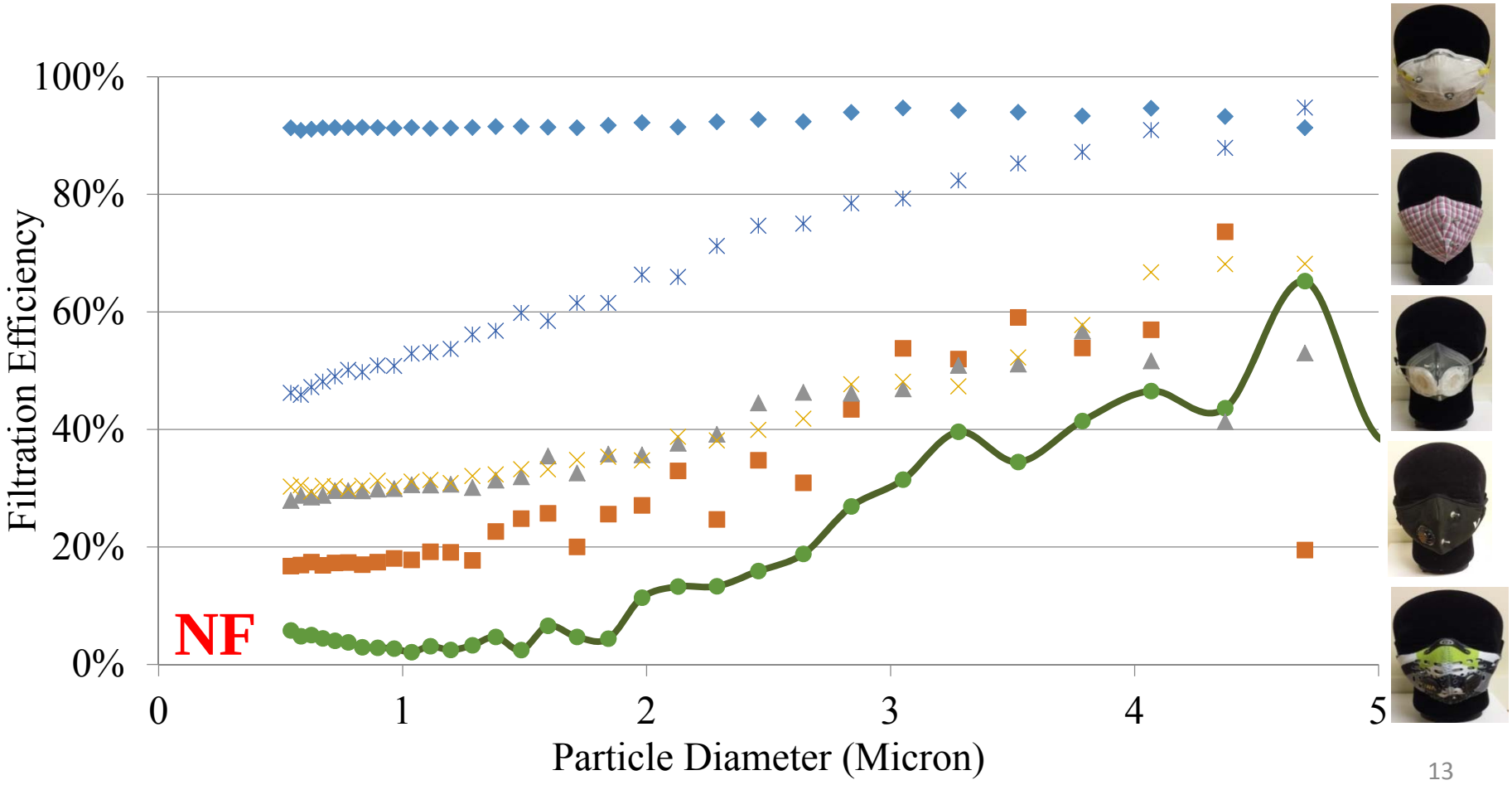
Filtration Efficiency of different dust masks: head 1

Although the dust masks employed high efficient filter media, their practical efficiency is not high for all of them.



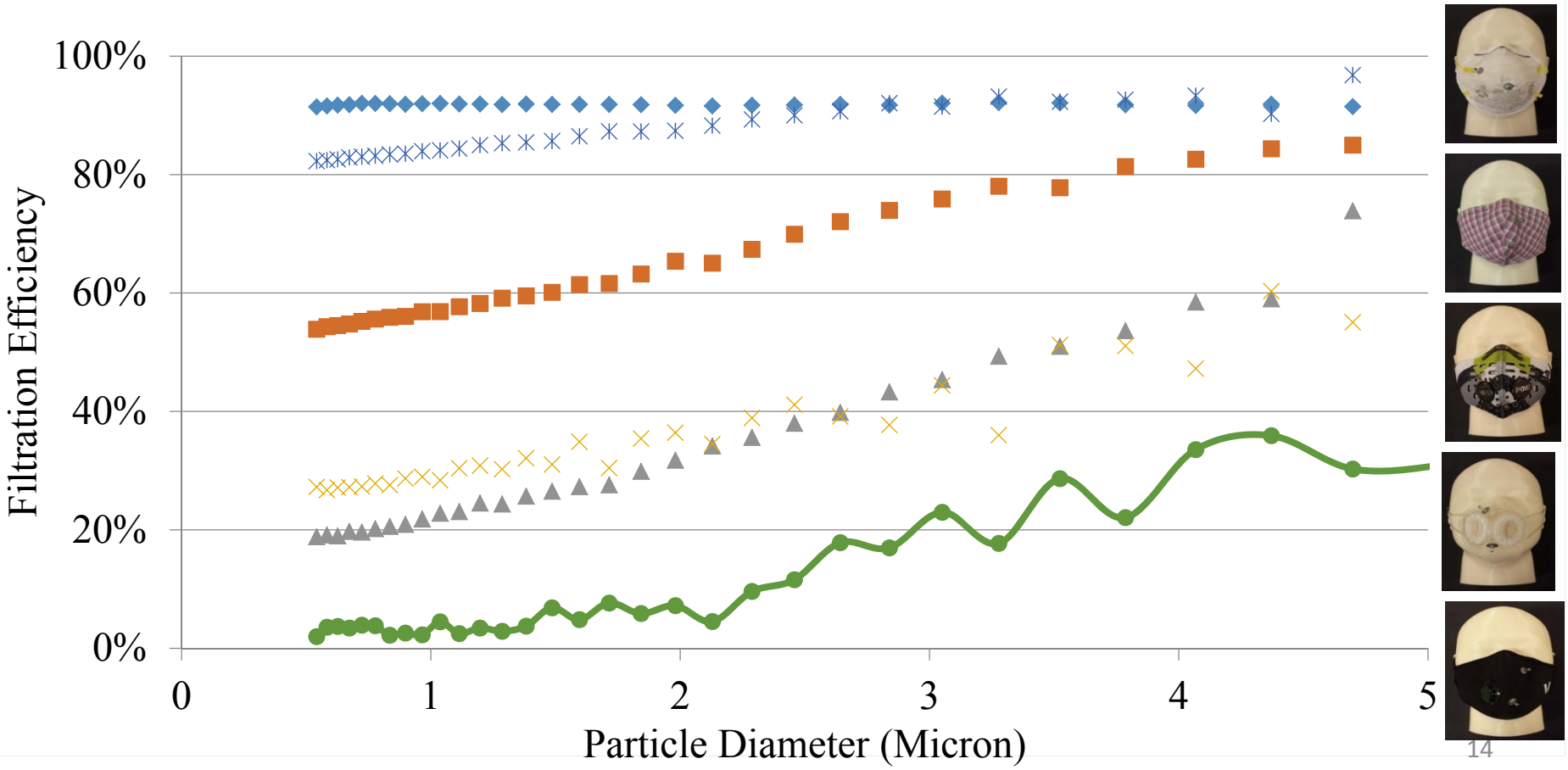
Filtration Efficiency of different dust masks: head 2

Dust masks perform differently for different head's shape

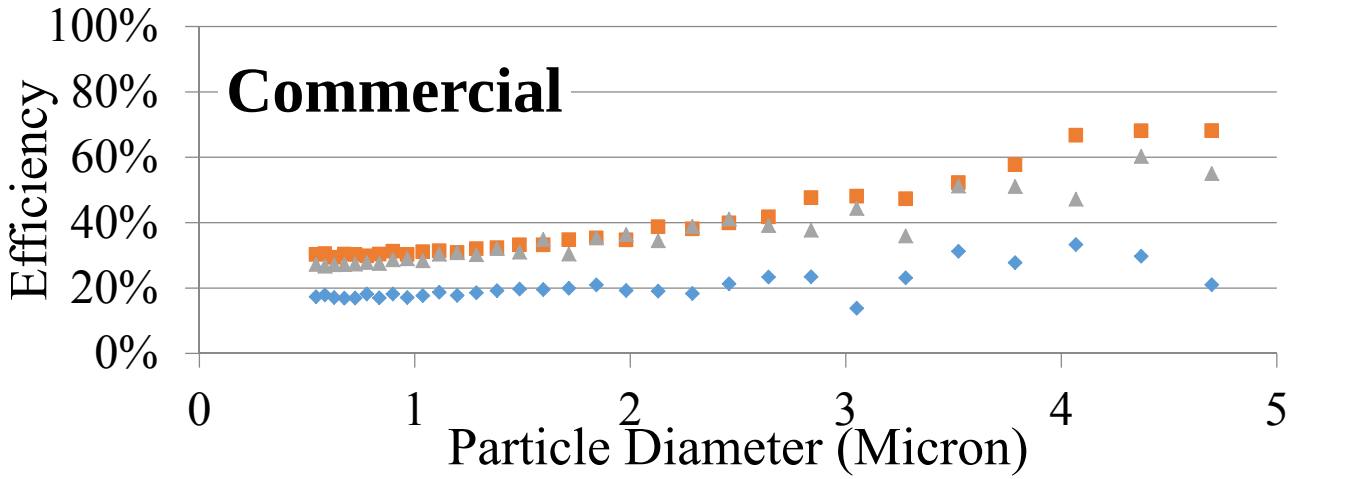


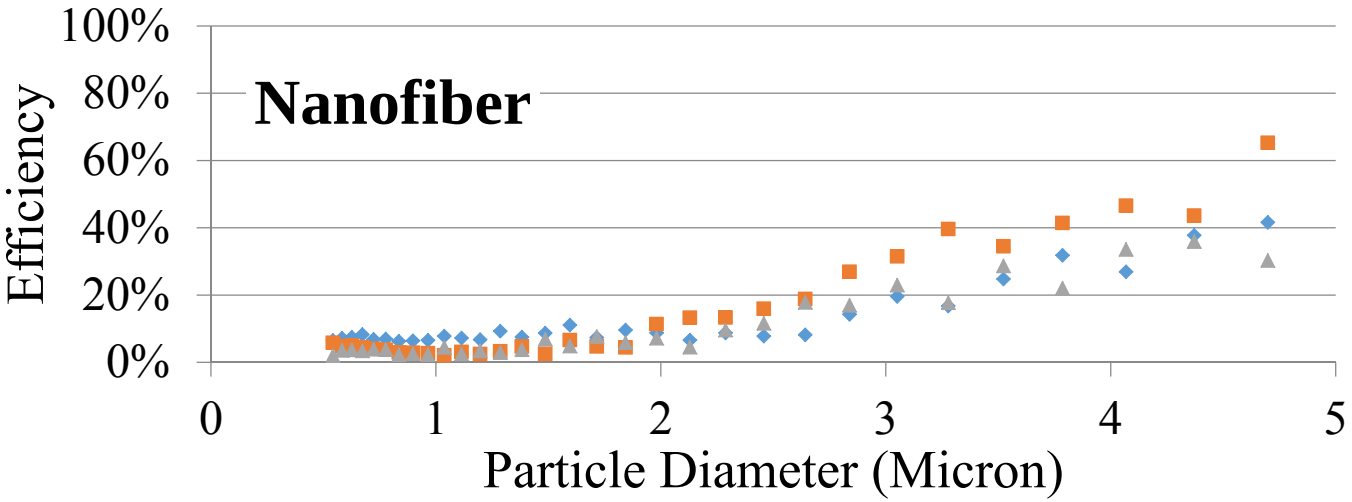
Filtration Efficiency of different dust masks: head 3

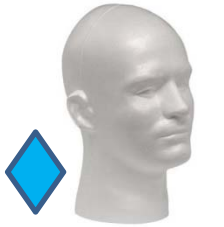
Statistical analysis showed that the head's shape has a strong significant effect on the performance of FFR ($P<0.05$)



Effects of head's shape on mask performance



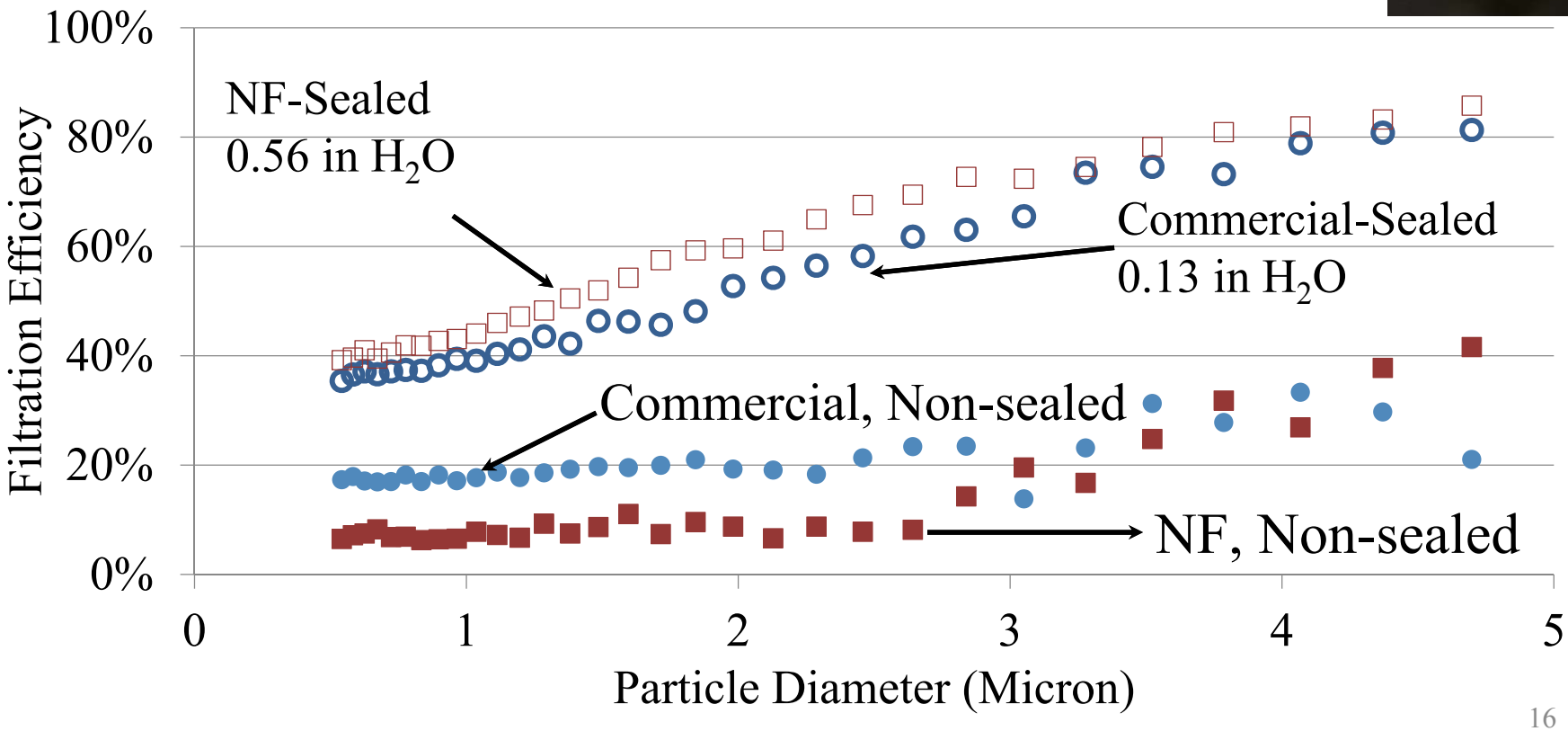




Leakage of dust masks for two filter media

Sealed NF>Commercial

Non-Sealed NF<Commercial



- ✓ The performance of dust masks depends on both face and mask shapes.
- ✓ The filtration of dust masks are the same for different heads in the case of sealed masks, because results eliminates the leakage of dust masks on the face.
- ✓ Employing the NF in the specific designed commercialized mask was not effective due to the high leakage
- ✓ NF must be employed in dust mask with the larger surface area and lower leakage

Acknowledgment

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