

Filtration Principles and Technologies of Facemasks for Protection against Coronavirus Disease 2019 (COVID-19)

February 18, 2020, 9:00-9:45a, ET

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Moderator: Tom Justice, Director of Marketing, WFI



Mr. Justice is well known throughout the filtration industry having spent over 38 years in various assignments from R&D to Operations and Sales. He served as VP of Operations for Clarcor until 2005 and later as COO of Flanders. Active in industry trade associations, he is currently President of the National Air Filtration Association, member of UL Standards Technical Panel for Air Filter Units, a voting member of the US TAG to ISO/TC 142 for international air filter test standards and US expert to ISO for Aerosol Filters for Nuclear Applications.

THANKS to Expert Panel



Christine Sun (USA)



Chao Tan (Canada)



Peter Tsai (USA)



Bob Burkhead (USA)



Tom Justice (USA)



Eric Fu (Australia)

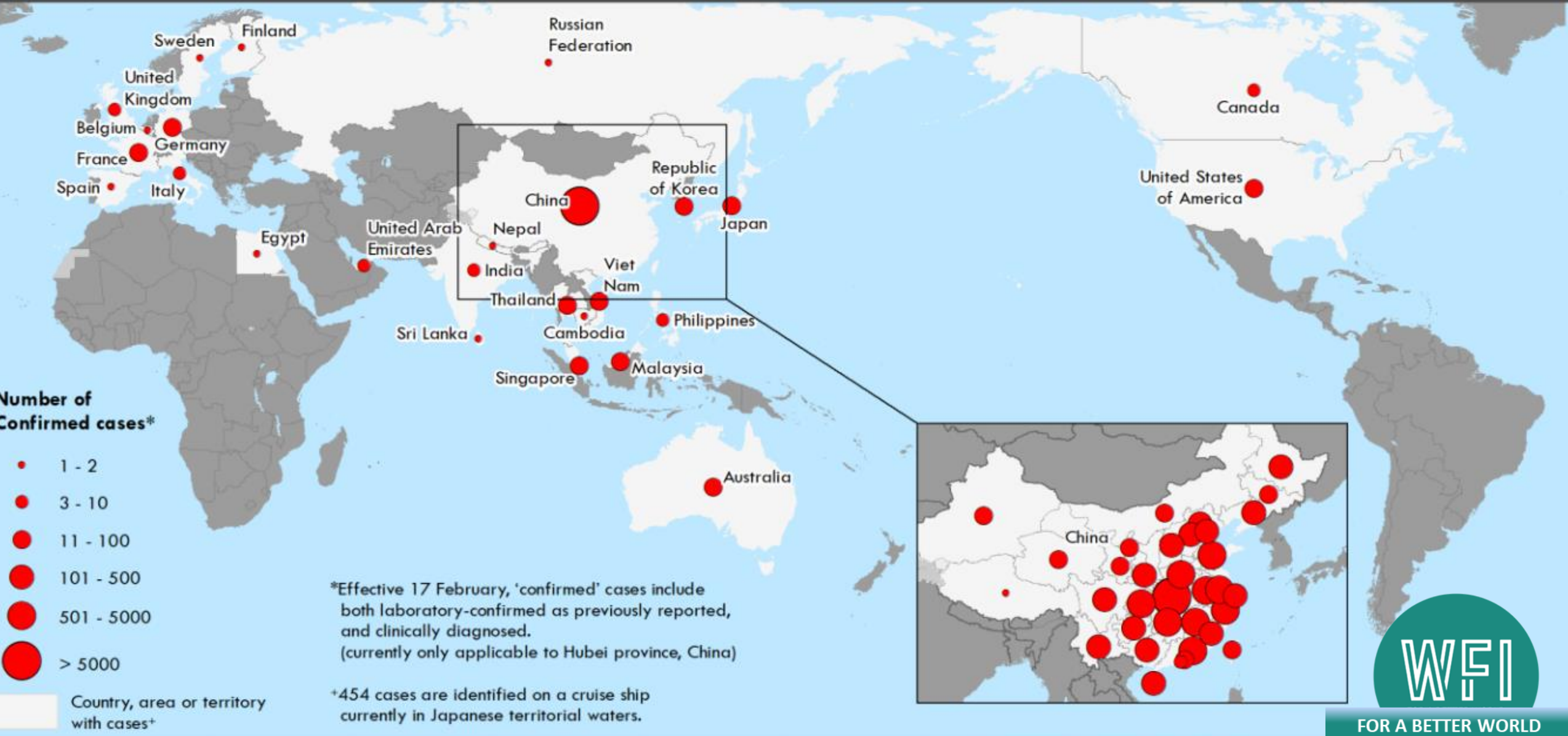


Vincent Hu (Taiwan)



Gajanan Bhat (USA)

Distribution of COVID-19 cases as of 17 February 2020



WHO named the disease COVID-19, short for “coronavirus disease 2019”

COVID-19 Leads to Worldwide Facemask Shortages



Questions

- What type of facemasks should I be wearing to protect me from novel Coronavirus ?
- What type of rating should I be looking for?
- Does it provide me with 100% or 95% protection?
- How long can I use it? Can I reuse it?
- ...

Next Speaker: Christine Sun, President, WFI



Dr. Sun is a globally renowned expert and leader in the filtration Industry. She served as the Chair of the American Filtration and Separations Society (AFS) from 2016-2017 and is the current Operation Chair of 13th World Filtration Congress to be held on April 20-24, 2020, San Diego, CA, USA. She received the AFS Fellow Award in 2019. With over 30 years of experience in both academia and industry, Dr. Sun has both broad and in-depth knowledge of filtration, and extensive and hands-on experience in product development.



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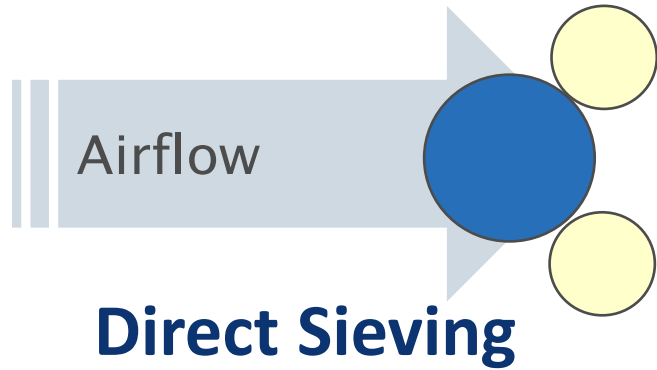
Facemask Is A Filter



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Filtration Mechanisms



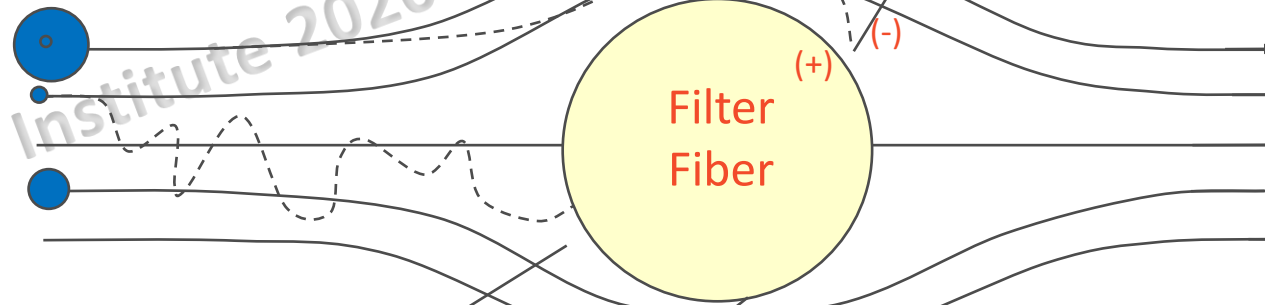
Indirect Interception

Inertial Impaction

Electrostatic Attraction

Brownian Diffusion

Interception



What Is Filtration Efficiency?

Penetration, $P = \frac{\text{Downstream Concentration}}{\text{Upstream Concentration}}$

$$\%P = 100 \times P$$

Efficiency, $E = 1 - P$

$$\%E = 100 \times E = 100 - \%P$$

What does it mean by N95?



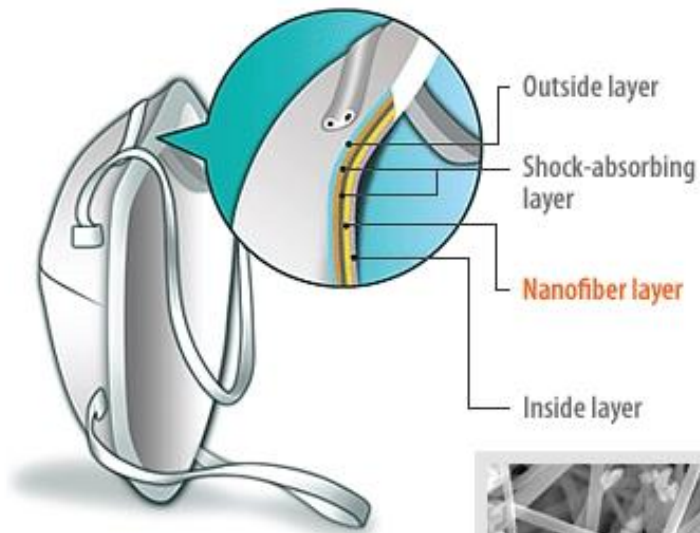
Key Technologies in Facemasks



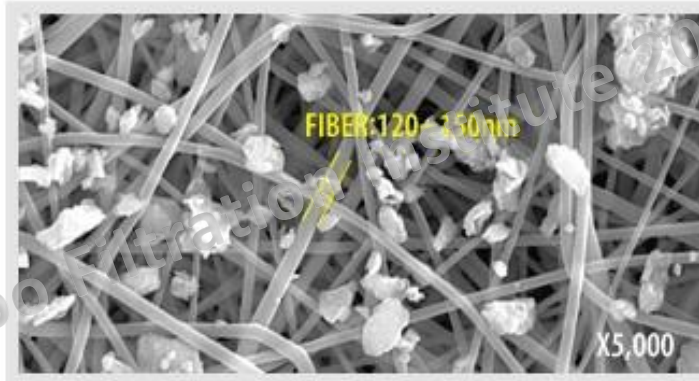
Middle filtration Layer
MB PP Eletret



New Developments with Nanofibers and Membranes

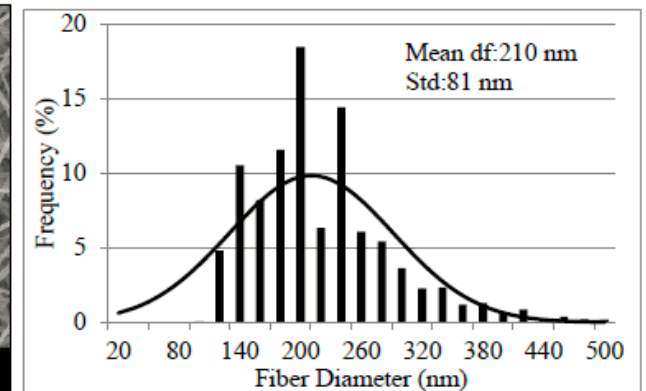
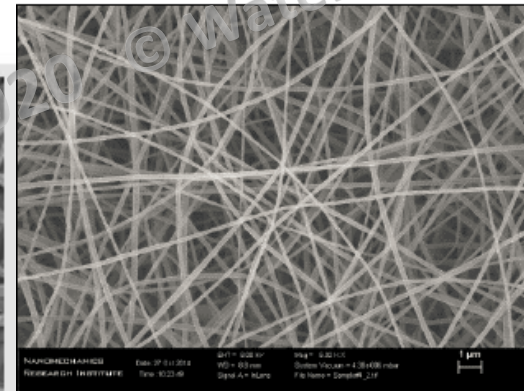
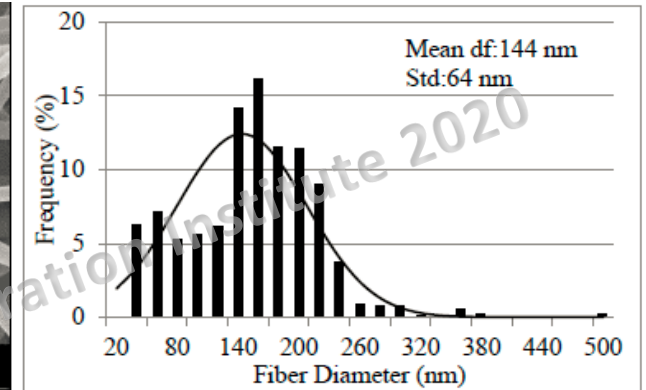
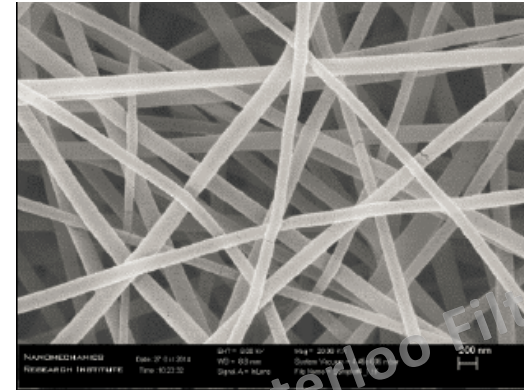


Application



Nanofibered mask

Fine dusts are filtered and collected by mechanical structure of nanofibers.



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Types of Masks for Protection against COVID-19

Medical Mask	N95 Mask (or R95, P95, KN95)	APR (Air Purifying Respirator)	PAPR (Powered Air Purifying Respirator)
BFE ≥ 95% PFE ≥ 95% @ 0.1um	≥ 95% for 0.3um particles	95%, 99%, 99.97% for 0.3um particles	95% , 99%, 99.97% for 0.3um particles



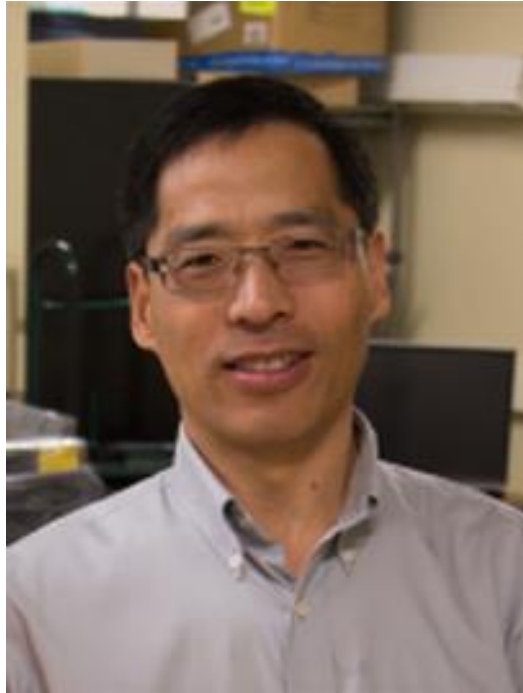
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Facemask Test Standards and Certification

Medical Mask	N95 Mask (or R95, P95)	APR (Air Purifying Respirator)	PAPR (Powered Air Purifying Respirator)
ASTM F2100 *	NIOSH 42 CFR 84	NIOSH 42 CFR 84	NIOSH 42 CFR 84
FDA reviews 510(K) submission and clears for marketing	Certified by NIOSH under 42 CFR 84	Certified by NIOSH under 42 CFR 84	Certified by NIOSH under 42 CFR 84

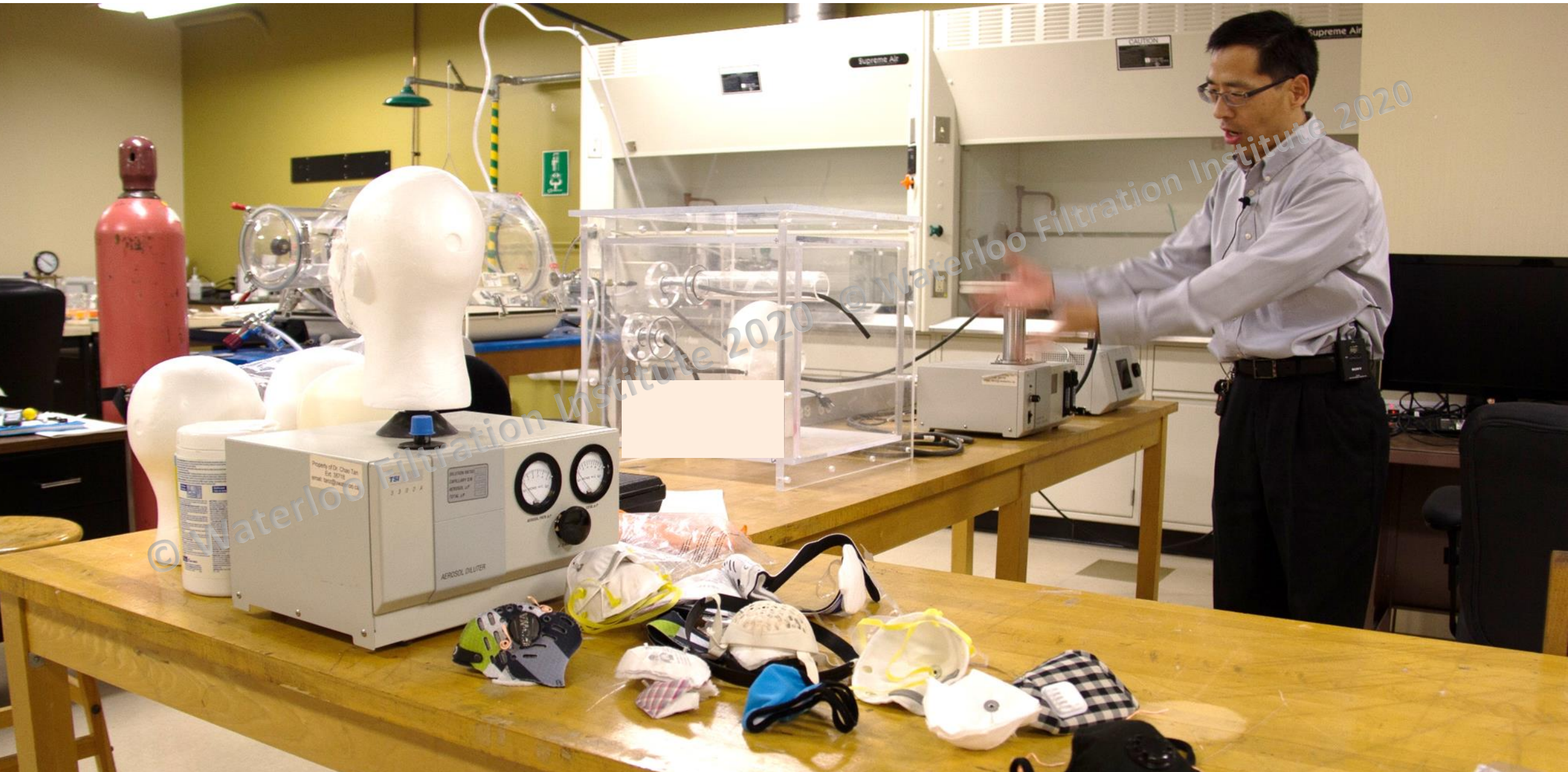
* Including multiple test standards, uch as ASTM F2101, ASTM F2299, etc.

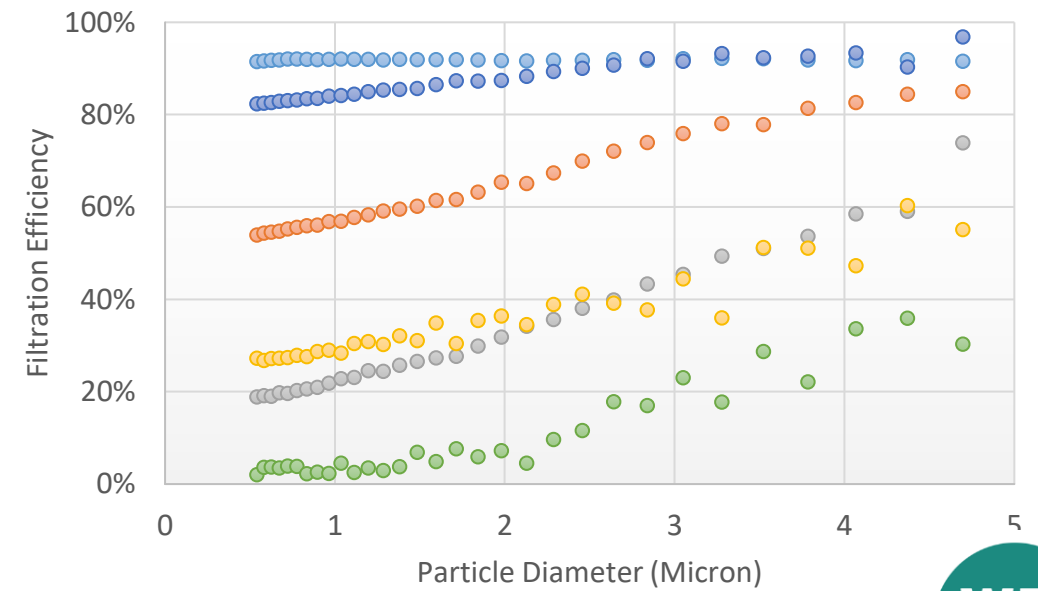
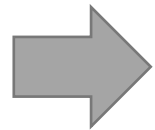
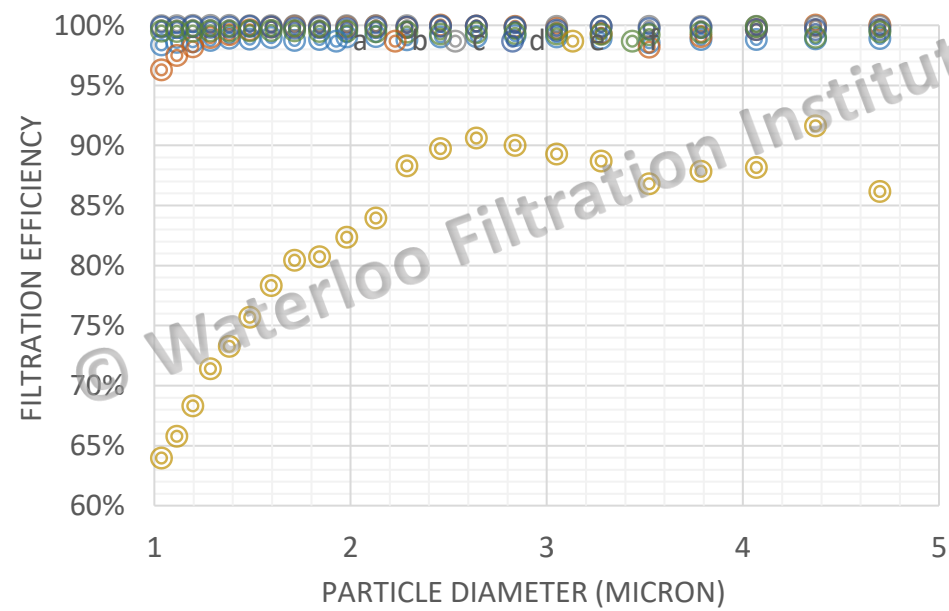
Next Speaker: Chao (Zhangchao) Tan, Univ. of Waterloo



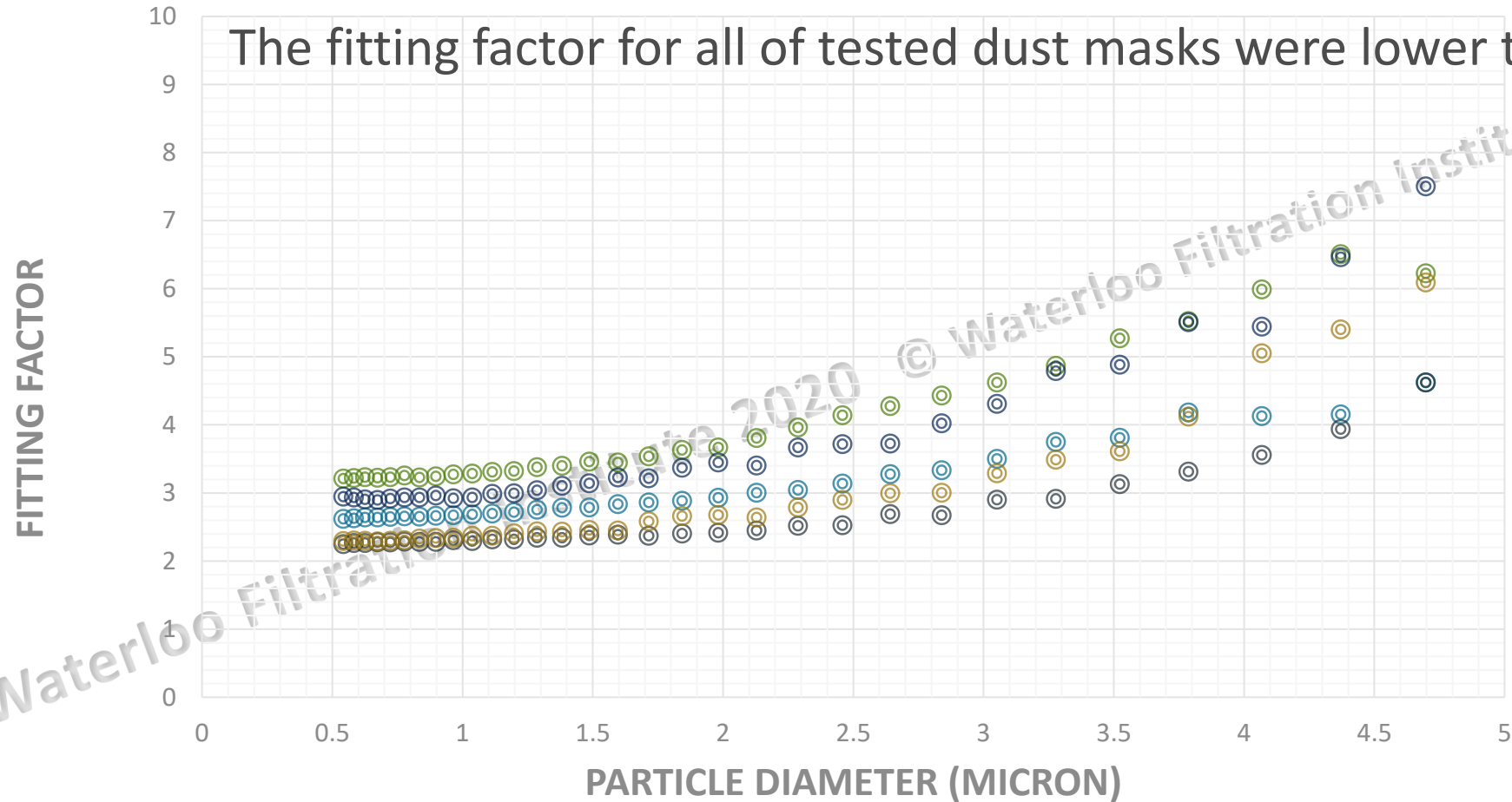
Dr. Tan is a Professor and Associate Dean, International at the Faculty of Engineering, University of Waterloo, Canada. He is the Director, Green Energy & Pollution Control Lab at the University of Waterloo, and the Executive Director of the Tsinghua University - University of Waterloo Joint Research Center for Micro/Nano Energy & Environmental Technologies. His research is focused on clean energy and air emission controls including air cleaning, air monitoring technology, filtration and separation, greenhouse gas emission control, and renewable energy resources.

Does a N95 Facemask Provide You with 95% Protection?

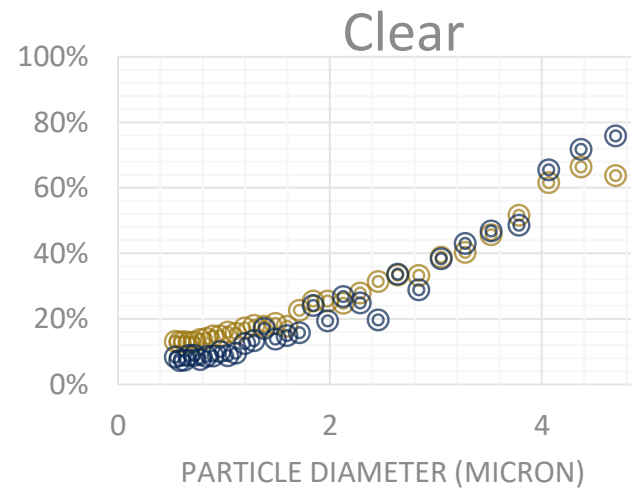
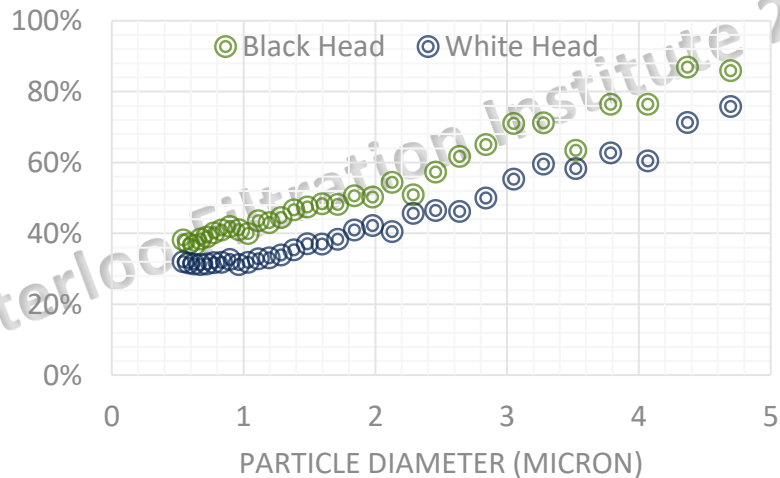
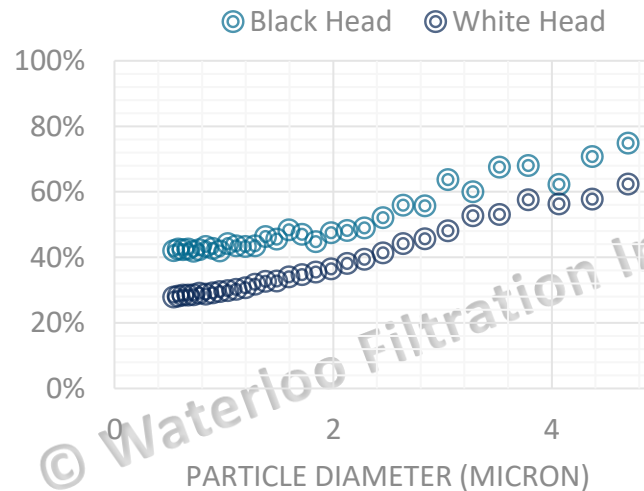
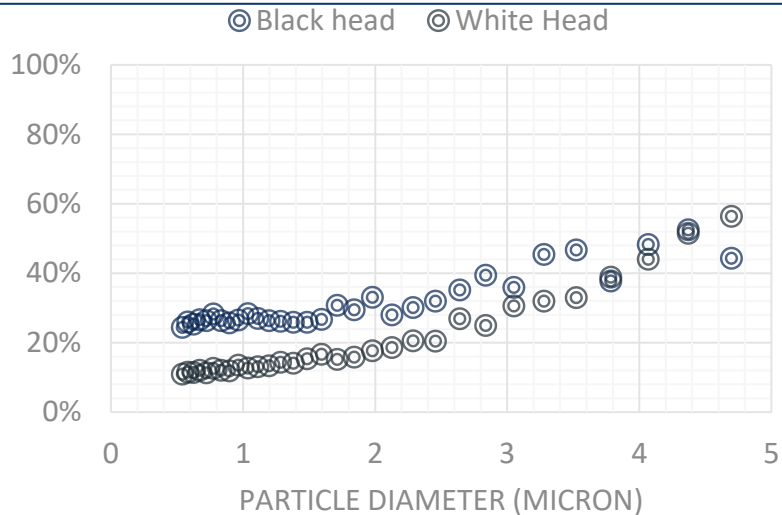




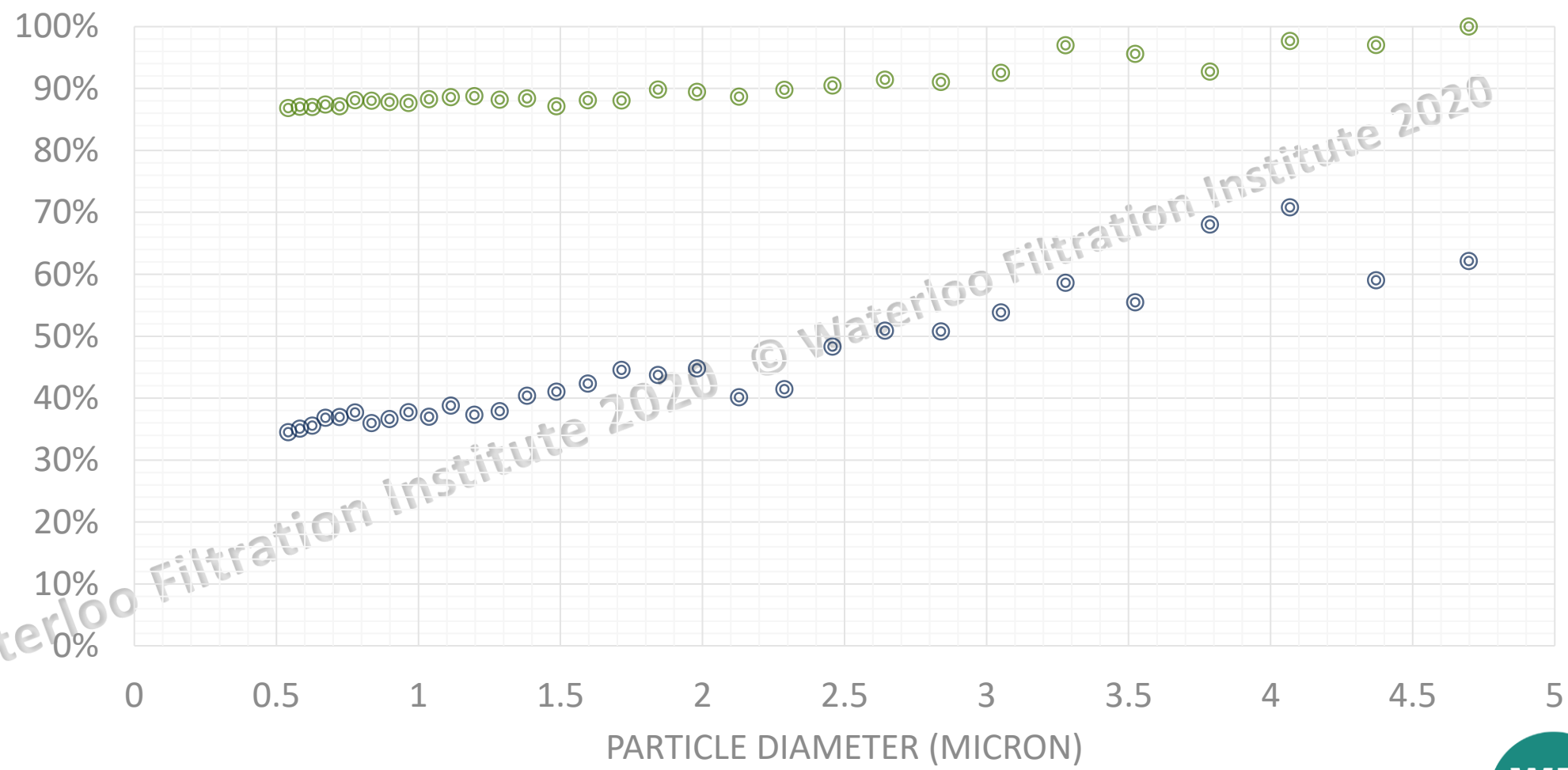
Fitting Factor



Comparison between Heads



Effects of Sealing on Filtration Performance



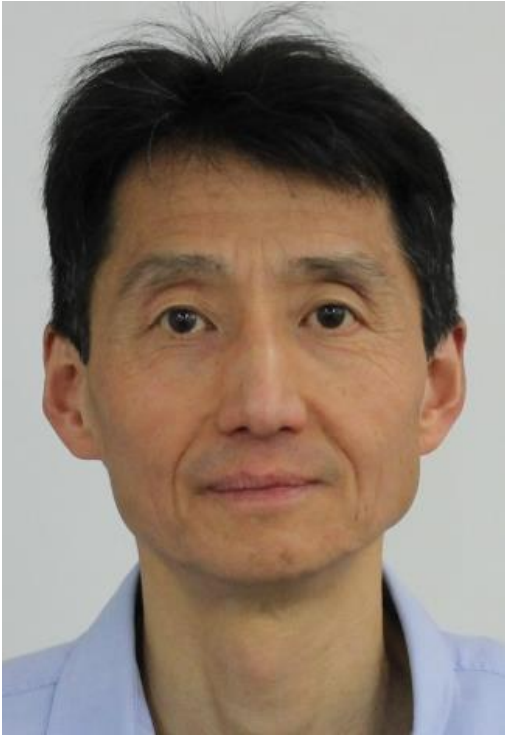
Facemask Is A Filter



**A loose-fitting, half-open
& unsealed filter!!
Not 100 protection!!**



Panel Speaker: Eric Fu, Founder of Aimwell Australia



Mr Fu is one of the pioneers of making the traditional powered respirator smaller and more user friendly. In 2009, he cofounded PAFec Australia, invented CleanSpace respirators, a unique low-profile powered respirator that had since found widespread adoption in industrial personal respiratory protection field across Australia, Europe and now in the USA. In 2017, he founded Aimwell Australia, continuing his passion in respiratory technology and products in a boarder application fields with over 30 years of prefesional experience in the area.

Factors Contributing to Low Protection

- Not worn properly (leak)
- Wrong mask size (leak)
- Mask profile not matching face (leak)
- Facial hair (leak)
- Damaged mask (leak)
- Wet mask (reduced filtration)
- Inferior mask brand (lower filtration, higher resistance)

Protection Improvement

- Establish training program – correct use / selection
- Conduct Fit Testing – discover / mitigate issues found
- Elastomeric face mask (APR) for better seal / protection (reusable)
- Powered respirator (PAPR) for even better protection (reusable)
- Note: To be reusable, stringent cleaning & sterilization procedures are required.

Fit Testing Example - Qualitative

3M™ Qualitative Fit Test Apparatus Kit FT-30, Bitter (Bitrex)



Fit Testing Example - Quantitative

TSI PortaCount



Panel Speaker: Peter Tsai, Univ. of Tenn.



Education: Ph.D. in Material Sciences, The University of Tennessee (UT)

Expertise: Development of meltblowing (MB) system and the electrostatic charging (EC) of materials for making air filter electrets. The MB and the EC developed by PT have been used in the industries worldwide making billion pieces of N95 or above face masks. He receives three most prestigious awards from UT in recognition of his contribution in technology innovation and transfer. PT is entitled by AFS as a Fellow Member. More details in the following two links.

Electrostatic Charging of Fibrous Materials (Electret)

- **Corona charging – Efficiency increased by 10X**
- **Triboelectrification – Efficiency increased by 20X**
- **Polarization (not suitable for filter media)**

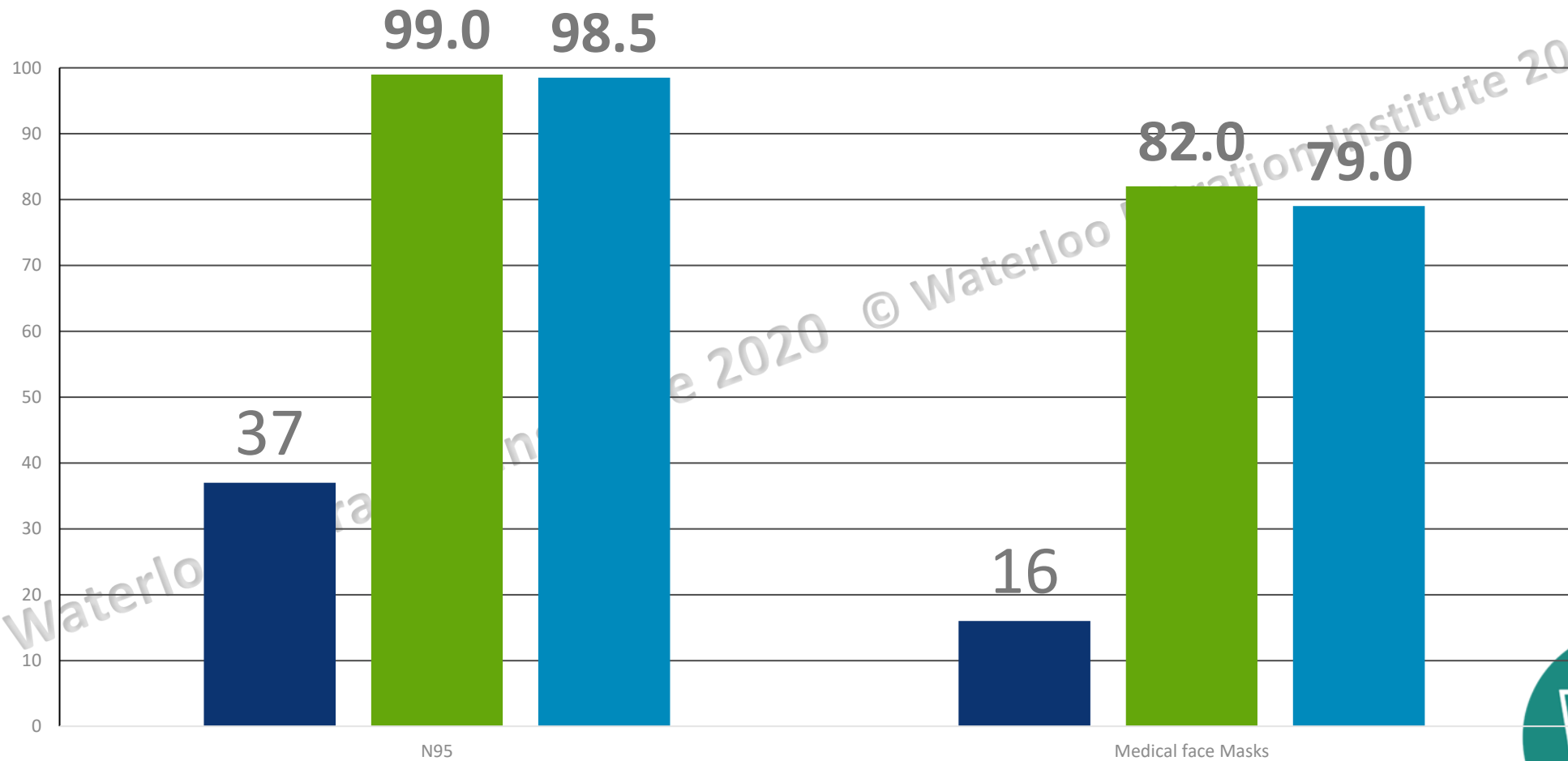
Difference between surface and embedded charges

- **Surface charges by contact, separation, or friction – Charges dissipate in the air by ionized air or by impurities in water**
- **Embedded charges in the electret by the charging process – Charges will not dissipate in the air or in water but by some other means**

Charge Decay

- Quiescent charge decay (Shelf storage)
- By heat, depending on temperature and time
- By water, steam or humidity
- By alcohol (Isopropyl alcohol - IPA)
- By loading
- Solid particles
- Liquid particles, e.g., DOP, PO, or water droplet
- Depolarization (Electret by polarization)

Efficiency of Uncharged, Charged, and after 70C, 24 hrs



Panel Discussion Experts

- Dr. Christine Sun, Waterloo Filtration Institute (USA)
- Mr. Tom Justice, Waterloo Filtration Institute (USA)
- Dr. Peter Tsai, University of Tennessee (USA)
- Dr. Chao Tan, University of Waterloo (Canada)
- Dr. Vincent Hu, Advanced Filtration Center, TTRI (Taiwan)
- Mr. Eric Fu, Aimwell Australia
- Dr. Gajanan Bhat, University of Georgia (USA)
- Mr. Bob Burkhead, Blue Heaven Technologies (USA)

Questions Received

- According to Dr. Tan's research, the actual filtration efficiency when people wear is much lower than reported, what is your suggestion for the doctors who directly deals with COVID-19 patients? Or people in a highly infected area?
- How long can I use my facemask?
- Can I reuse it? Does the charged PP decay or lose the charge? What is normal self life for the meltblown PP charged media?
- I cannot find N95 masks in the store, but there are R95/P95 available. Can I buy them instead?
- Can I use alcohol or detergents to sterilize it?
- What electrical charge do viruses have?
- Does tantret electrical charging of melt blown face mask media work?
- What is the balance between supply and demand for face mask media in the world today?
- What advice do you all have for a new entry into manufacturing face mask media:
 - manufacturing capacity (masks/year)
 - price to charge (\$/sq meter)
 - standards for product to meet
- Is there an available face mask on the market that can target and capture the virus i.e. is there a face mask that can protect you from 0.05-0.1 micron size particles which is the size of a virus
- What in your opinion would be an ideal face mask solution for the virus i.e. functionalized particles to target and capture the virus
- Is it possible to actually develop a face mask that will protect you 100% from a virus, or is the case that you'll never be 100% protected
- What kind of face mask technology could actually capture the virus and kill the virus, is this possible?

Panel Discussion Questions

1. According to Dr. Tan's research, the actual filtration efficiency when people wear is much lower than reported, what is your suggestion for the doctors who directly deals with COVID-19 patients? Or people in a highly infected area?
2. How long can I use my facemask? Can I reuse it?
3. Does the charged PP decay or lose the charge? What is normal self life for the meltblown PP charged media?
4. I cannot find N95 masks in the store, but there are R95/P95 available. Can I buy them instead?
5. Can I use alcohol or detergents to sterilize my facemask?
6. What electrical charge do viruses have? Does tantret electrical charging of melt blown face mask media work?
7. Is there a mask which will give me 100% protection?
8. What is the current balance between supply and demand?

Reference

Advice on the use of masks in the community, during home care and in health care settings in the context of the novel coronavirus (2019-nCoV) outbreak

Interim guidance
29 January 2020

[WHO/nCov/IPC_Masks/2020.1](#)



<file:///C:/Users/chris/Downloads/2020-01-29-advice-on-the-use-of-masks.pdf>



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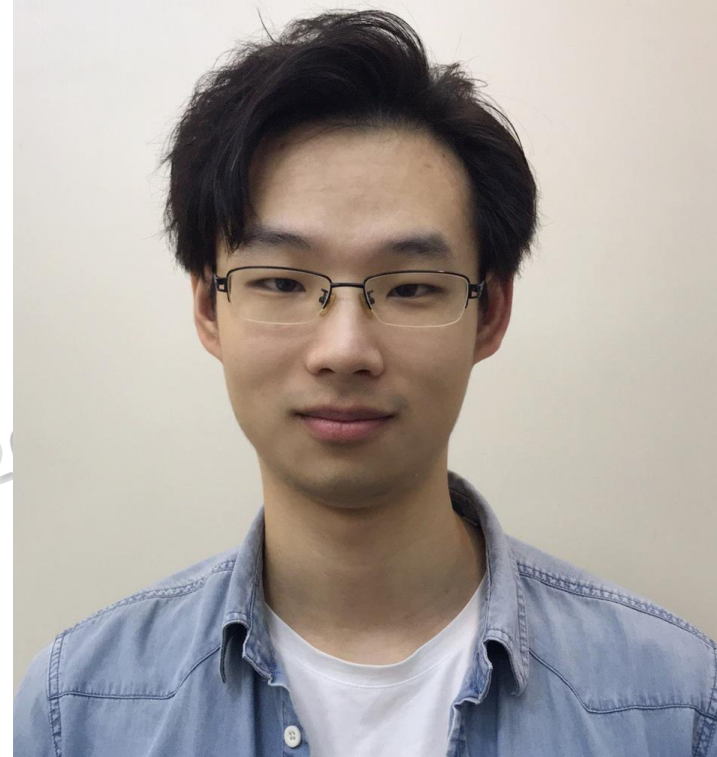


Gajanan Bhat (USA)

Thanks to WFI Program Team



JOAN DU, P.ENG, LEED AP
Executive Director



Dr. Yifu Li
Program Support Manager

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Thank You for Your Attention

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Address: Suite 101, 150 Bridgeland Ave, Toronto, M6A 1Z5, Canada

Email: info@wfinstitute.com

Phone : 1-866-546-0688