

Hepa / Ulpa μ -Glass Filtration Media vs. ePTFE Membranes

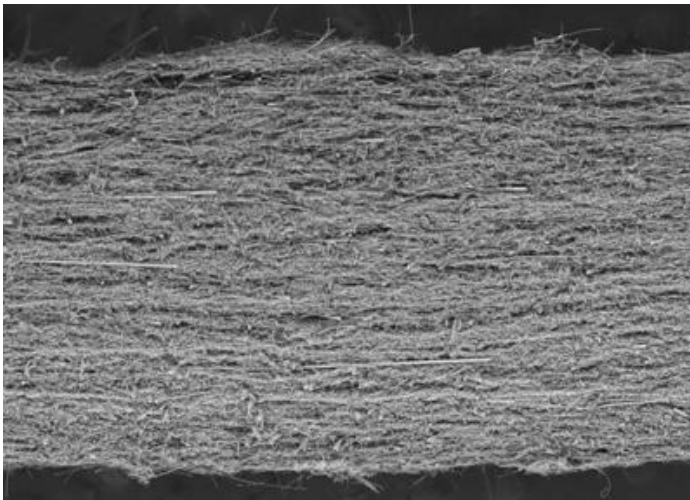
12 Dec 2016
TCTA- Taiwan



- **Structural and physical properties**
- **Filtration properties**
 - Performance when loading different aerosol (DOP & NaCl)
 - Charge effect and Charge dissipation
- **Energy consumption**
- **Out gassing (Boron & VOC)**

■ μ Glass media

- Even pore size distribution assuring laminar flow
- Combination of surface and depth loading
- Very high specific surface area (fiber surface area)
- Proven technology in clean room and laminar flow applications
- Pass DIN -, French and UL fire classification



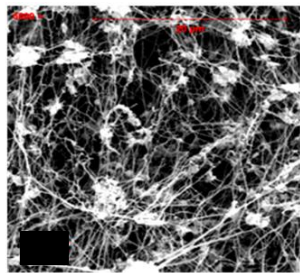
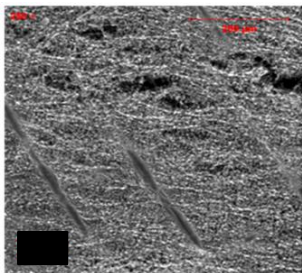
- Very high porosity (>90%) and very high 3D tortuosity.
- Large dust holding capacity
- Typical BW: 70 to 78g/m²

Structural and filtration properties

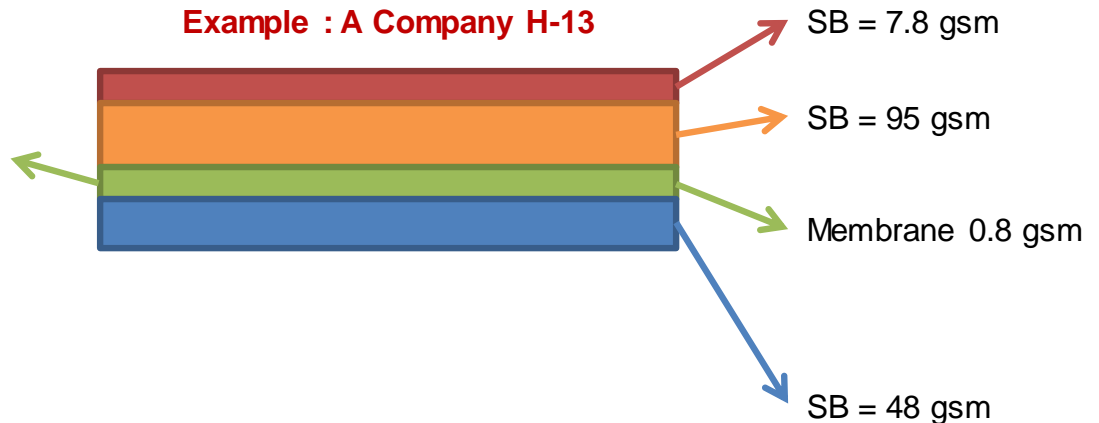


■ ePTFE Membranes used in **Semi Conductor applications**

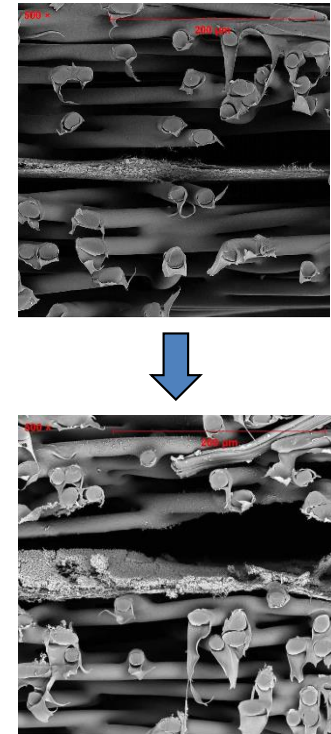
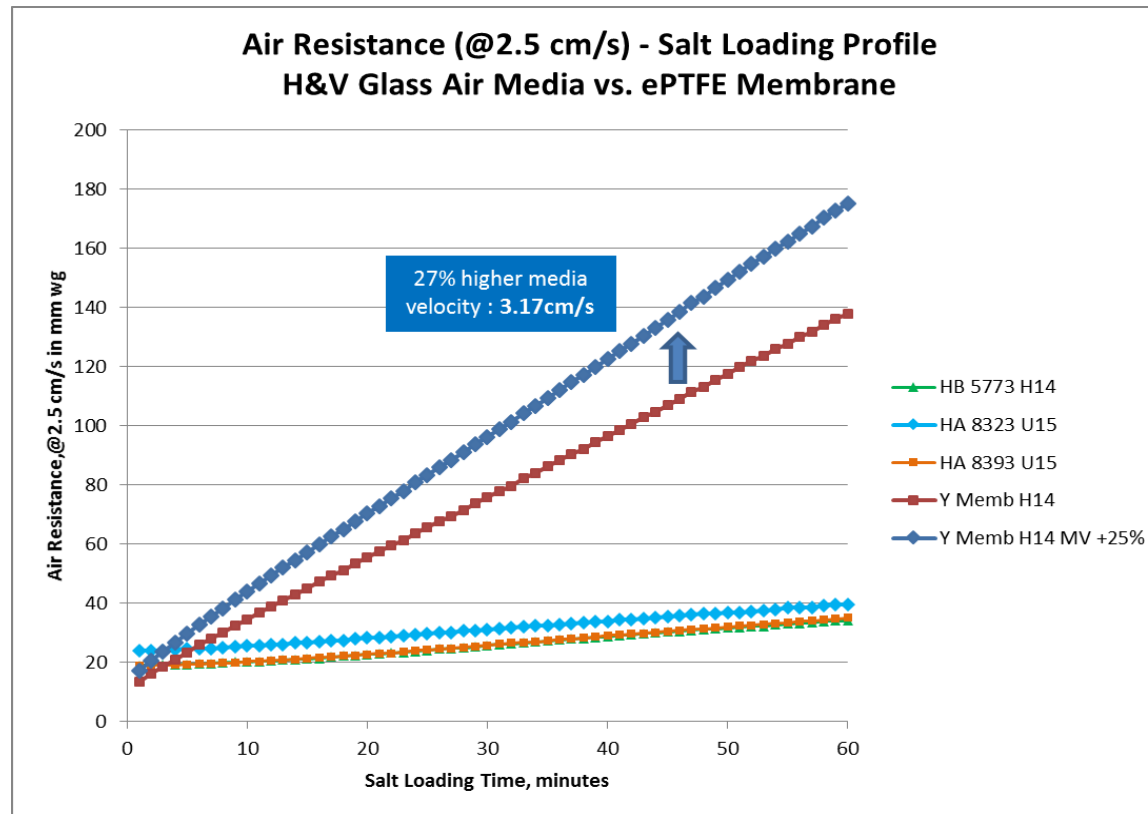
- Delicate thin film with support from non-woven layers
- Relatively high porosity variability
- Higher gamma (High efficiency with low air resistance)
- Membrane like 2D fiber layer
- Surface loading, very low dust capacity
- Bad flame retardancy



Example : A Company H-13



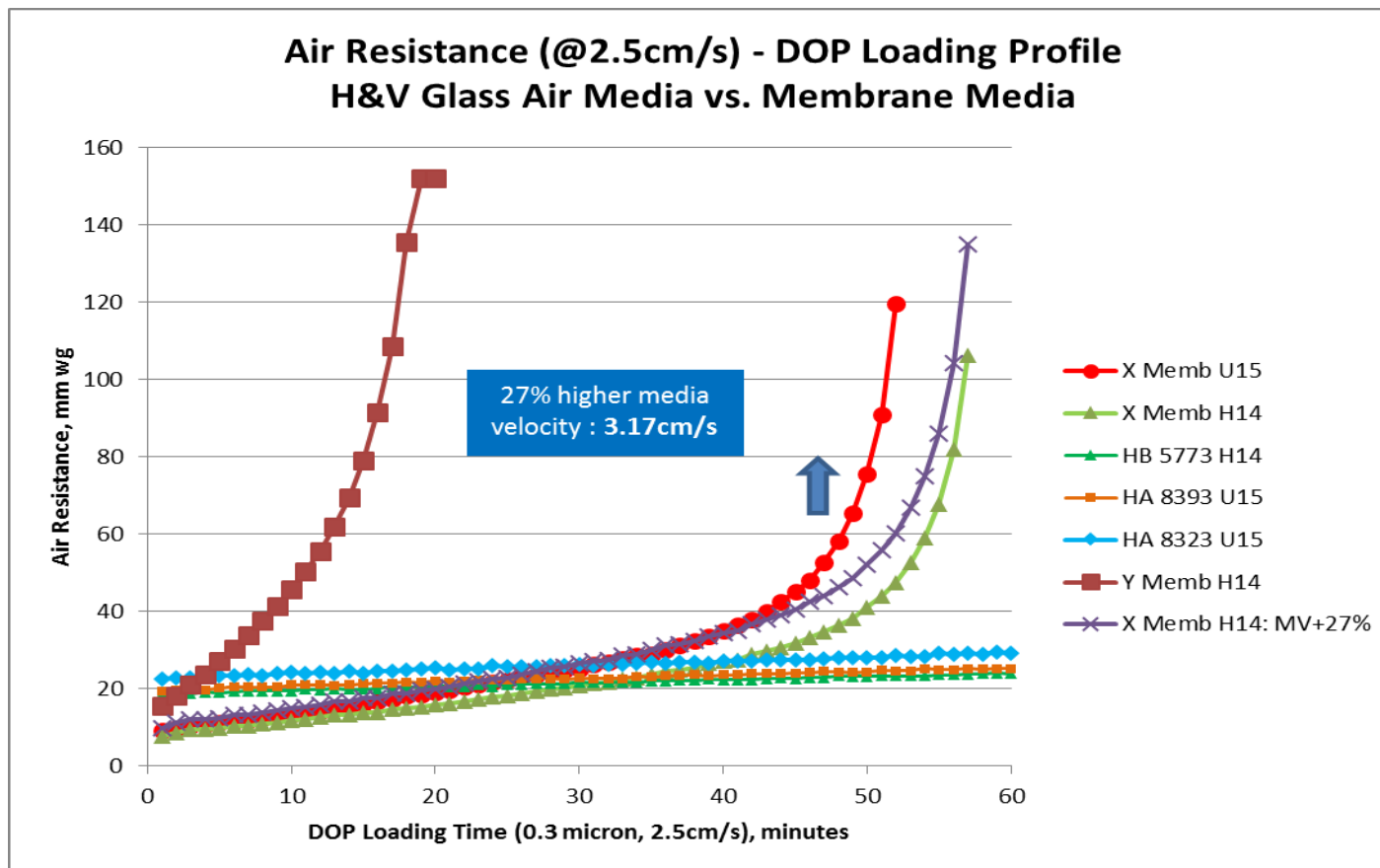
Filtration properties – NaCl Loading Evolution of Air Resistance



ePTFE Air resistance increases rapidly with small loading of fine particles (sub micron) while
The air resistance of glass media increases very moderately

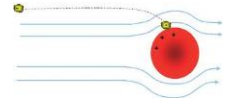
Filtration properties – DOP Loading

Evolution of Air Resistance



- The effect of increased media velocity has not been represented in this graph
- Compared to glass media, membranes are very sensitive to loading with oily substances
 - Oil, hydro carbons, diesel exhaust, ...

Effect of charge



H&V in house test result
(performance of ePTFE before and after discharge treatment)

Grade	Air Resistance mmH ₂ O	Penetration %
X Membrane	10.8	0.0014
X Membrane (discharge IPA)	15.6	0.0023

TDA100P – DOP - 5.3 cm/s – 0.3 μm

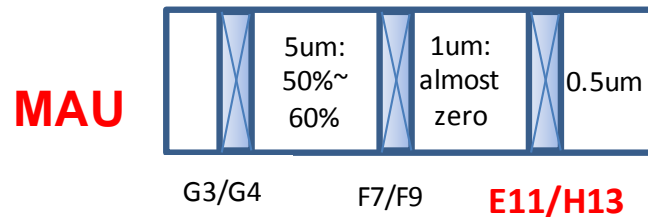
50% increase pressure drop and
almost double penetration

EN1822 – synthetic media need to be
discharged prior performance rating.

ePTFE filters: uncertainty on energy saving



- ePTFE: low initial air resistance
- But the air resistance increases sharply during dust loading

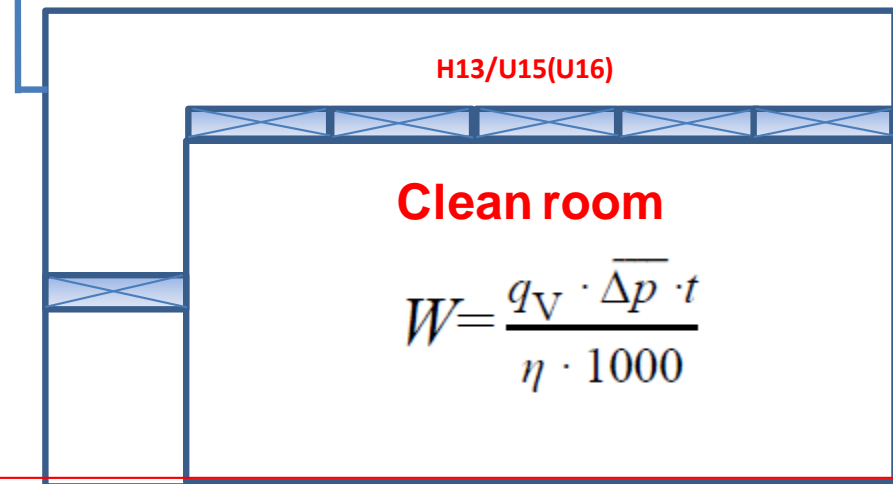


ePTFE: Final filters of MAU have to be H13 glass media

Glass media: Final filter of MAU only need to be E10/E11 glass media

The air resistance of H11 glass media is only 55% of H13,

Using filters made of H11 media as final filters will greatly reduce the energy consumption of MAU



The energy consumption of cleanroom depends on the average resistance of filters instead of the initial resistance

System energy consumption = Cleanroom energy consumption + MAU energy consumption

- H&V has 2 glass media product lines
 - Standard glass
 - Boron Oxide (B_2O_3) content +/- 10%
 - Boron content : +/- 3%
 - Low Boron glass
 - Boron Oxide content +/- 0.015% (traces due to process contamination)
 - Boron content : +/- 0.0045 % (660 times less compared to std μ -glass)
- Sources confirm that Boron content in low boron glass has not been identified as cause for rejection rate in the semi-conductor industry

Technology requirements for wafer environmental contamination control



No	Process	Items	UOM	2015 (24nm)*1	2020 (15nm)*1
1	Full Process	Critical Particles Size	nm	15.9	8.9
2		Number of Particles	/m3	ISO CL1	ISO CL1
3	Litho	Inorganic Acids	pptV	2,000	2,000
4		Organic Acids	pptV	2,000	2,000
5		Bases	pptV	2,000	2,000
6	Gate	Metals	pptV	10	10
7		Volatile Organics	pptV	20,000	20,000
8	Salicidation	Inorganic Acids	pptV	500	500
9		Organic Acids	pptV	5,000	5,000
10		HF	pptV	200	200
11	Dopant	Boron	Ng /m3	<4.5	<4.5

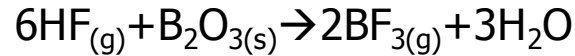
*1: DRAM line width is minimum 1/2 Pitch

(Cite: 2013 ITRS)

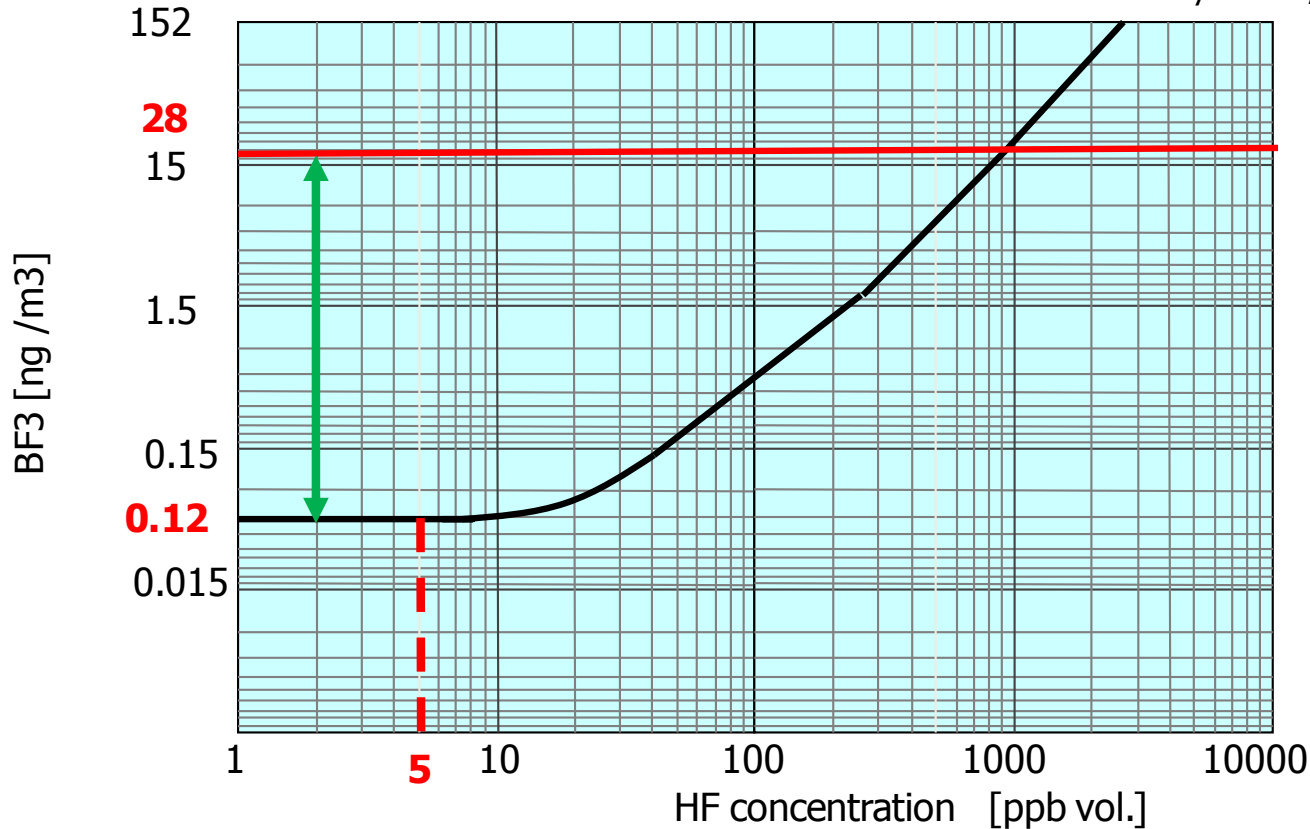
2005 ITRS AMC control:

Dependent on the process, the **max acids concentration is 5000 pptM**

Boron Outgassing of Low Boron Glass Media in a HF Atmosphere



Filter Face Velocity: 0.35m/s



Limit requirement B is 4.5 ng/m³. This represents a limit of 28 ng/m³ BF₃

Due to the imitations of acid gas concentration in cleanrooms there is extremely low outgassing of boron, lower than the allowed concentration

VOC Outgasing @ 40 °C 1hr



Test Result*1 (unit : $\mu\text{g}/\text{m}^2$) @40°C TENAX-GR (GS-MS)
*1 : Minimum Limit of Quantification : Hexadecane Conversion $1.5\mu\text{g}/\text{m}^2$

No	Test Piece	TOC	C6-C10	C10-C20	>C20
1	Normal Glass Media·1	<1.5	<1.5	<1.5	<1.5
2	Normal Glass Media·2	8	8	<1.5	<1.5
3	Low Boron Glass Media	11	11	<1.5	<1.5
4	PTFE Media	1032	<1.5	1032	<1.5

- PTFE media VOC is ~100 times than Glass Media

VOC Outgasing @25 °C 1hr



Analyzed by TD-GC-MS
(Thermal Desorption - Gas chromatograph - Mass spectrometry)

Test Piece	TOC ($\mu\text{g}/\text{m}^2$)	C6-C10 ($\mu\text{g}/\text{m}^2$)	C10-C20 ($\mu\text{g}/\text{m}^2$)	>C20 ($\mu\text{g}/\text{m}^2$)
HEPA Glass	4.7	0.5	4.2	ND
ePTFE membrane	26.9	0.6	26.3	ND

- PTFE media VOC is ~6 times than Glass Media at RT

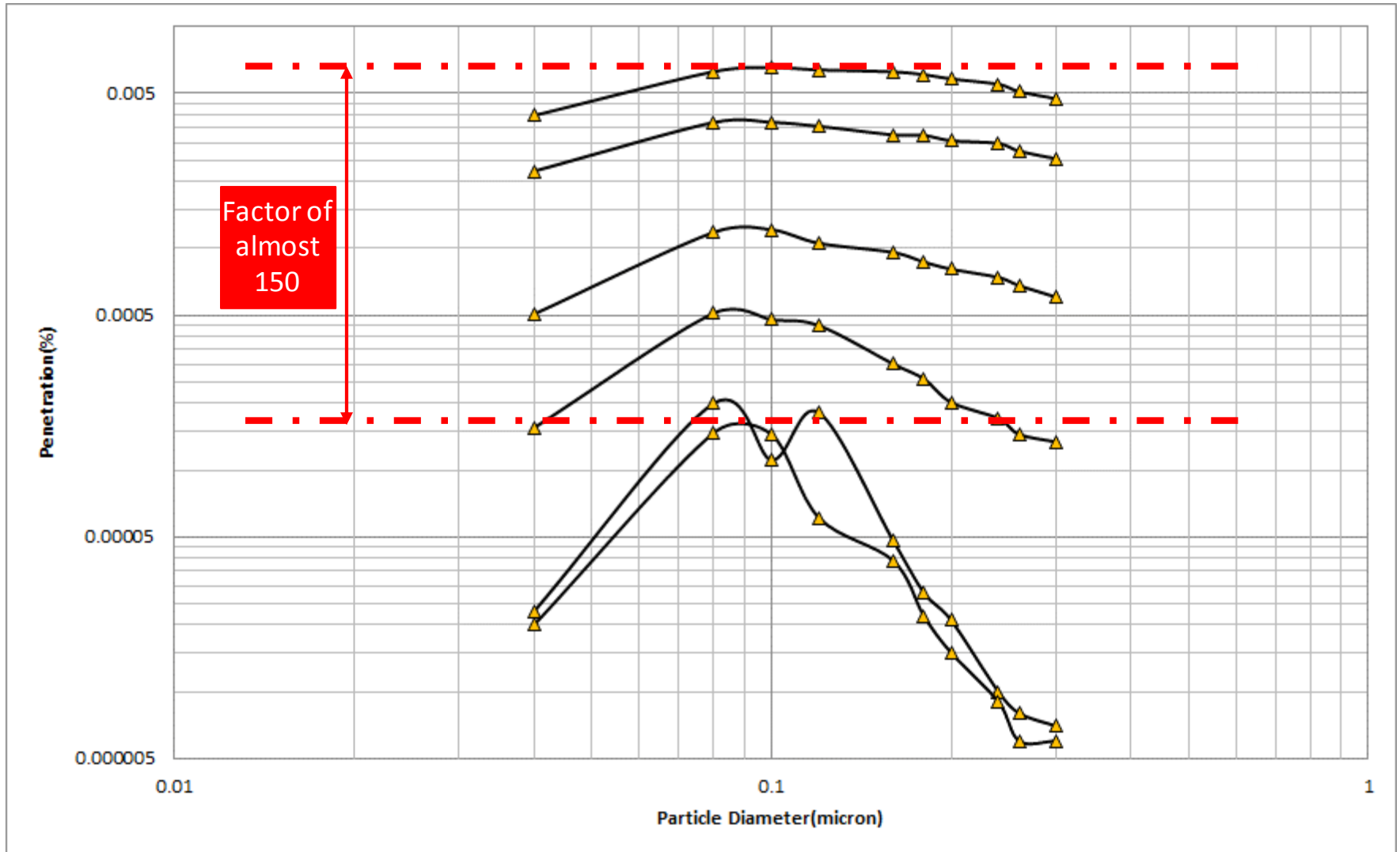
Glass Composition



- Not all glass compositions are suitable for fine fibers used in air filtration

GLASS COMPOSITION	A-GLASS (%)	B-GLASS (%)	C-GLASS (%)	E-GLASS (%)
SiO ₂	69.0 - 72.0	55.0 - 60.0	63.0 - 67.0	50.0 - 56.0
Al ₂ O ₃	2.5 - 4.0	4.0 - 7.0	3.0 - 5.0	13.0 - 16.0
B ₂ O ₃	< 0.09	8.5 - 11.5	4.0 - 7.0	5.8 - 10.0
Na ₂ O	10.5 - 12.0	9.5 - 13.5	14.0 - 17.0	< 0.6
K ₂ O	4.5 - 6.0	1.8 - 4.0	0 - 2.0	< 0.4
CaO	5.0 - 7.0	1.0 - 5.0	4.0 - 7.0	15.0 - 24.0
MgO	2.0 - 4.0	< 2.0	2.0 - 4.0	< 5.5
Fe ₂ O ₃	< 0.2	< 0.25	< 0.1	< 0.5
SO ₃	< 0.2	< 0.2	< 0.2	< 0.2
TiO ₂	-	-	-	< 1.0
ZnO	0 - 2.0	2.0 - 5.0	< 0.1	-
BaO	-	3.0 - 6.0	< 0.1	-
F ₂	< 1.0	< 1.0	< 1.0	< 1.0

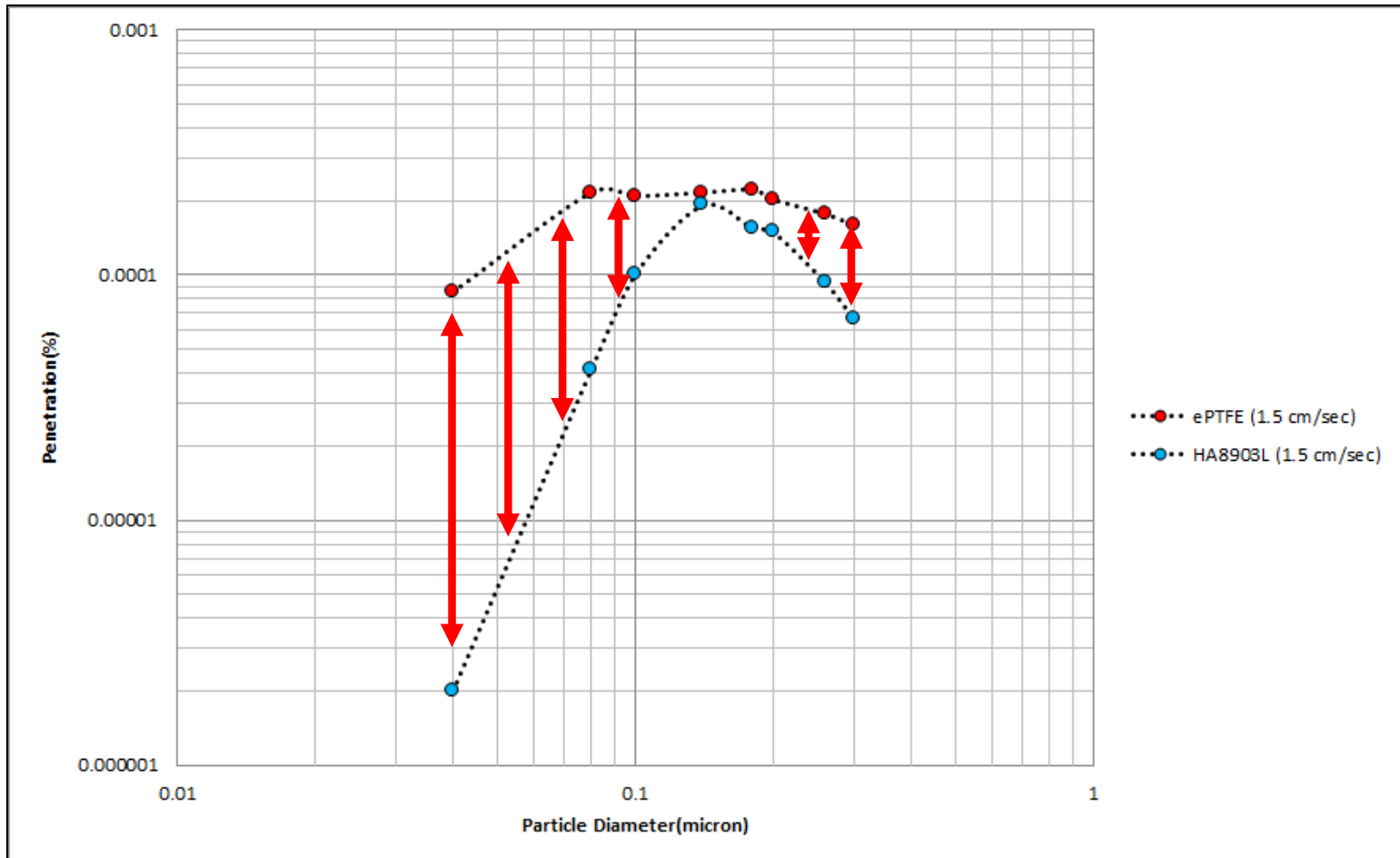
Lot Variability of ePTFE membrane performance



Shape of the MPPS curve



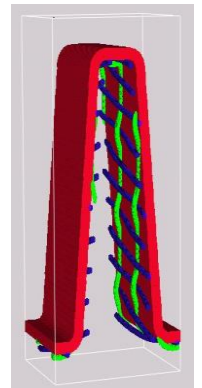
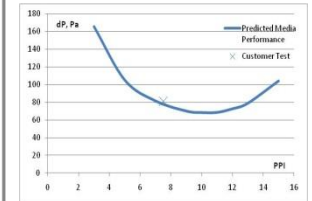
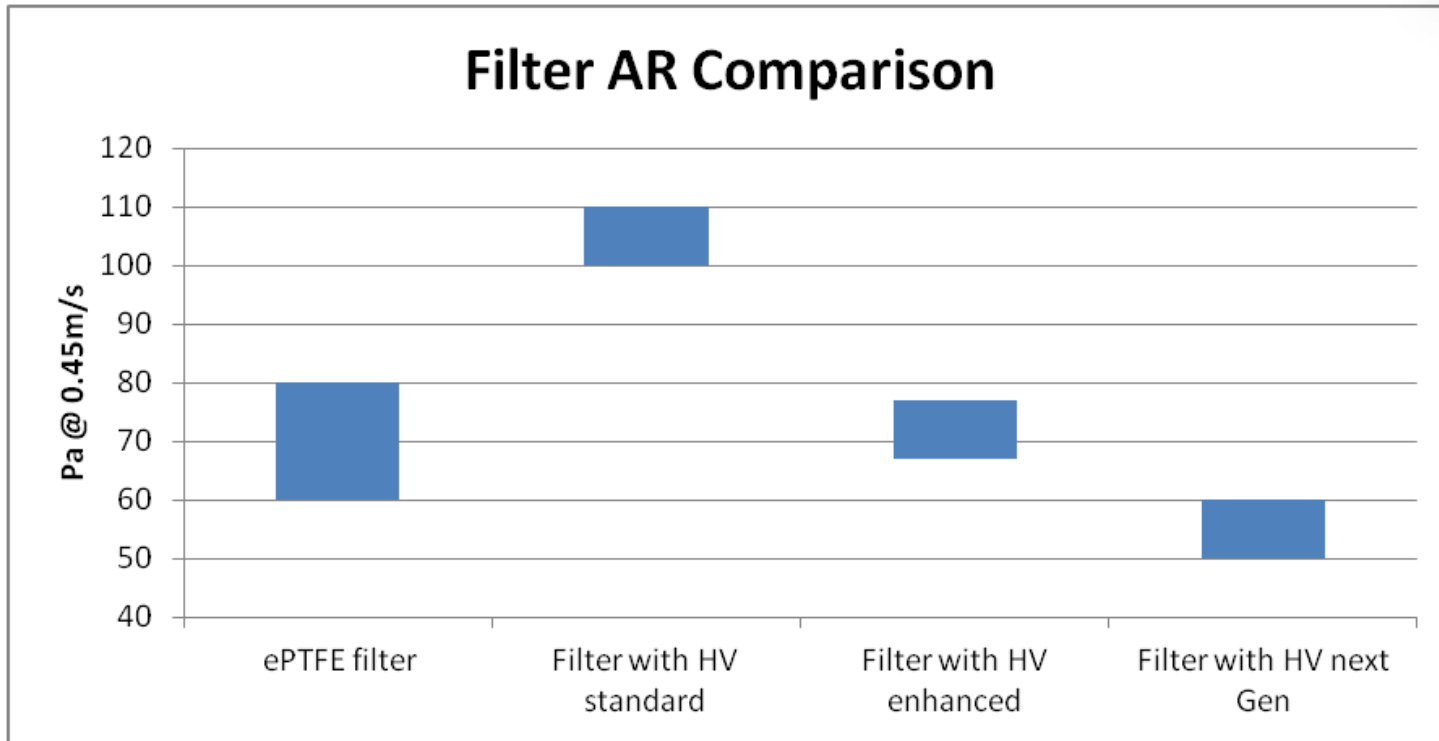
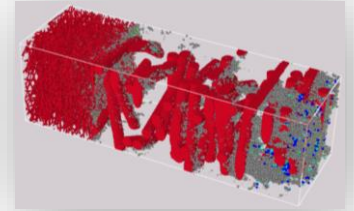
- Glass media with the same MPPS efficiency has a much higher overall efficiency



High Efficiency low Pressure Drop Glass Filter



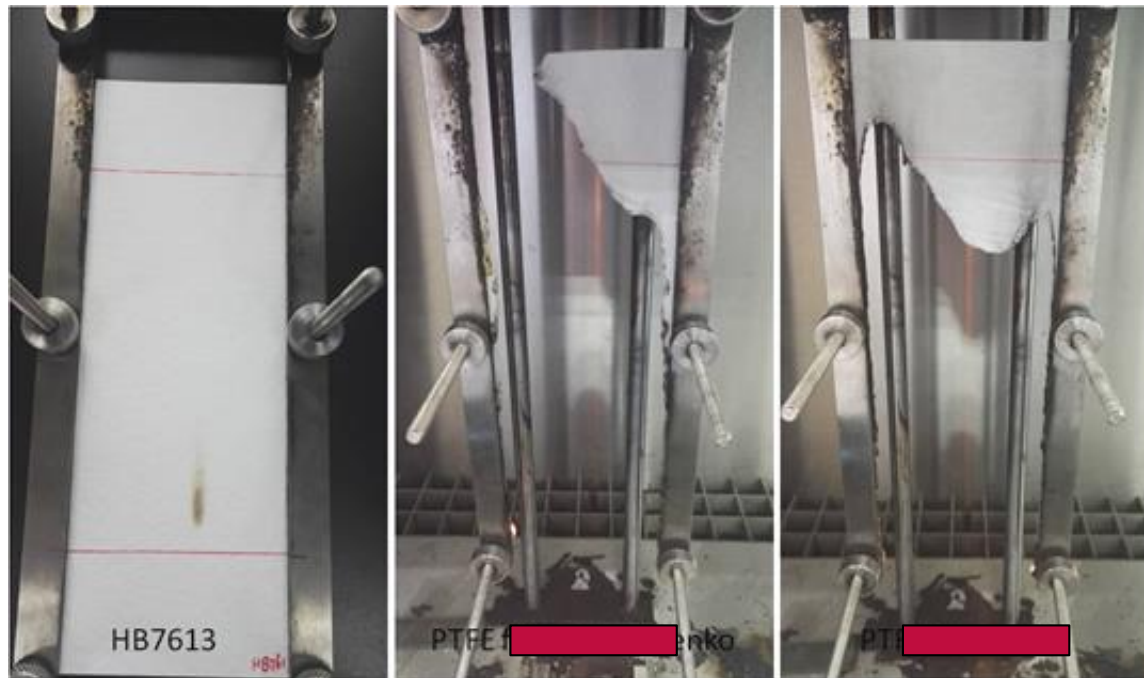
- Increase the pleat height of glass filter, can dramatically decrease the AR, save huge energy of Cleanroom.



Flammable Testing acc. DIN53438 - 3



- Glass classification F1 = **pass**. Fire does not destroy media
- ePTFE classification F3 = **fail**



Conclusion



	u-Glass media	ePTFE Membranes
Media structure	3D fiber	2D fiber +support layer
Filtration technology	Surface and depth filtration	Surface filtration
Dust holding capacity	High	Low
Filtration properties	Higher pressure drop, consistent performance	Low initial pressure drop, increase sharply
Charge effect	No charge	Charge may exist
Boron outgasing	Low (traces)	None
VOC outgasing	Low, lower risk of chemical pollution	High, higher risk of chemical pollution
Fire retardancy		
Cost	Low	High
Energy consumption	Higher initially, increase slowly	Lower initially, increase sharply

Hollingsworth & Vose



Thank You for Your Confidence !

HV *Advanced Materials for a Cleaner World*
Hollingsworth & Vose