Comparison of Different Neutralizing Methods by IPA on Electret Filter Media

Min Tang[1], Sheng-Chieh Chen[2], Drew Thompson[1], David Y.H. Pui[1]

[1]Particle Technology Laboratory, University of Minnesota
[2]Virginia Commonwealth University

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CONTENT

- Introduction
- Methodology
- Comparison of Different Neutralizing Methods
- Conclusion

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1. Introduction

- It has been broadly demonstrated that electrostatic charges added to polymer fibers by creating electrets will improve particle capture abilities without increasing the pressure drop.

- Filtration applications require knowledge of the minimum efficiency provided by a filter (worst-case performance). (Tronville and Rivers 2012)

- In existing test standards, e.g. EN 779 and ISO 16890, isopropanol (IPA, in liquid or vapor phase) is used to eliminate electrostatic effects from filter media.

P. Tronville and R. Rivers, Looking for the minimum efficiency of fibrous air filters during their service life, 11th World Filtration Congress - Session G16, 2012

1. Introduction

Proposed hypotheses of IPA discharging mechanism:

- Cantaluobe et al. (1979) suggested that charge decay was not due to the screening of the charges by dipoles of organic solvents, but to detrapping of charges which occurs by the motion of the charges themselves.

- Rychkov et al. (1992) reported that either the internal decay through conduction or the external due to ion deposition or masking may also contribute to charge deterioration.

Cantaloube, B., Dreyfus, G., and Lewiner, J., Vapor-induced Depolarization Currents in Electrets, J. Polym. Sci. Polym. Phys. Ed. 17, 95–101 (1979).
Rychkov, A. A., Cross, G. H., and Gonchar, M. G., A Method for Discriminating between 'External' and 'Internal' Processes Leading to Voltage Decay from Electrets in Humid Conditions, J. Phys. D Appl. Phys. 25, 522–524 (1992)

1. Introduction

Standard	Discharging Method for Electret Media
EN 779-2012 ISO/TS 21220:2009	Filter media are immersed in IPA liquid.
ISO 16890-1:2016	Filter media are exposed to IPA vapor.

- IPA liquid immersion can cause structural changes of nanofiber by solvent swelling effect (Sun 2009), while IPA vapor is non-destructive.
- Essential question: can these methods fully discharge the electret media?
- There is a huge controversy in the fiber charge characterization techniques of electret media. (Kilic etc. 2015)

C. Sun, Implications of Discharging Conditioning on Air Filter Media, INTC 2009
A. Kilic, E. Shim, B. Pourdeyhimi, Measuring electrostatic properties of fibrous materials, Journal of Electrostatics, 2015(74): 21-26

Objective

Goal:

- Develop a simple and reliable method to determine whether the filter is fully discharged.
- Compare the neutralization effect of IPA liquid and vapor discharging.

CONTENT

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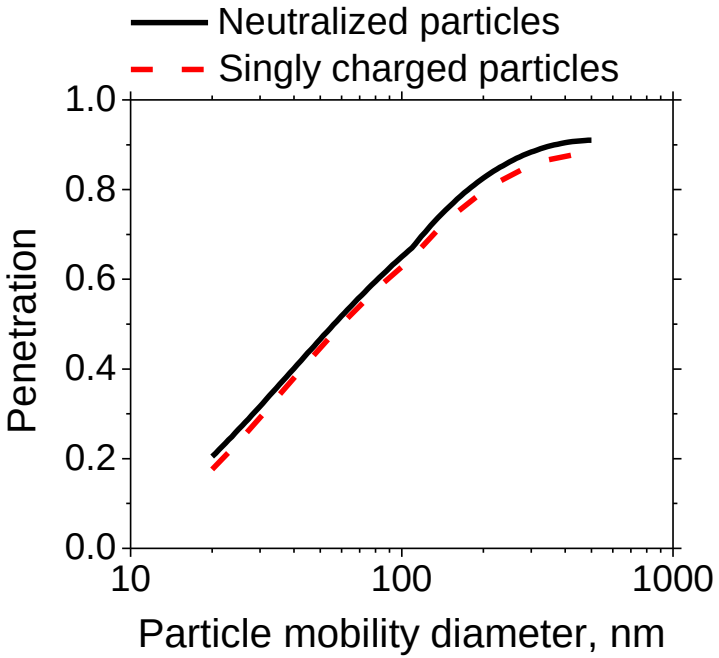
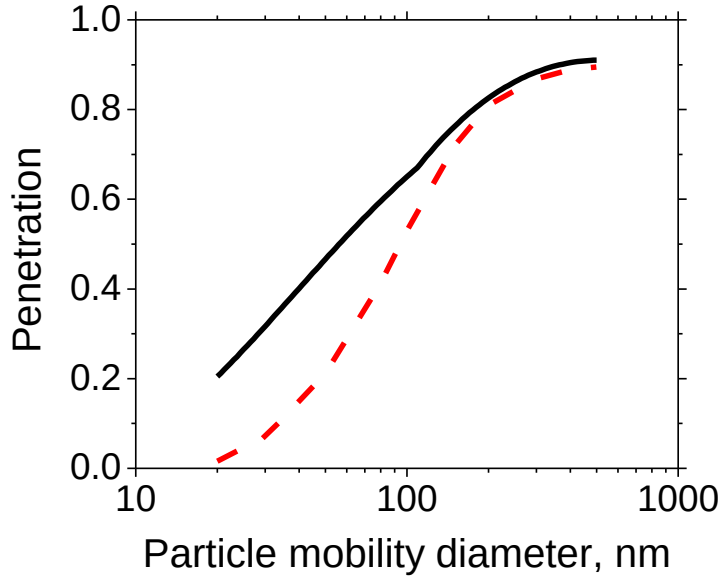
2. Methodology

- Method to indicate whether the filter is charged

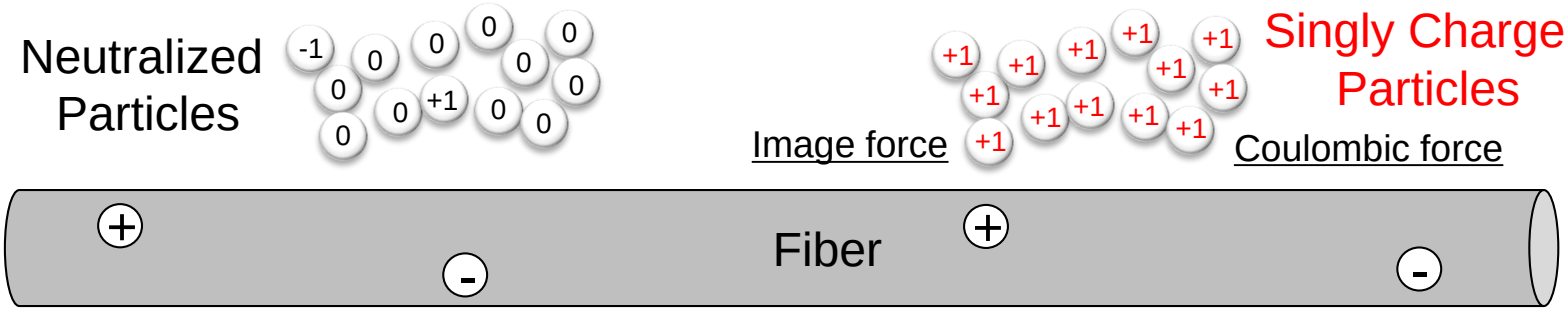


(1) Mechanical filter

**Results based on model of R.C Brown (1993)*

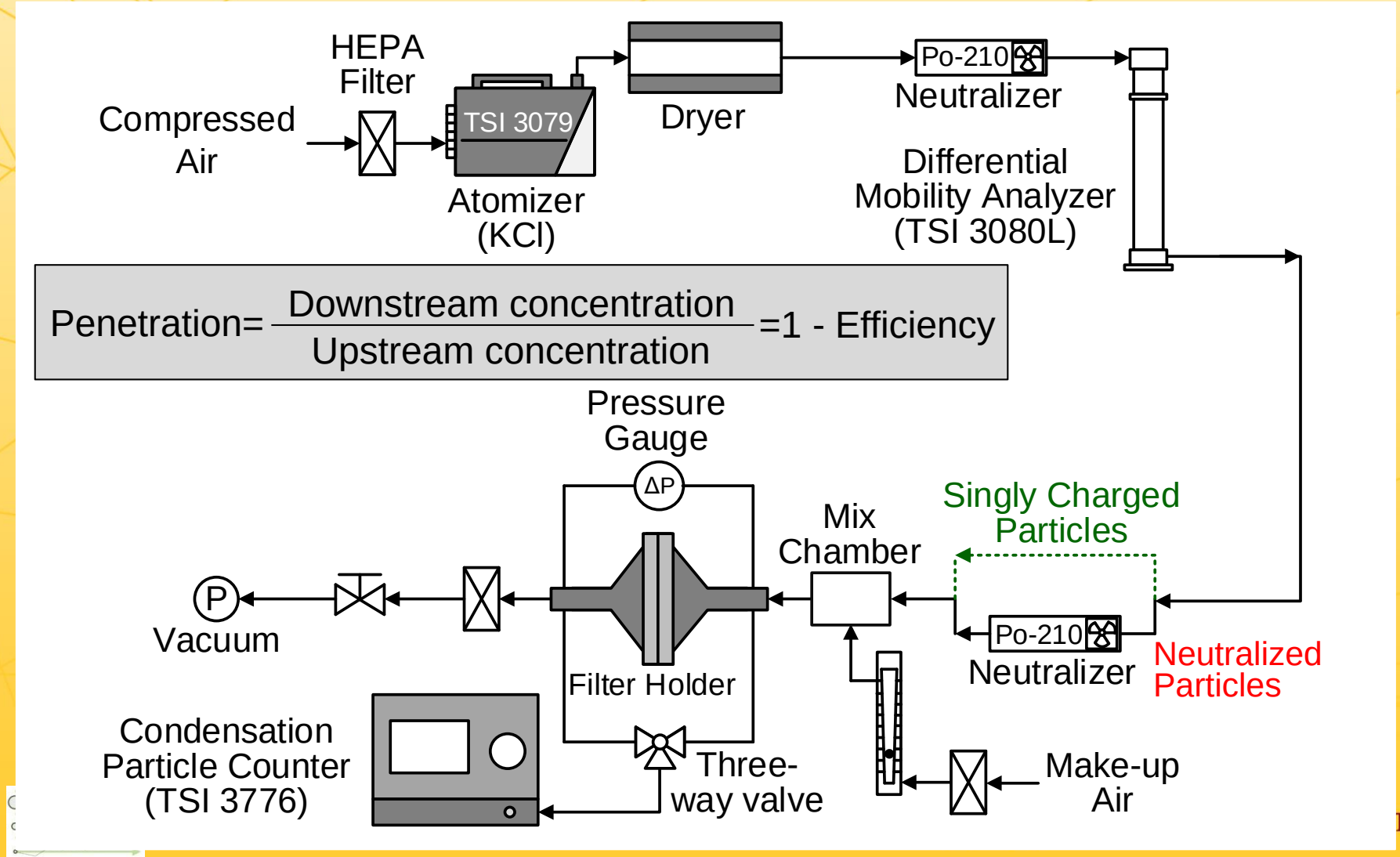


(2) Filter with low charge level



2. Methodology

- Setup of Penetration Test

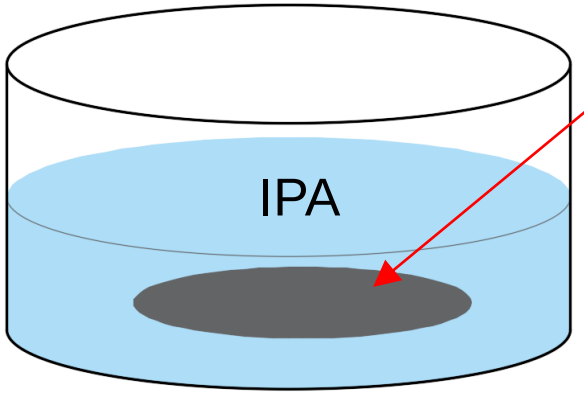


2. Methodology

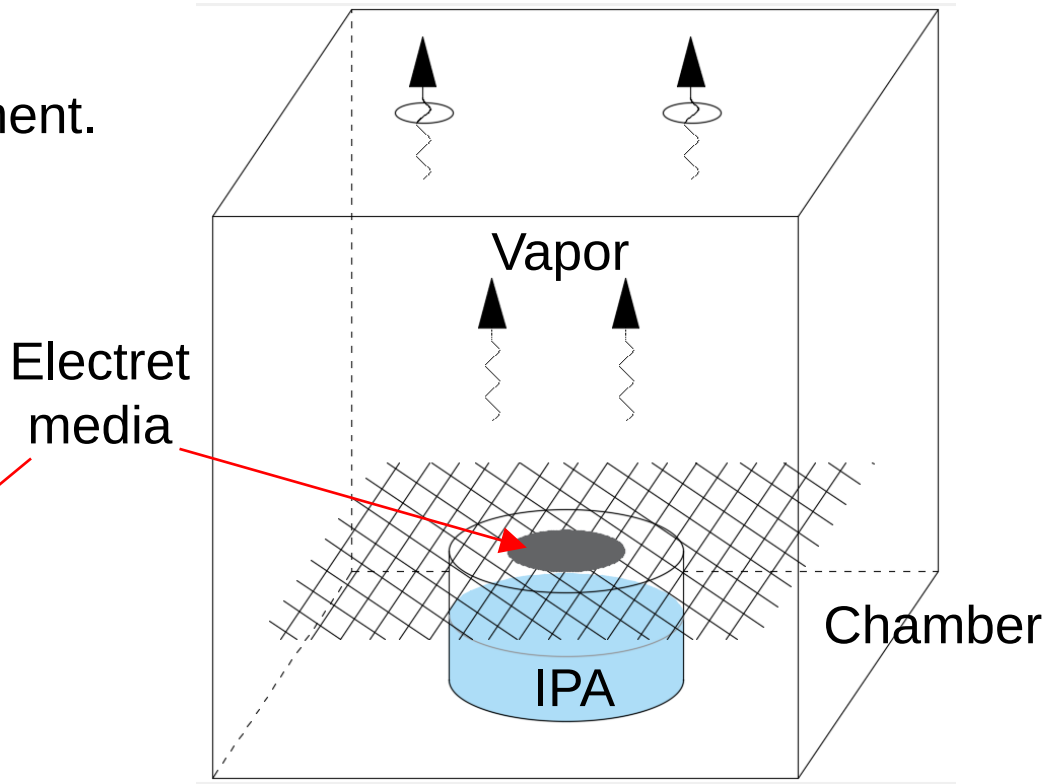
❖ Neutralizing Methods

(1) IPA liquid treatment

- Dip in IPA for 24 h.
- Dry in ambient environment.



(2) IPA vapor treatment (24 h)

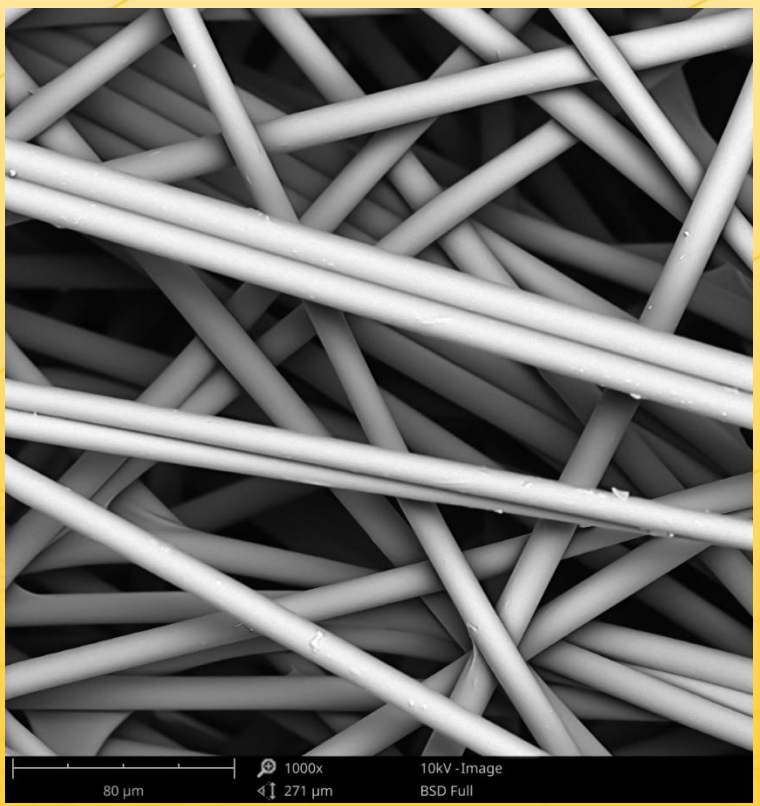


2. Methodology

- Electret HVAC Filter Media

Thickness, mm	0.826
Effective Fiber Diameter, μm	15.6
Charge Level	**High**
Basis weight, g/m²	76.7
Solidity (volume density)	10.2%

Data from manufacturer



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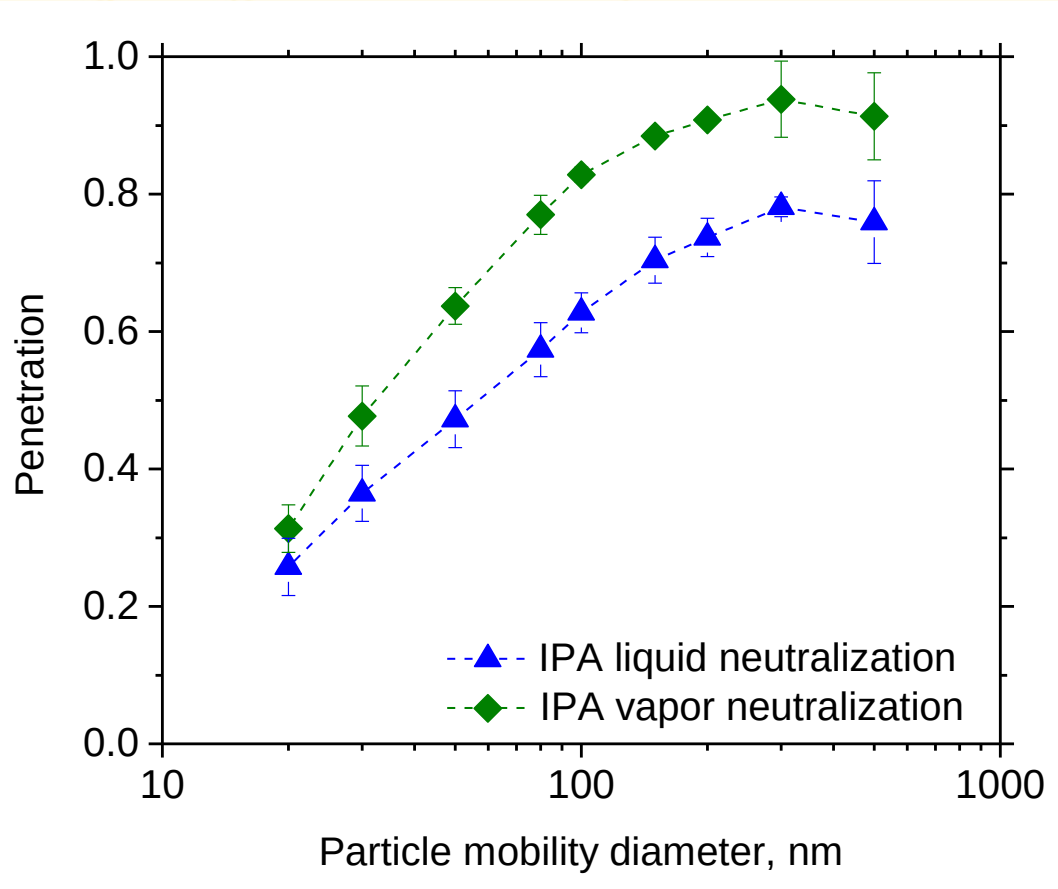
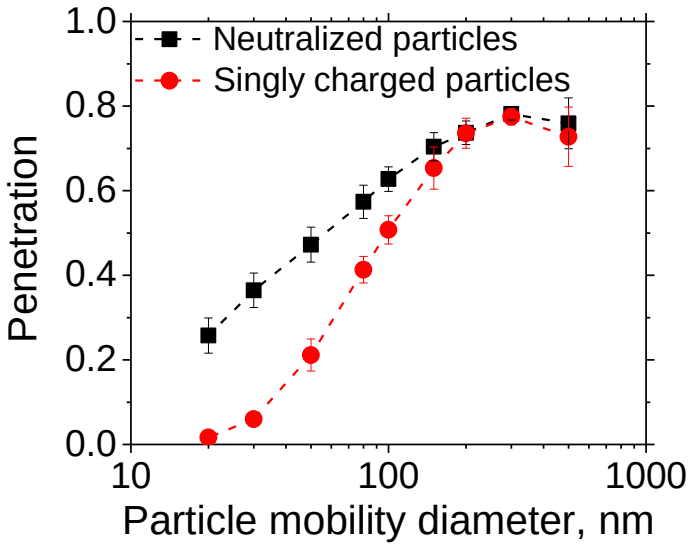
3. Comparison of Different Neutralizing Methods

- Penetration of electret media discharged by IPA liquid and vapor.



IPA vapor treatment showed better neutralization effect than IPA liquid.

3. Comparison of Different Neutralizing Methods

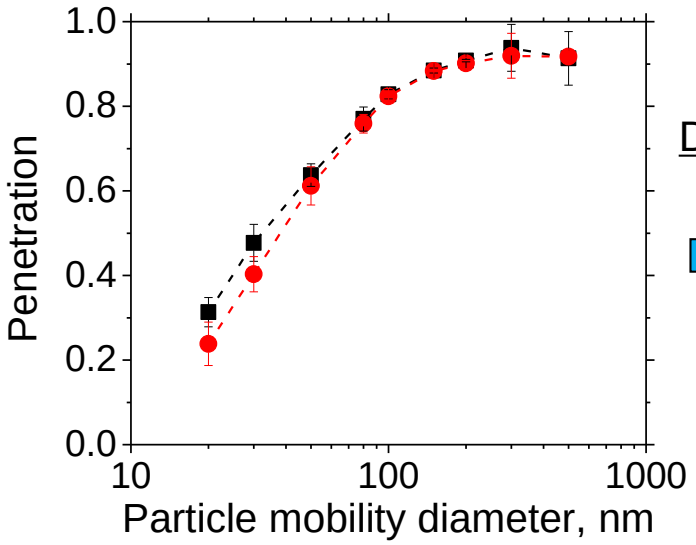


(1) IPA liquid neutralization

Possible reasons:

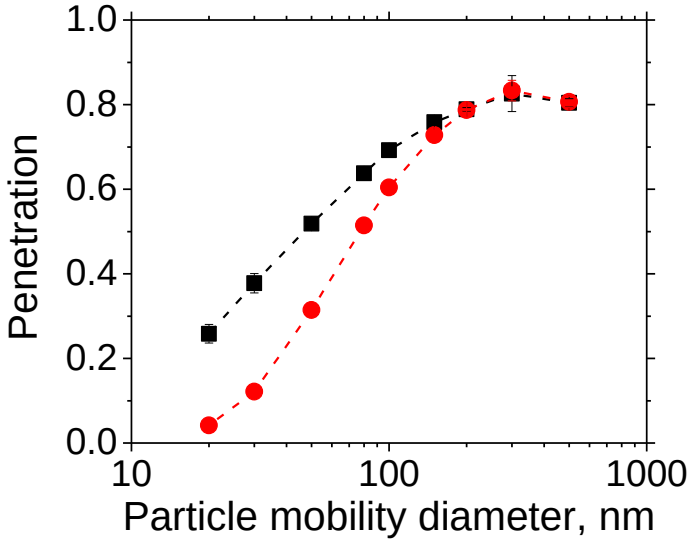
(1) IPA liquid cannot fully neutralize the electret media.

(2) During drying, IPA evaporation can induce undesirable charges on fiber surface.



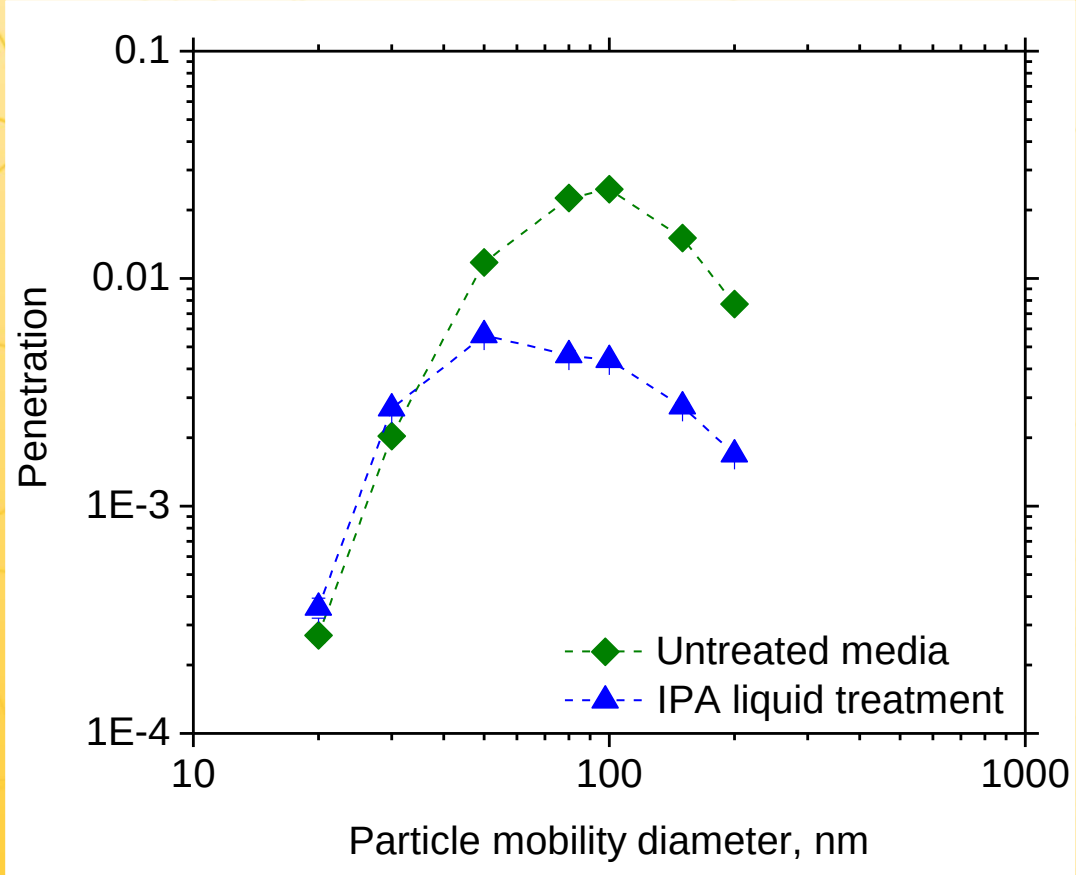
(2) IPA vapor neutralization

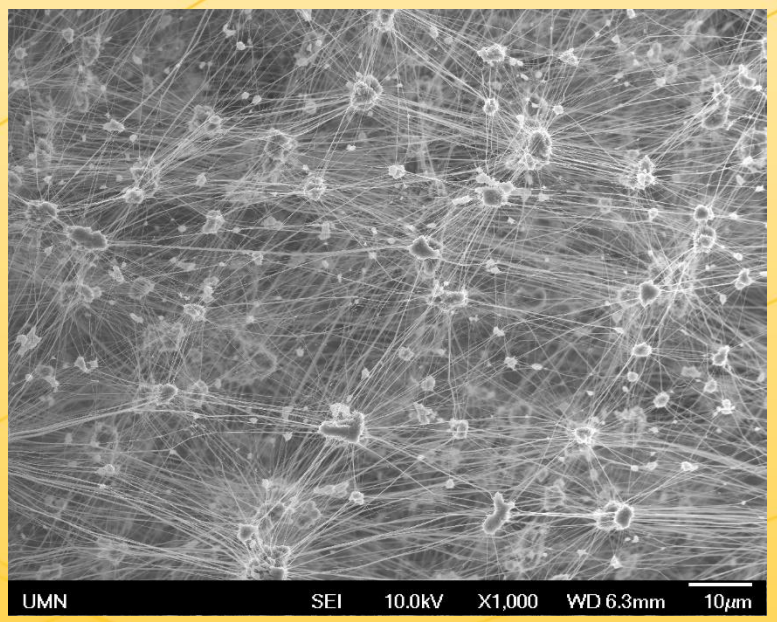
Dip into IPA liquid and then dry



3. Comparison of Different Neutralizing Methods

- Other filter media ---- Fluororesin nanofiber media

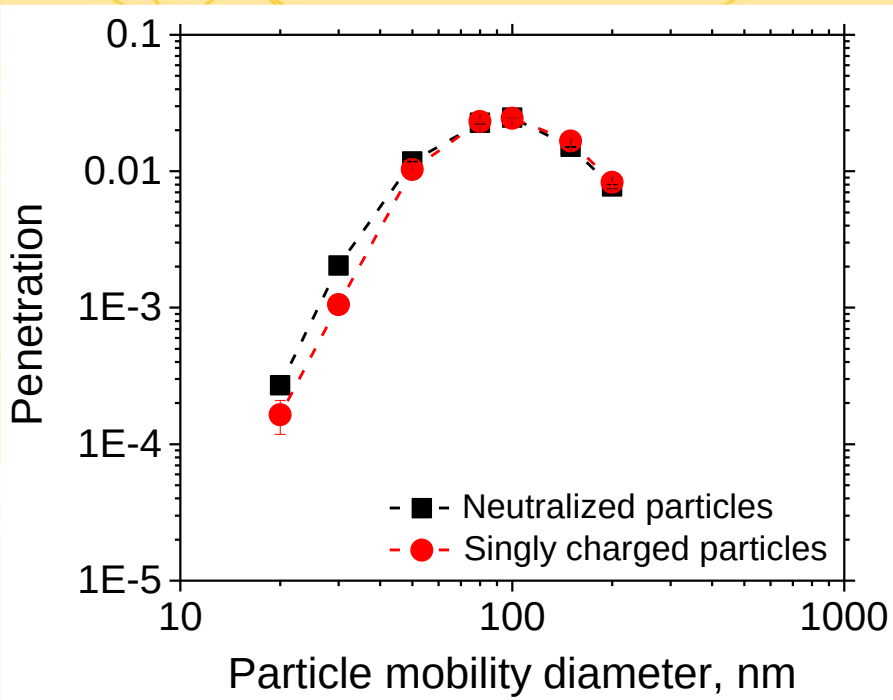




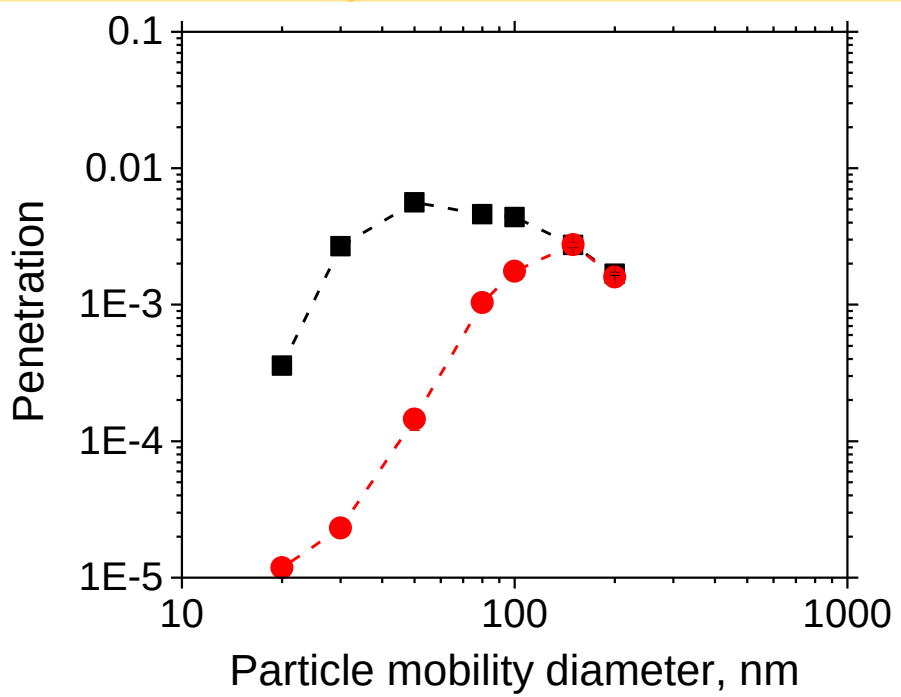
Filter media treated by IPA liquid showed lower penetration than untreated media.

3. Comparison of Different Neutralizing Methods

- Other filter media ---- Fluororesin nanofiber media



(1) Untreated media

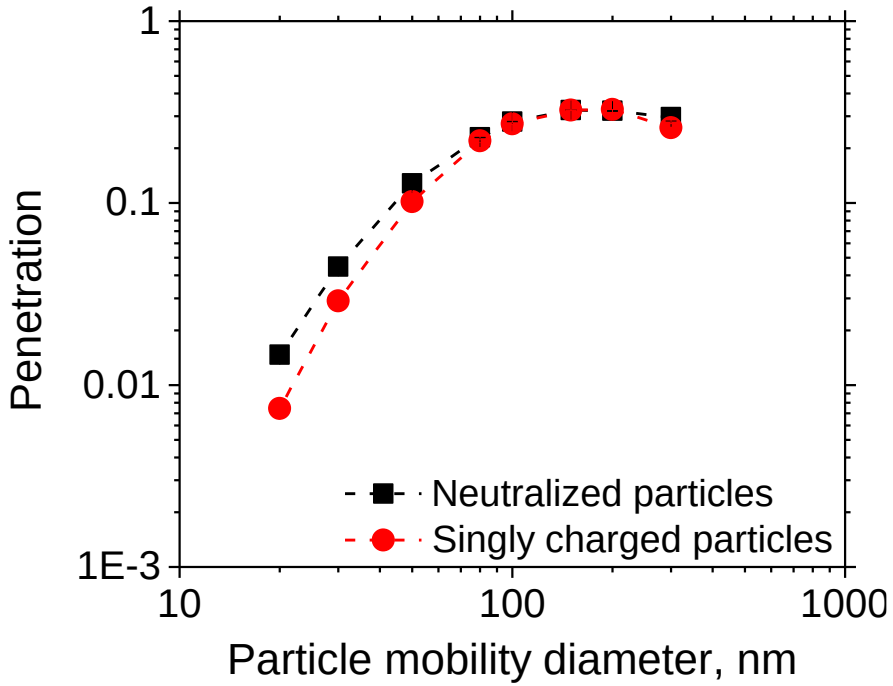


(2) Media treated by IPA liquid

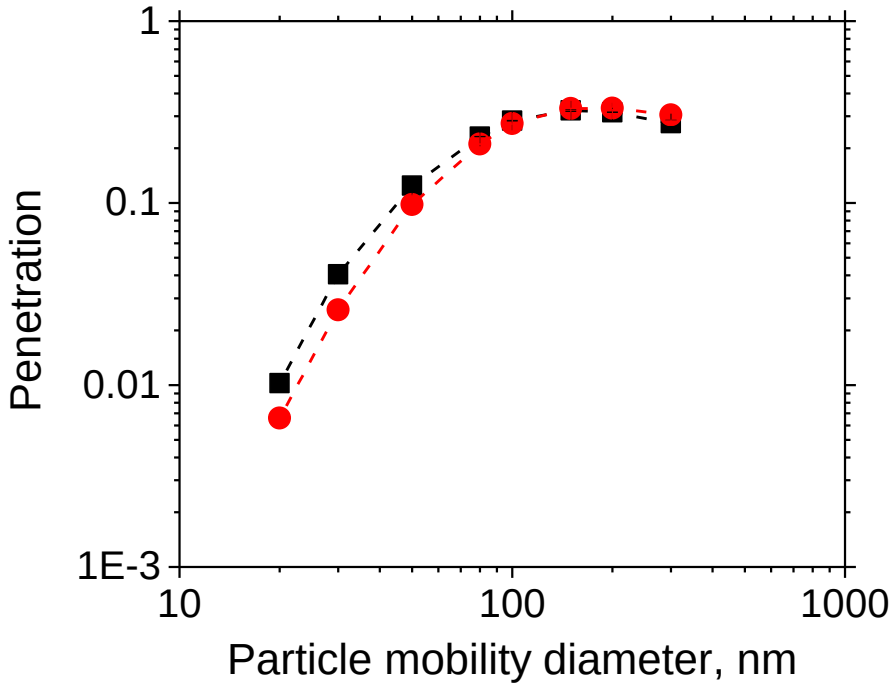
IPA evaporation can induce charges on surface of fluororesin nanofiber.

3. Comparison of Different Neutralizing Methods

- Other filter media ---- Fiberglass media (F9)



(1) Untreated media



(2) Media treated by IPA liquid

IPA liquid treatment has no impact on penetration of fiberglass media.

3. Comparison of Different Neutralizing Methods

- Triboelectric Series of Fiber Materials

Most positively charged	
Fiberglass Wool Nylon Viscose Cotton Woodpulp	Donate electrons ↑
Polyester Acetate Acrylic Polyethylene Polypropylene PTFE	↓ Accept electrons
Most negatively charged	

Irwin M. Hutten (2016)

Undesirable static charge could be related to triboelectric difference of IPA and fiber materials. Intimate contact of two dissimilar dielectric materials induces a charge transfer.

CONCLUSION

- IPA vapor treatment showed better neutralization effect than IPA liquid.
- IPA liquid treatment can induce undesirable charges on fiber surface.
- Undesirable static charge could be related to triboelectric difference of IPA and fiber materials.