A Brief History of N95 and Tsai's Progress
淺談N95

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Respirator (tight seal, L) and Mask (loose fit, R)

Respirators against viruses

- N95 (95%, 35 mmH2O inhaling, 25 mmH2O exhaling) – CFR 84 Part 42, 1995
- FFP2, FFP3 (94% or 99%) – EN 143, 149, 2002
- KN95 (95%) – GB 2626, 2006
- KN94 (94%) -

Sara Little Turnbull, House Beautiful editor, bra designer

Variety of respirator shapes

Conventional MB electret for COVID-19 respirators

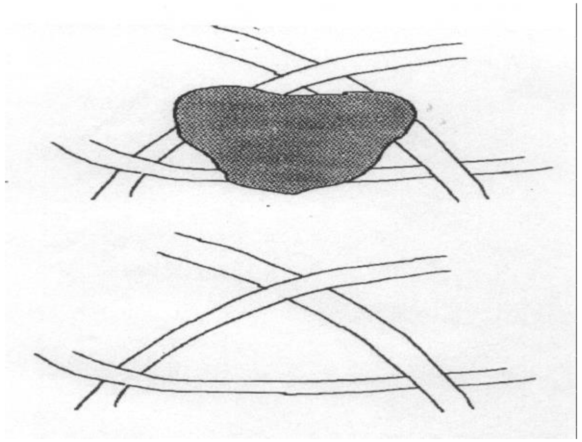
Excellent efficiency and perfect seal but unbearable breathability

Lack of oxygen: 21% at sea level, 15% inside N95, equivalent to 2,3000 meter above sea level

Argument: Can MB electret capture coronal virus?

In terms of size:

COVID virus – 0.08 microns
Pore size of a MB fabric for N95 - 20 microns



In terms of electrostatic attraction:

Virus is electrically neutral

專家 - 磚家
教授 - 叫獸
院士 - 怨士

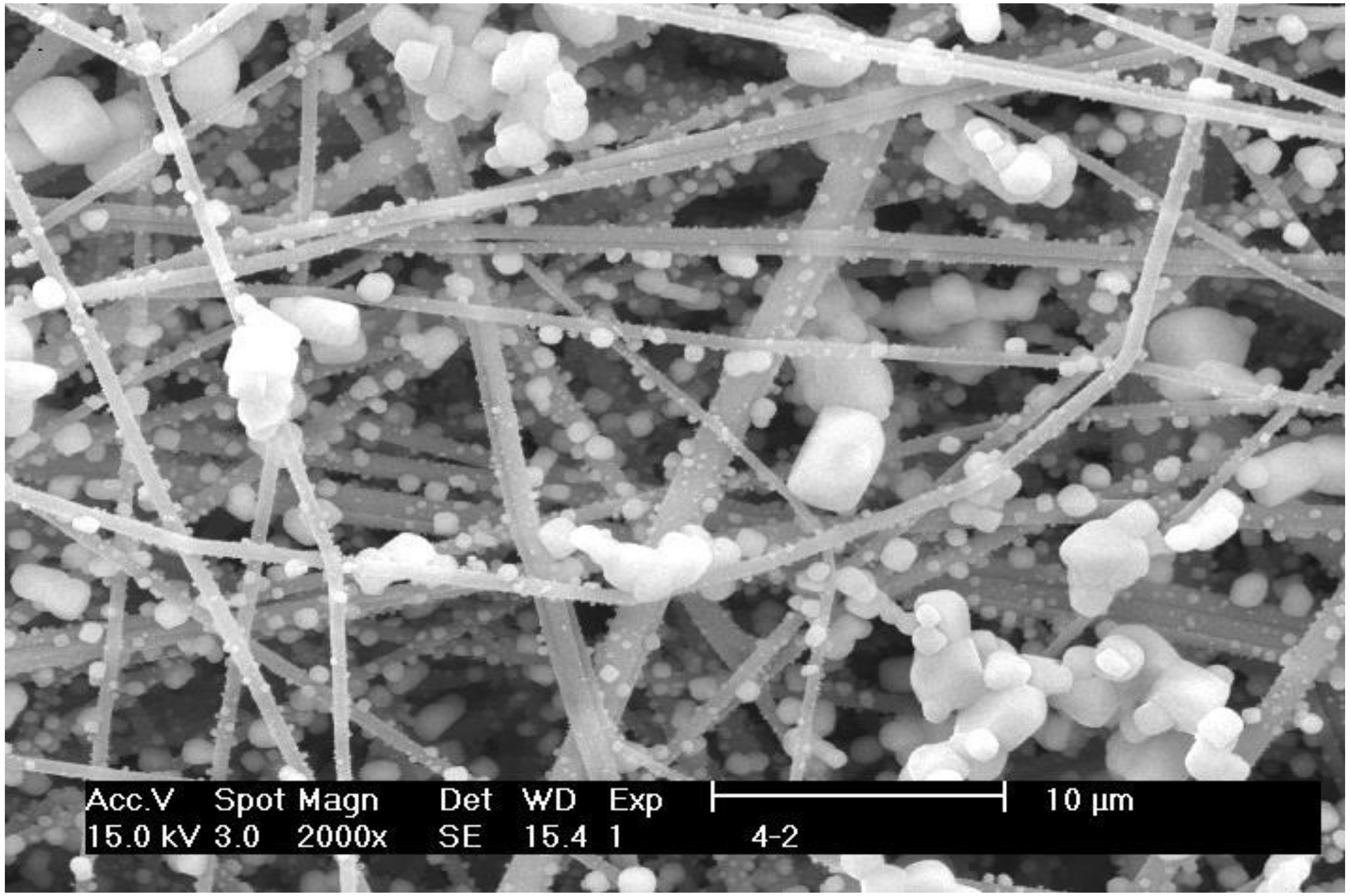
啼熊

SEM image of fine particles captured on the fiber surface by

vander waal forces (mechanical mechanisms)

Columbic force (positive charges attract negative particles and vice versa

Image force (attraction of neutral particles by polarization)



Efficiency of corona charged materials

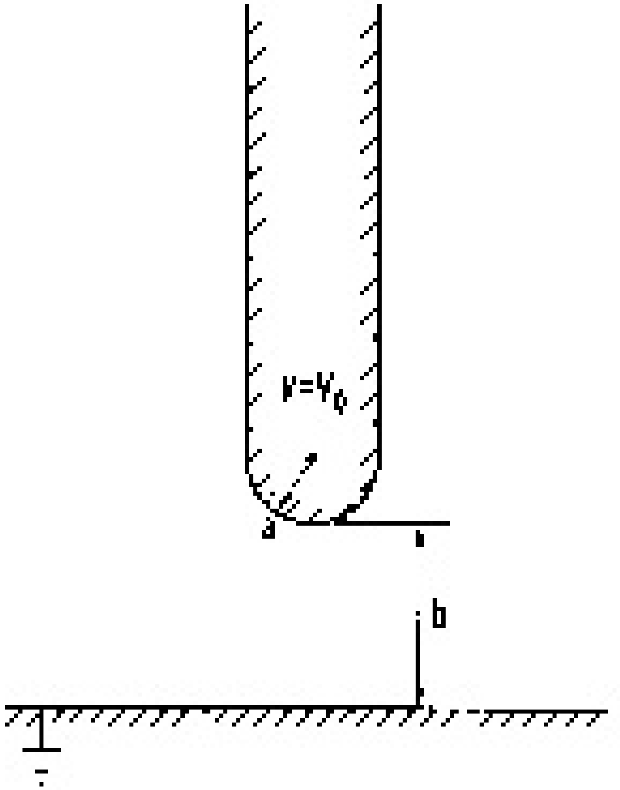
Ten-fold higher than uncharged, meaning
1 ply of charged =10 plies of uncharged

e.g.,

35% - uncharged
98.6 - Charged

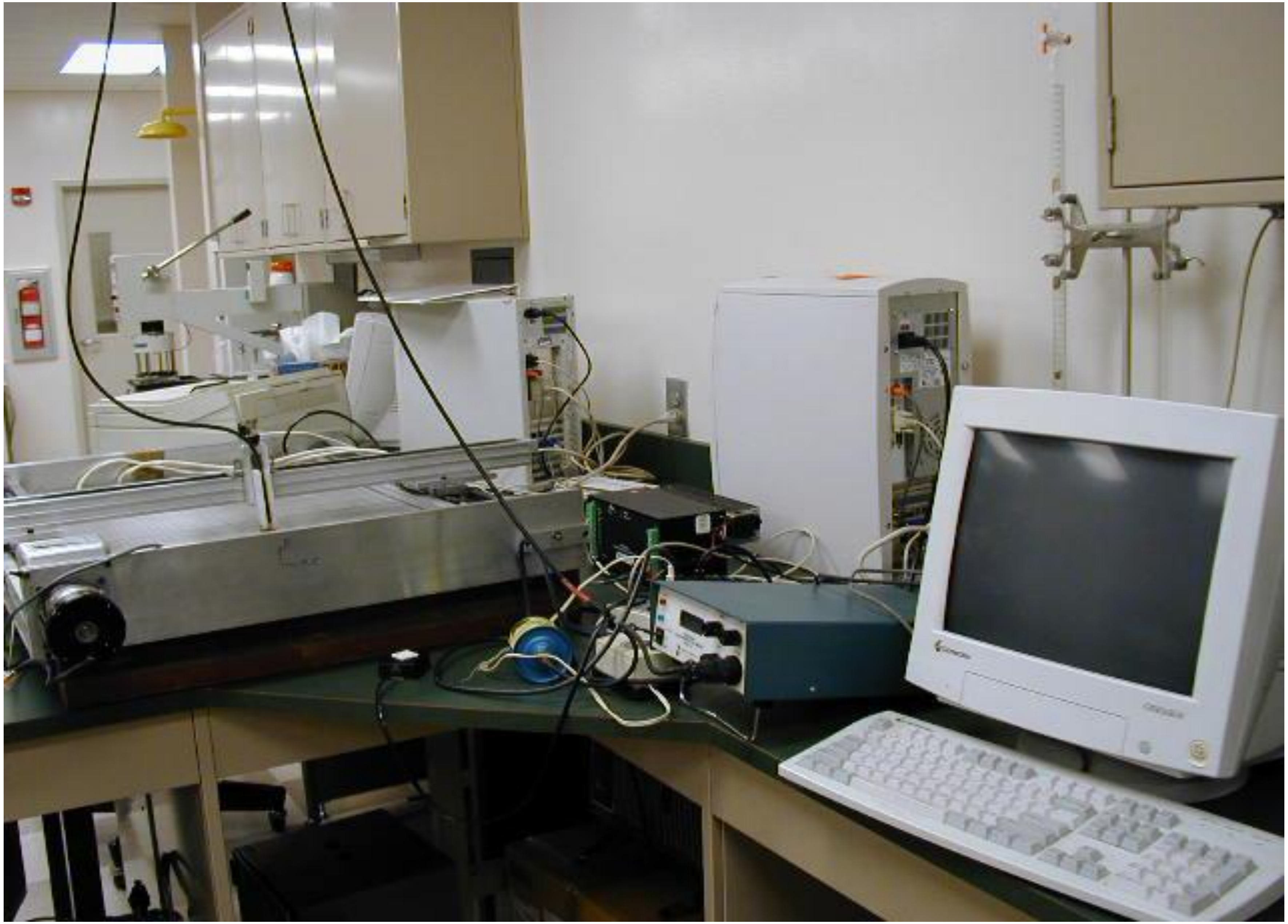
Corona Charging by Highly-Intensified Electric Field

$E > 3\ \text{MV}/\text{m}$



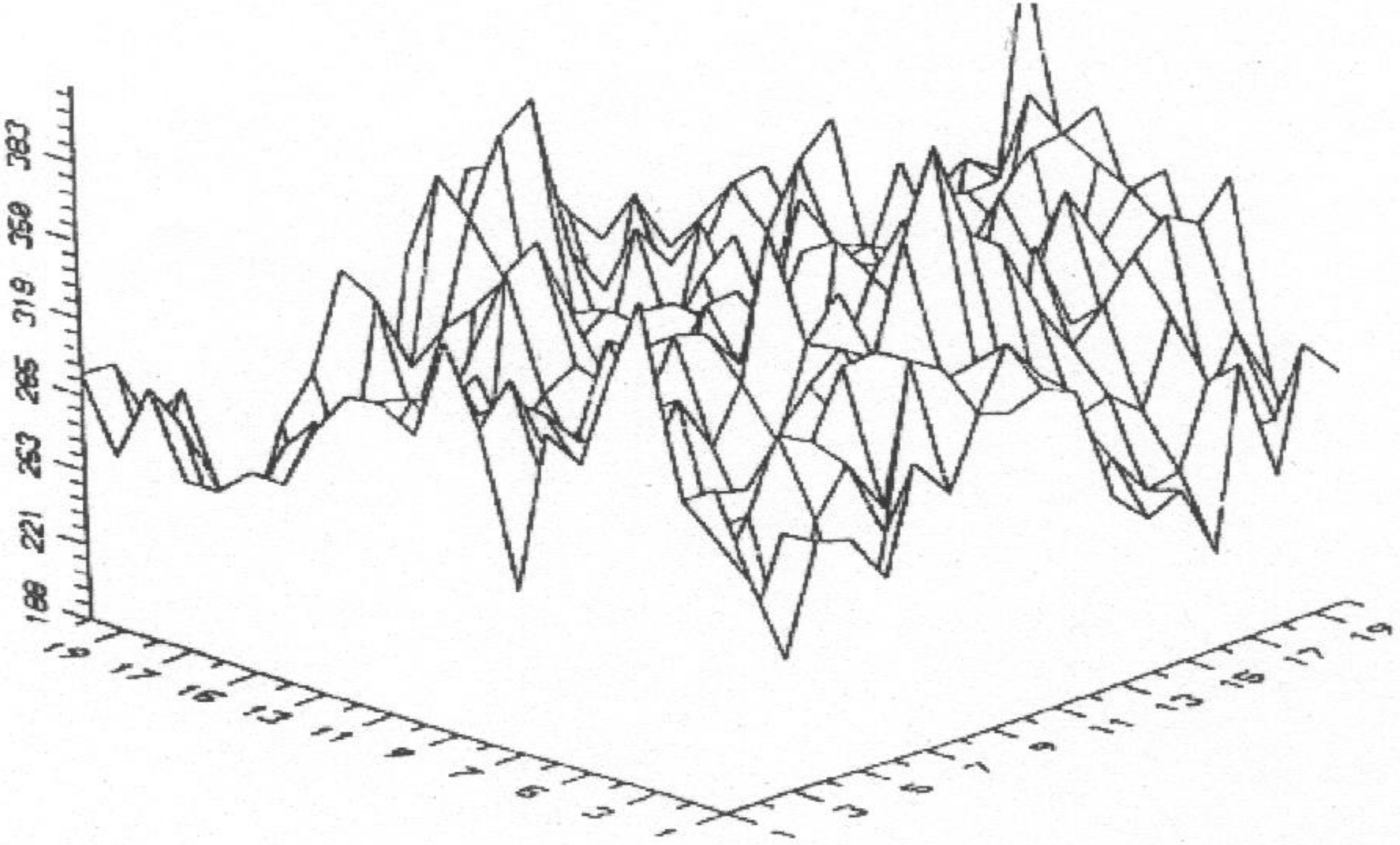
$$E_s = \left(\frac{V_0}{a}\right)\left(\frac{1}{1-\frac{a}{b}}\right)$$

A Surface Charge Potential Measuring System



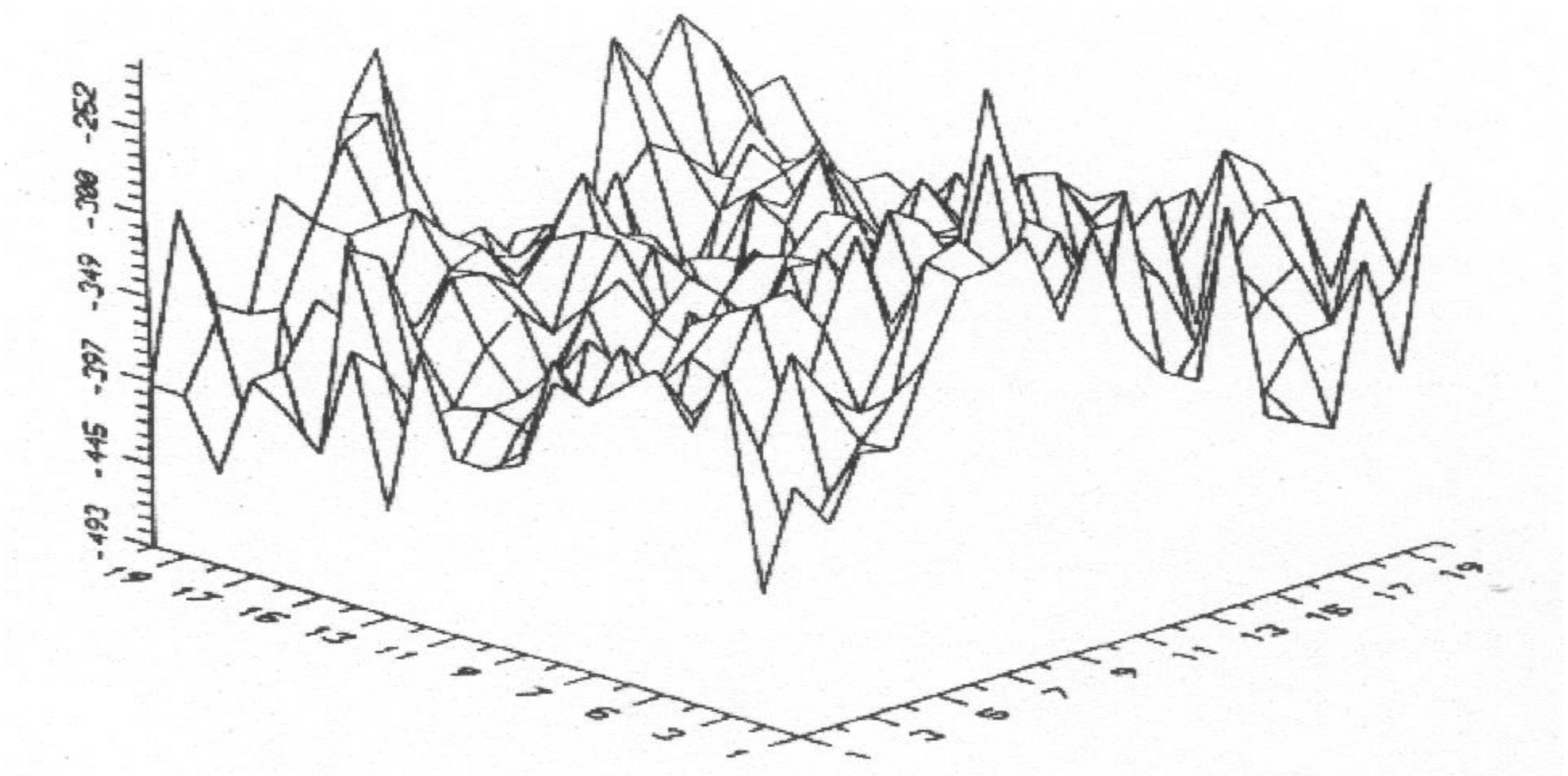
Surface Charge Potential on Face Side

Single polar, uniformly-distributed positive charges



Surface Charge Potential on Screen Side

Single polar, uniformly-distributed negative charges



Conversion of Charge Potential (V) to Charge Density

$$\sigma = \frac{V\varepsilon_0\varepsilon_r}{t}$$

V - measured charge potential from Slide 14

ε_0 – permitivity in vacuum ($8.854187817... \times 10^{-12}$ F/m)

ε_r - relative permitivity (dielectric constant)

t - thickness of the media

$\sigma = 2X10^{-9}$ C/cm2

Tribocharging

Two or more dissimilar electronegativity of fibers

Hydrocharging (friction between fibers and polarized liquid)

Efficiency of tribocharging

20-fold higher than uncharged
Two-fold higher than corona charged

e.g.,

35% - uncharged
99.98% – hydrocharged
98.6% - corona charged

Factors affecting tribocharging

Impurity in fibers (friction of fibers)

Conductivity of liquid (Hydrocharging), rigorous friction – Thunderstorm up in the air

More can be done in terms of respirator structure

$$\Delta P \propto v$$

$$v = \dot{Q}/A$$

$$\Delta P \propto \dot{Q}$$

Respirator with exhalation valve not allowed for virus respirators

Sterilization of COVID viruses

70% Alcohol
UV - UVC
Autoclave or boiling water
Peroxide
Heat – 70C, 1 hr
Ozon - Latex

Shape deformation after boiling

Suspended N95 (L) for ozone treatment for 25 minutes, cracks on rubber band (R).

Survivability of COVID-19 on the surface of Materials (70F, 50% RH)

NEJM: March 14, 2020

Copper surface for 4 hours

Cardboard for 24 hours

Stainless steel for 2 days

Plastic surface for 3 days

Respirator Inactivation of COVID-19 validated by NIH

Vaporized H_2O_2

UV-C (254 nm, 1J/cm2)

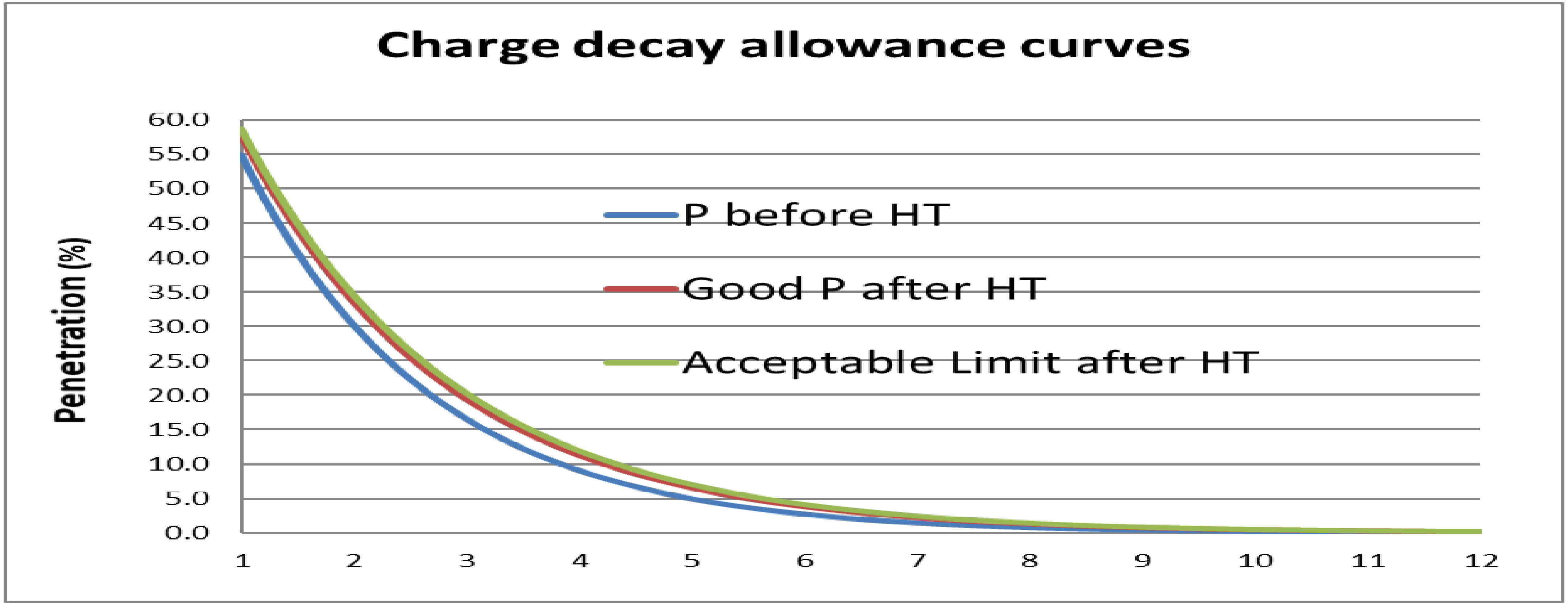
70C dry heat for 60 mins

Five days after use

Natural Sterilization (7 days)

Shelf-life time (quiescent charge decay) and stockpile of respirators

Quiescent charge decay rate



An example of N95

Initial: 98.5%

After Heat Treatment: **97.82%**

Shelf life of respirators and masks

2 yrs (masks) – 5 yrs (respirators), 9 years seen in a commercial respirator

Say 10 yrs of shelf life

Manufacturing of **one billion** pieces for stockpile w/population of 300 M – Ship and refill 200 million pieces each year in the sequence of manufacturing date

Meaning, 1 billion pcs in the warehouse all the time, the shipped 200 million pcs have at least **5 years** of shelf-life time.

蔡老的心路歷程

出生
成長
求學
工作
留學
北科大客座教授
研發N95材料

出生 － 台中清水
蔡秉燚 － Peter Tsai
Tsai (sai)

成長

種田 養鴨
逐水草而居

天為蚊帳地為床
清風伴我同泣
明月與我同眠

不幸的人 一生被痛苦的往事所折磨
我把昔日痛苦倉桑的往事
化為今日談笑風生的題材

求學

工專纖維科
聯考所決定

世有拒絕聯考的小子
我是被聯考所拒絕

工作

CTTRC – 學了一套管理體系 （N95 Documents)
工業界 （Routine Work）
貿易商 (Social)

積蓄- 赴美留學
貧賤不能移

企業永續經營的理念

自主研發創新的能力
先進的技術 製程 和設備
嚴密的管理和人事制度
透明的財務分析與報表
堅強的銷售陣容

赴美留學

飛越太平洋到達彼岸
首站洛杉磯
鳥瞰洛杉磯城
車子在寬廣整齊 全世界上最複雜的公路網飛馳
真是 車如流水馬如龍
不愧是世人所稱的黃金國土
摸摸口袋只有$700美元
涙灑機場
此景並非唯我獨尊
是當時我們留學生的共同寫照

法國哲學家尼采說
假如你哭泣
你獨自哭泣

假如你歡笑
大家跟着你歡笑
而且笑得比你還燦爛

强忍淚灑機場的悲痛

北科大客座教授 – 1996

台海危機 回北科大客座教授
只為堅持我的理念 實現我的諾言
依然離開我綠草如茵的家園 初次體驗英雄氣短兒女情長
回台的747班機上 只有我一個乘客 另外13個機組人員
彷彿是坐空軍一號總統專機
中央日報 有人說 國家有難 就回國共赴國難
滿口荒唐言 一把心酸淚

當忠孝難以雙全 捨孝求忠 蔡老做到了
芳名可以載入史冊 雖不能萬古流芳 但足以名垂青史

N95材料 – 熔噴加靜電布

二戰 - 生物戰劑（Biological Warfare Agent)
超細玻璃纖維是微塵過濾的良好材料
1956 – 美國海軍太空實驗室研發了熔噴制程
1957 – 蘇聯發射了第一顆人造衛星Spuntik 1
一星震醒夢中人
1961 – NASA 美國國家航天局
1969 – 人類登陸月球

競爭是激勵進步的原動力

1970's – 過濾機理 英國皇家科學院
1980's – 參與熔噴制程的研發

智慧的結晶初見端倪 綻放出心路歷程的光芒

1992年申請電暈加靜電技術 － N95的前身
30多年來 一路改良優化熔噴製程和技術
15個專利和數十個Trade Secrets
技術轉移到全球五大洲30餘家公司
北美（美國，加拿大）
南美
歐洲（東歐、西歐）
澳大利亞
亞洲（韓國、大陸、台灣）
擔任過全世界100餘家公司顧問
一直忙著，不是在工作的路上，就是在路上工作
服務華人滿蒙回藏五大民族
跟世界上紅黃藍白和五大種族談笑風生

5+1個5

5 - 500個學分
5 - 50個國家
5 - 5,000,000公里
5 - 500個出入境章
5 - 發表了500篇論文
5 – 接受世界50餘家媒體採訪

行萬里路 讀萬卷書 - 錯
行萬里路 勝讀萬卷書 - 謬

歷史淵源
地理環境
文化背景
文明程度
人文景觀

立於不敗之地

健全的體魄
豐富的知識
熟練的技能

英國哲學家 Francis Bacon
知識更豐富
思想更成熟
技術更精進

Mens et Manus (Mind and Hand)

Pen professor vs. Screw-driver professor

Katalin Kariko - mRNA

COVID-19 Pandemic

婉拒酬勞 服務人類社會

高貴的情操是一個人的特質

Thank you for your attention!

謝謝大家！