

산업세정연구회 세미나

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및 연구개발 동향 (2)

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## Argon Snow Cleaning Applications



### Removal Efficiencies of Other Contaminants

Contaminant Materials	Dimension	Remarks
Bearing grease film on glass		Complete removal
Polystyrene latex film on glass		Complete removal
Fingerprints(oil droplets) on glass	~50microns	Not removed
Wax residue spots on silicon	~30microns	Not removed
Glass microspheres on silicon	1.6 microns	Complete removal
Polystyrene latex microspheres on silicon	0.6, 0.5&0.3 microns	Complete removal
Silicon debris on silicon	0.1~30 microns	Complete removal

# Argon Snow Cleaning Applications



Figure SEM image of polysilicon etch residue.

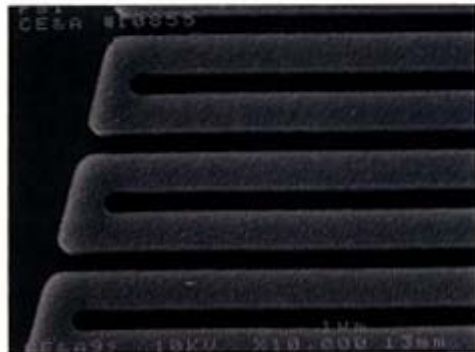


Figure SEM image of polysilicon lines after aerosol cleaning.

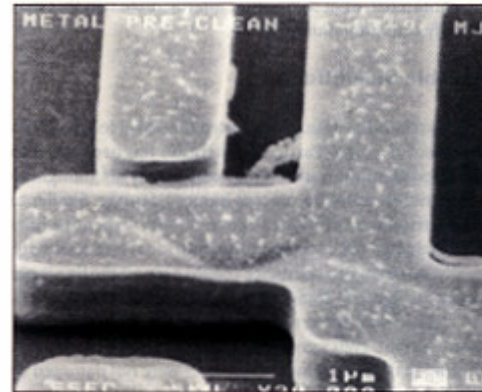


Figure 8: SEM image of metal corrosion on aluminum lines on uncleaned wafer.

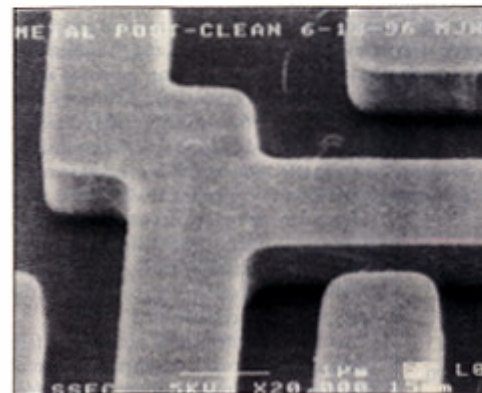
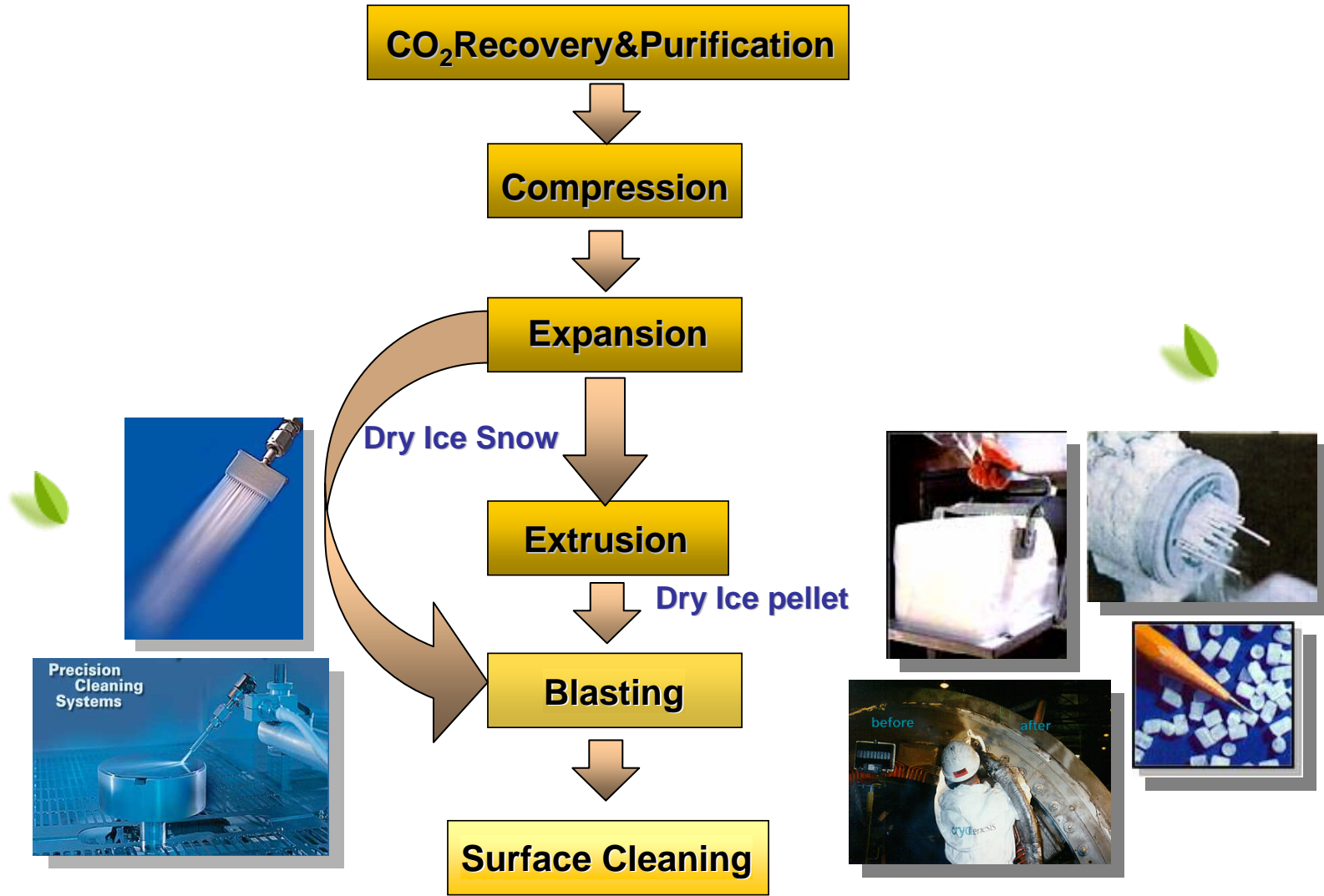


Figure SEM image of aerosol-cleaned metal lines showing no corrosion.



# Dry Ice Pellet Cleaning

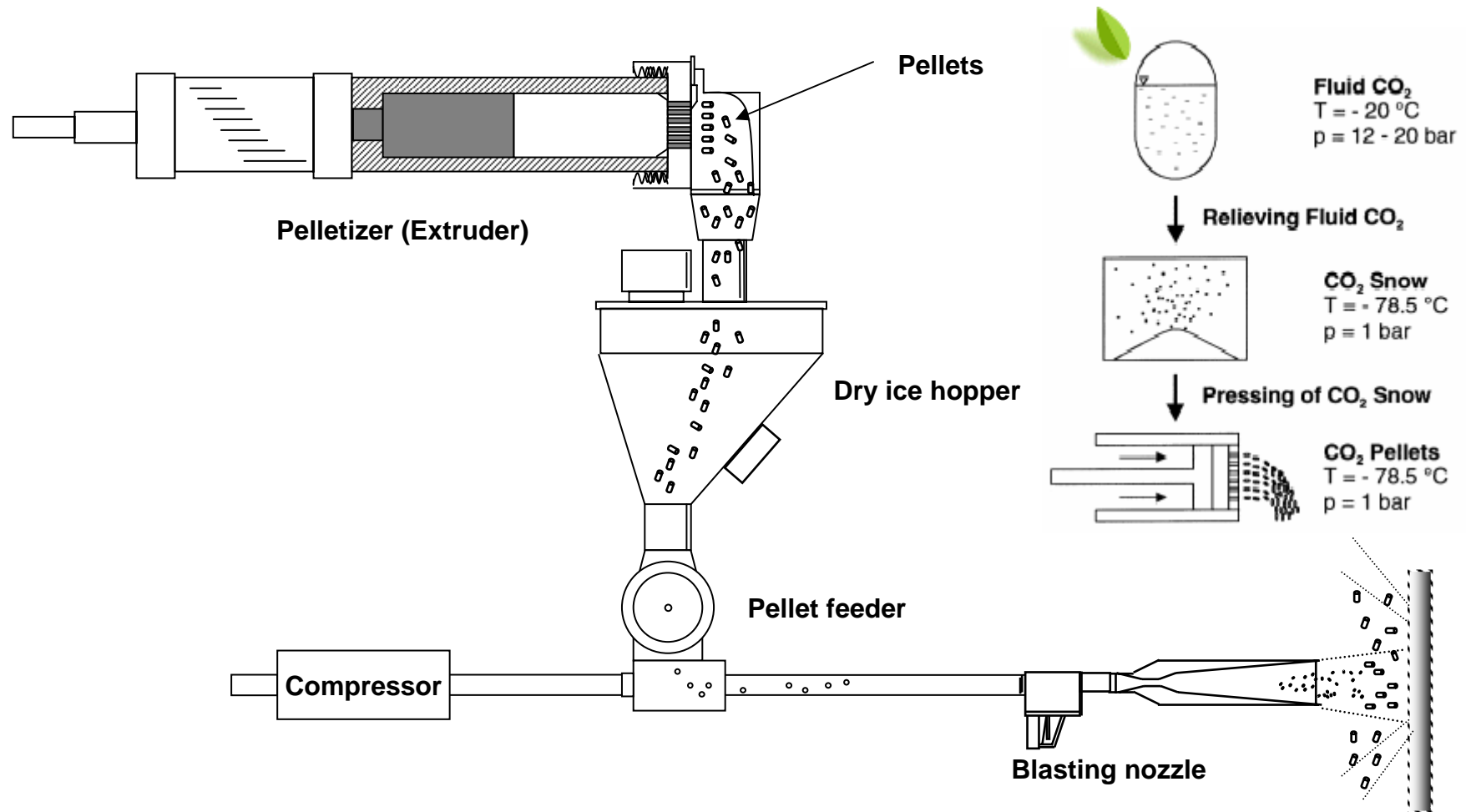
# Pellet 제조



# Dry Ice Pellet Cleaning

# Pellet 제조

Schematic diagram of dry ice pellet blasting

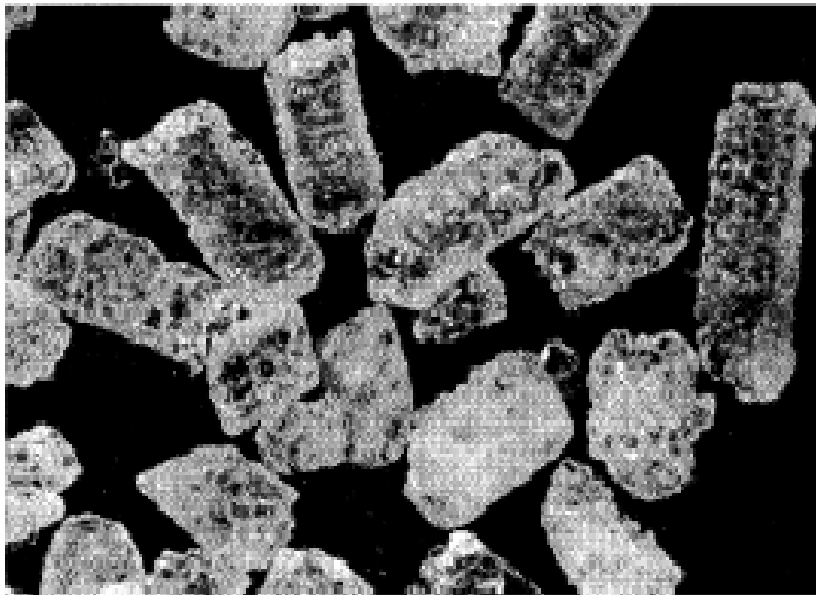


# Dry Ice Pellet Cleaning

## 특징

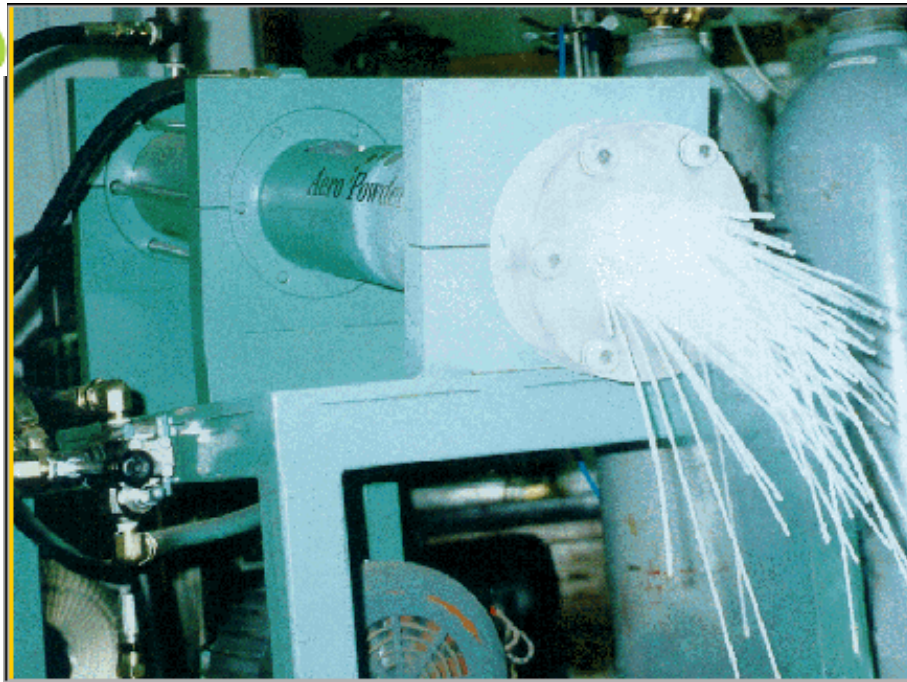
### Pellet Properties

Diameter	$D_p = 3 \text{ mm}$
Length	$L_p = 5 - 15 \text{ mm}$
Hardness	2 - 3 Mohs
CO <sub>2</sub> Content	99.95 %



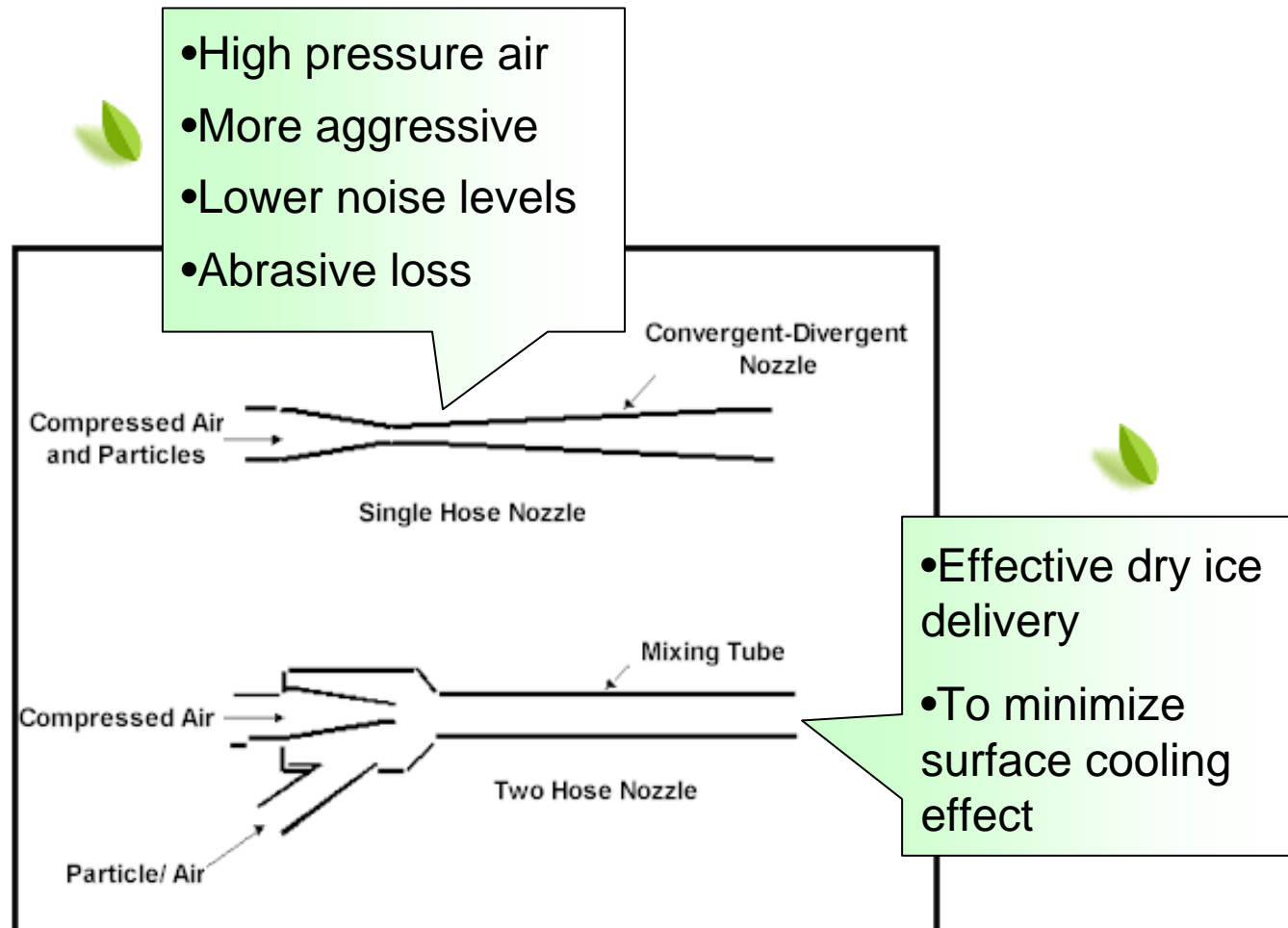


# Dry Ice Pellet Cleaning Pelletizer and blaster



# Dry Ice Pellet Cleaning

## 분사방법







## *Dry Ice Pellet Cleaning Applications*

- dirt - dust
- surface corrosion-rust
- oxidation
- plaster
- sealant
- Teflon
- adhesives
- mold
- chemicals - polymers
- petroleum
- scale
- marine growth
- anti-fouling coat

- oil - grease - tar
- carbon build-up
- coatings paint graffiti varnish
- moss
- cement
- weld splash/weld slag
- mortar
- isolate-separate-release agents
- protective films
- glue - silicones - wax - resin
- rollers cups
- soot

# Dry Ice Pellet Cleaning Applications



## Industries

- *Nuclear* -- for nuclear decontamination of fixed and smearable activity.
- *Chemical & Petroleum* -- cleaning resins, glues and deposits on equipment and inside tanks.
- *Electrical Power & Rotating Machinery* -- cleaning electric motors, SRC banks, open relays, bearings, etc.
- *Electronics Manufacturing* -- fully adjustable to allow very delicate components to be cleaned.
- *Food Processing* -- Retards bacterial growth (CO<sub>2</sub> is a disinfectant) and uses pharmaceutical/food grade Dry ice to clean surfaces completely.
- *Printing* -- quickly and easily removes ink and grease and significantly extends the life of printing equipments.



# Dry Ice Pellet Cleaning Applications

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## Industries

- *Marine* -- paint comes off dry and can be vacuumed right at the work site, or collected in cloths beneath it. Even underwater removal can be accomplished safely.
- *Mass Transit* -- surface preparation of aluminum, plastic, rubber and glass simultaneously without damage makes this method ideal for electric motors, escalators, elevators, rail cars, buses, floors, etc.
- *Steel Foundry* -- cleaning of permanent molds, hot molds core boxes, isocure cores all without down time.
- *Tire & Rubber* -- From cleaning large in-situ molds to small O-ring cavities.

# *Dry Ice Pellet Cleaning Applications*

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## Other than Surface Cleaning

- *Airport and Highway* : Fog dissipation
- *Weather control* : Seeds for artificial rain formation



# Dry Ice Pellet Cleaning Applications

## Cleaning of Large Electric Motors



Before



After



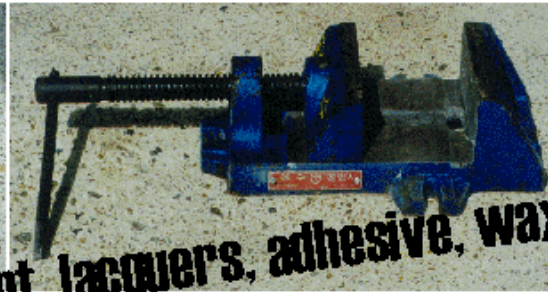
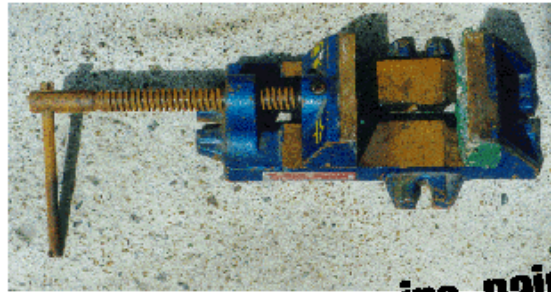


# Dry Ice Pellet Cleaning Applications

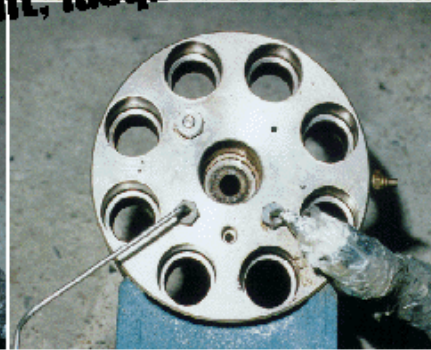
*Before*



*After*



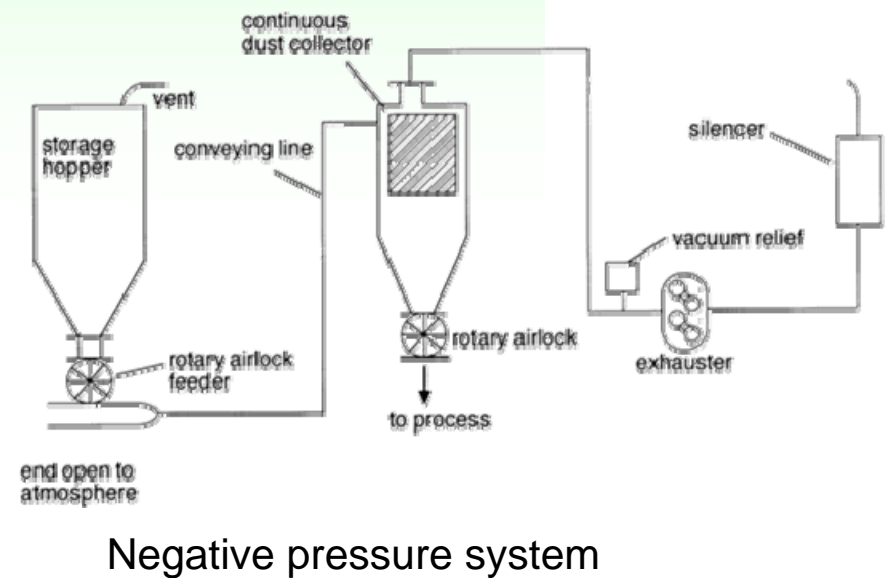
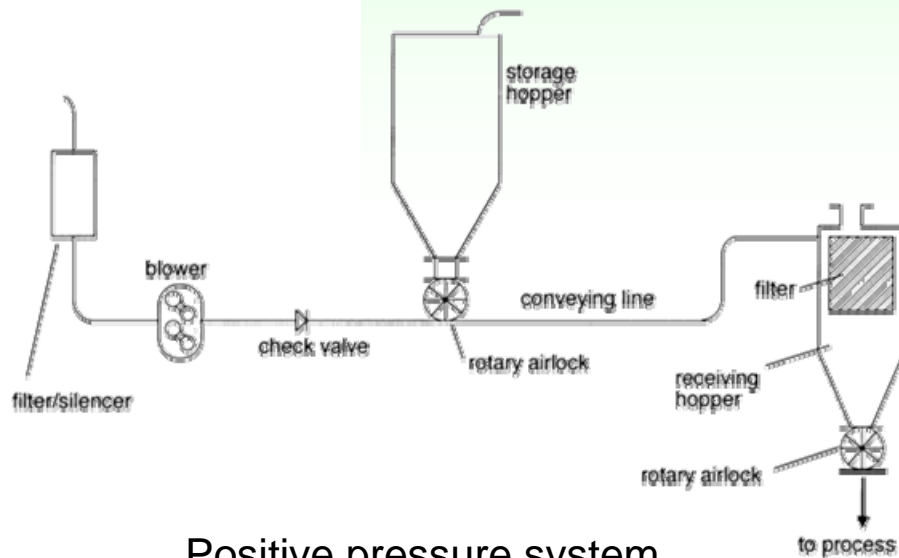
**Removal of rust, oil, resins, paint, lacquers, adhesive, wax, residues**





# Dry Ice Pellet Cleaning Issues

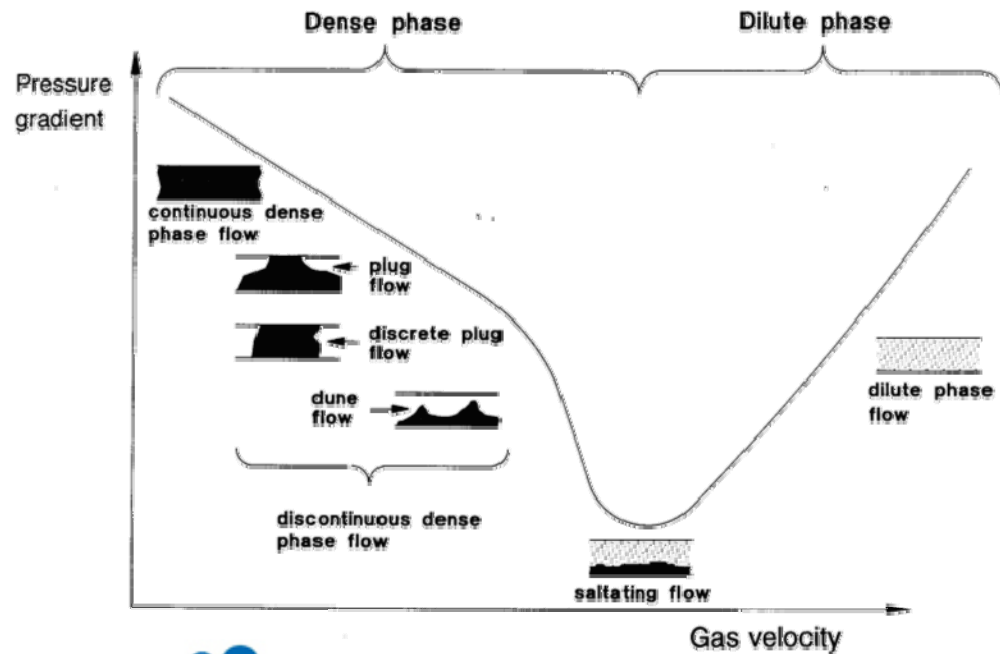
● Pellet feeding  
Mass flow  
Rotary feeder



# Dry Ice Pellet Cleaning Issues

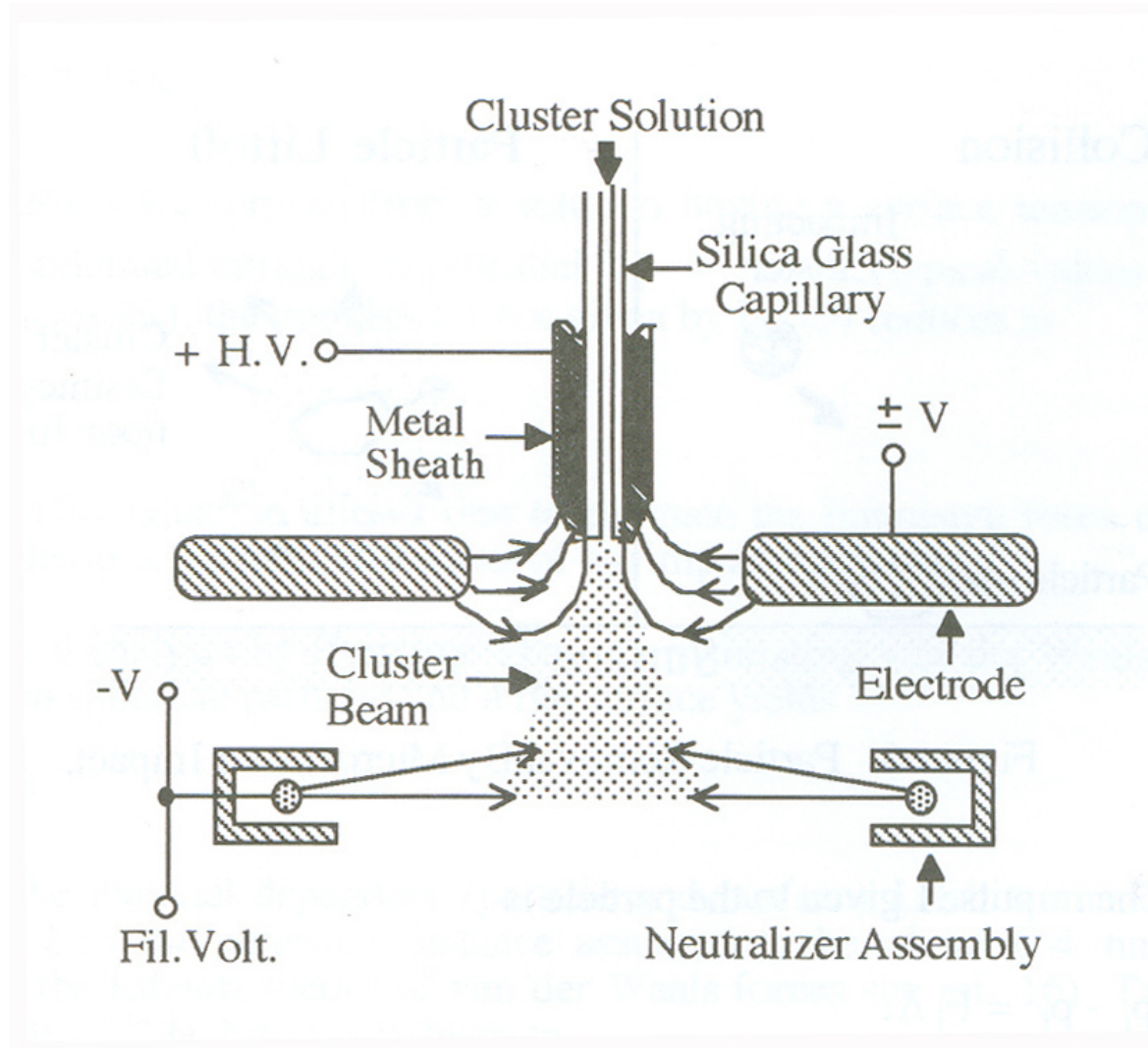
## Pellet transport

Pressure drop vs. gas velocity vs. pellet mass flow rate

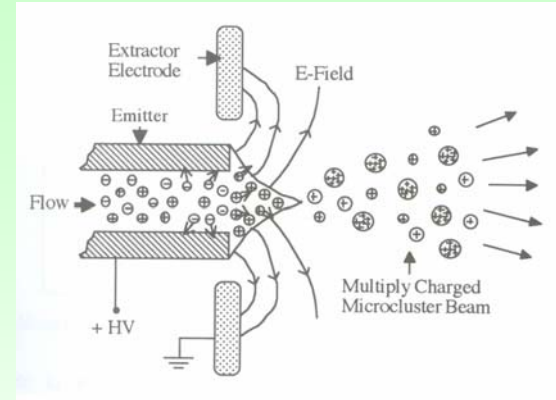
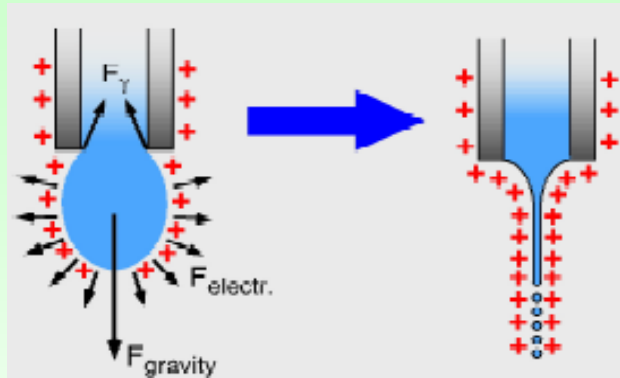


# Microcluster beam cleaning

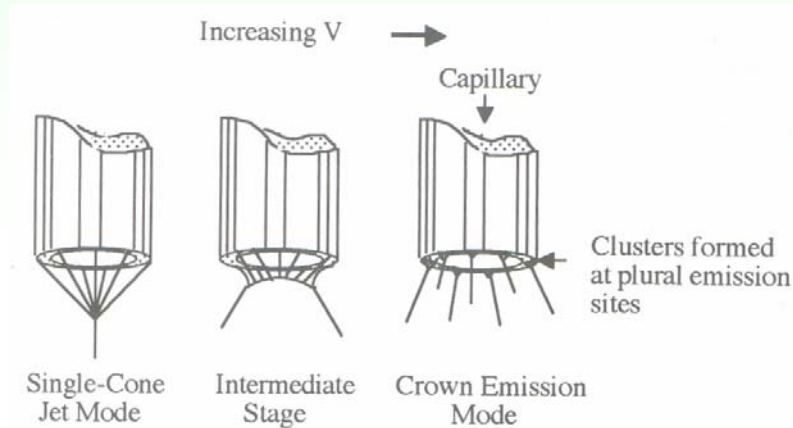
# 제조 및 세정원리



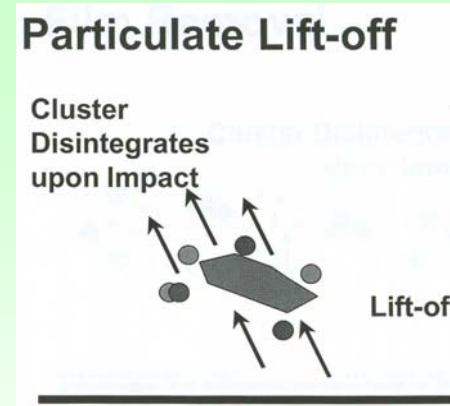
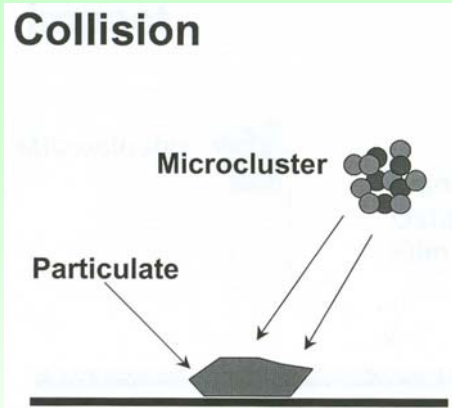
## Formation of droplets – Rayleigh limit



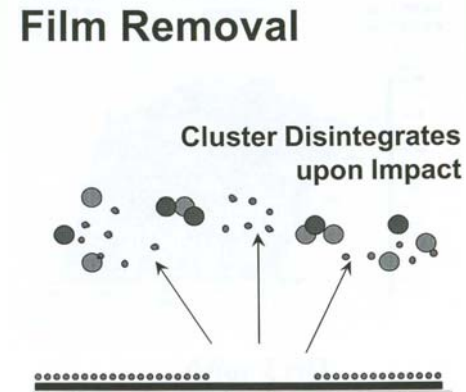
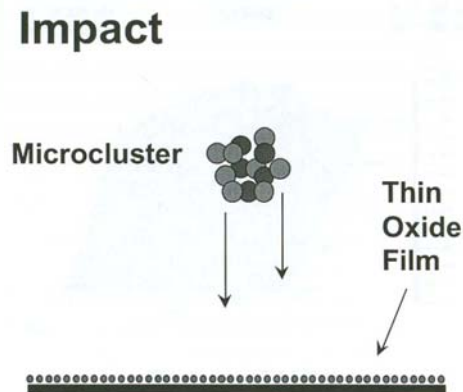
## Electrohydrodynamic atomization modes



**Particles**



**Contaminating films**





Outer diameter of capillary:  $< 710 \mu\text{m}$

Electric field:  $\sim 10\text{kV}$

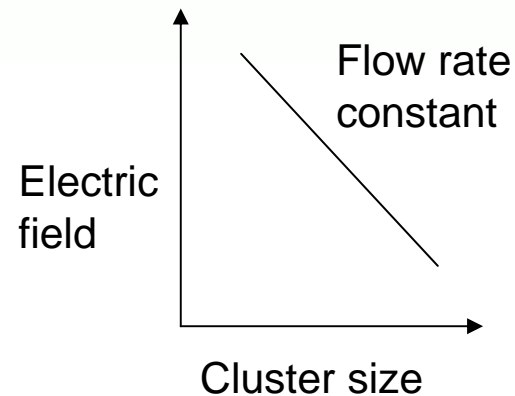
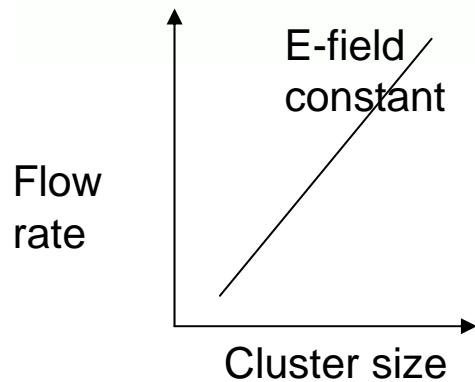
Solution flow rate:  $0.5\sim 2\mu\text{L}/\text{min}$

Solutions: Water:methyl-2-pyrrolidone mixture

+ Ammonium acetate

Glycerol

제어변수	Cluster 물성
Cluster 조성	Cluster 크기
용액 전도도	Specific charge
전기장 voltage	
용액 유량	Cluster 속도
가속 voltage	Impact energy





Impulsive force

$$F_i = 4\pi(\epsilon_0\gamma)^{\frac{1}{2}} r^{\frac{1}{2}} V_a$$

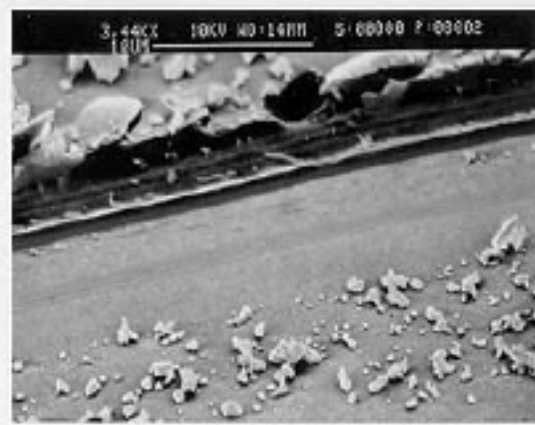
Van der Waals force

$$F_v \sim \frac{Hr}{8\pi z^2}$$

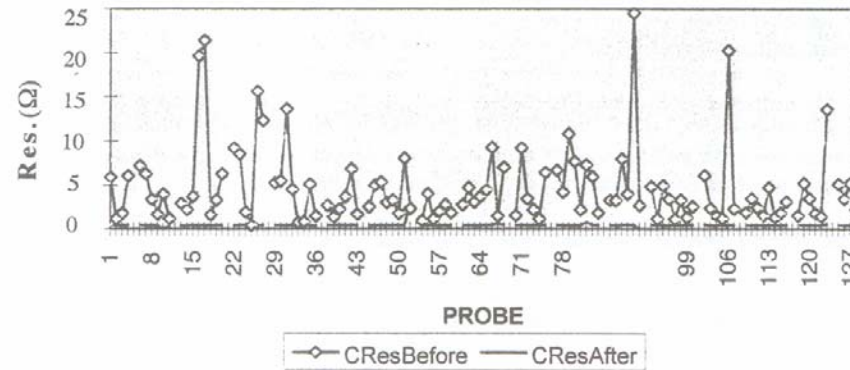
Particle radius( $\mu\text{m}$ )	$F_v(\text{N})$	$F_i(\text{N})$
0.01	$3.2 \times 10^{-9}$	$8.4 \times 10^{-6}$
0.10	$3.2 \times 10^{-8}$	$2.7 \times 10^{-5}$
1.00	$3.2 \times 10^{-7}$	$8.4 \times 10^{-5}$

$$\gamma = 5\text{mN} / \text{m} \quad V_a = 10\text{kV} \quad z = 0.4\text{nm} \quad H = 8.0\text{eV} = 1.28 \times 10^{-18} \text{J}$$

# Microcluster beam cleaning Applications

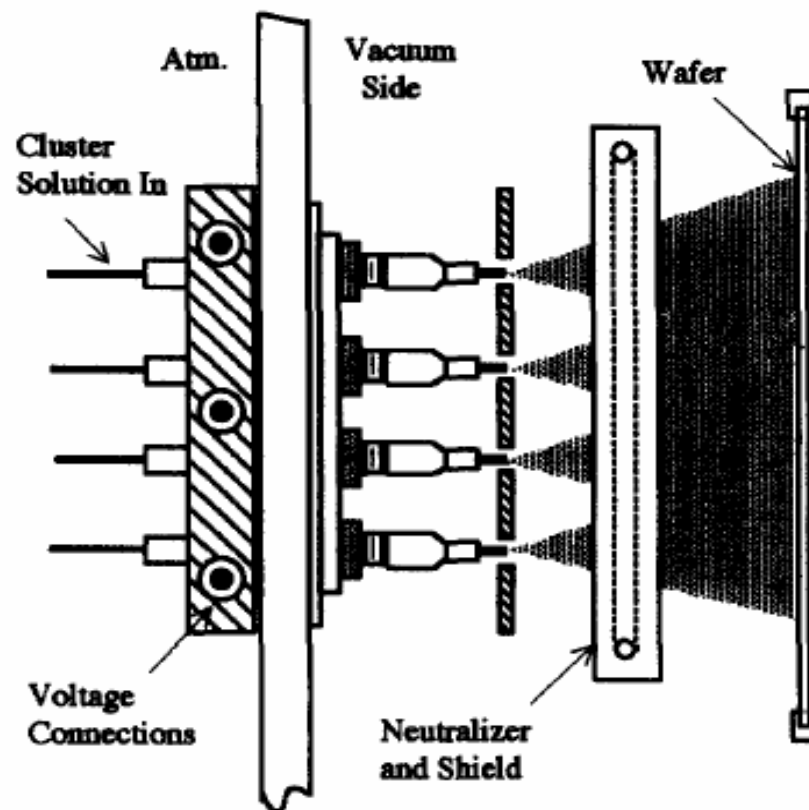


*Figs. 1 and 2 show the before and after results, respectively, of cleaning with NanoClean technology. (Source: Phrasor Scientific)*



Probe needle cleaning

# Microcluster beam cleaning Applications



## Microcluster beam cleaning 특징



- Crevices에 갇힌 오염입자의 효과적 제거
- 반도체 제조에서 진공상태의 전후 공정에 부합
- Valve, fitting, seal 등이 없어 고순도를 유지
- 세척수 사용 저감
- 건식공정의 과도한 기체사용 저감



### Aerosol Cleaning

- *clean, effective, economic, versatile*



- 세정력 향상
- 세정범위 확대
- 공정 및 장치 최적화
- *Hybridization*(+ UV, ozone, other aerosol)