나노 입자 공학 연구실
(Nano Particle Technology Lab.)
소개 자료

지도교수: 이동근

http://npt.pusan.ac.kr

donglee@pusan.ac.kr

연구실 구성원

지도 교수 : 이 동 근

(교수 연구실: 기계관 517호)

1994년: 서울대학교 기계공학과
2000년: 박사학위, 서울대학교 기계공학과
2001-2003: Post Ph.D at ME, Univ. of Minnesota
2003년: 조교수, 부산대학교 기계공학부
2007년: 부교수, 부산대학교 기계공학부
2012년: 교수, 부산대학교 기계공학부
2003년: *Sheldon K. Friedlander Award* (미국 에어로졸 학회)

학부 수업 교과목: 마이크로나노공학, 열전달, 유체역학, 내연기관

Sponsor	Period	Project
NRF 연구재단	2020.03 ~ 2025.02 (총괄책임)	반도체 공정 중 웨이퍼상 나노입자 오염도 모니터링 및 동시 소프트 건식 세정 기술
(주)삼성전자	2019.01 ~ 2021.12 (총괄책임)	건식 세정/Wafer monitoring을 위한 다목적 노즐 설계 원천기술 개발
LG전자	2020.08 ~ 2021.07 (공동연구)	유동장-정전기장 연성해석기술 개발

연구원	박사 과정	석사 과정	학부연구생
1	3	0	0
계	4 명*		

* 한국인 3 + 외국인 1

실험실:
통합기계관 106호 & B101-10호

대학원생 연구실:
통합기계관 915호

Research of Interest

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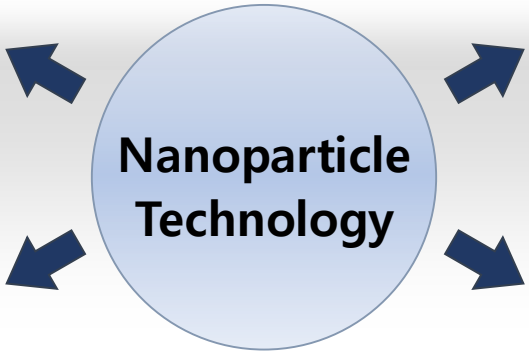
A. Production

- 마이크로, 나노 입자 제조
- 입자 부착 및 부착층 형상 제어
- 센서(chemical, biological sensing)
- 촉매(연료전지, 수전해)

B. Removal

- 미세먼지, 초미세먼지
- 오염물질(NOx, SOx) 제거
- 반도체 세정
- 집진(필터, 공기청정기)

Social Problem-Solving R&D
~
Academic R&D



Experiment
+ Simulation
+ Theory

C. Measurement & Prediction

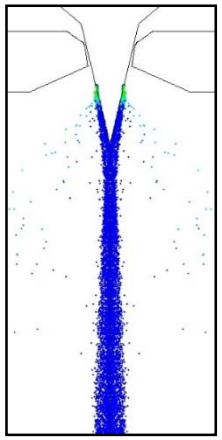
- 대기 중 부유물질 계측
  (수농도, 크기, 조성)
- 물성치 예측
  (입자 부착층 및 입자 강화 복합재료)

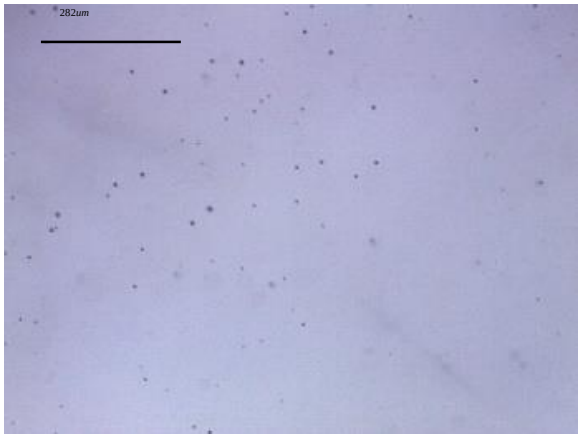
D. Application

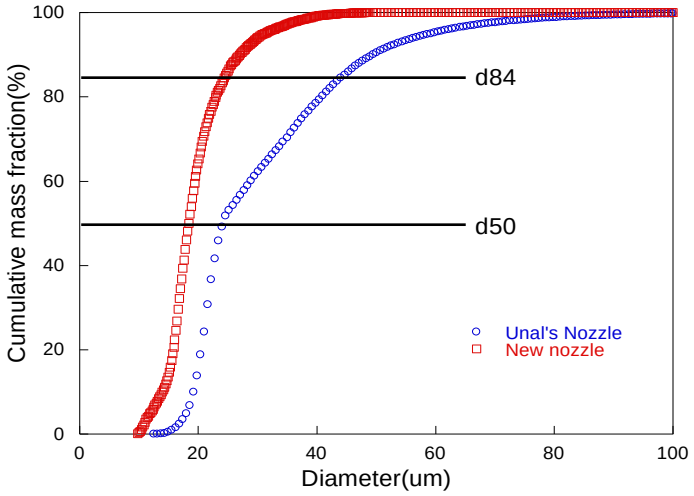
- Energy
  - Fuel cell (PEMFC, DCFC)
  - Ash-free coal 제조
- Nozzle design

Production (1/2)

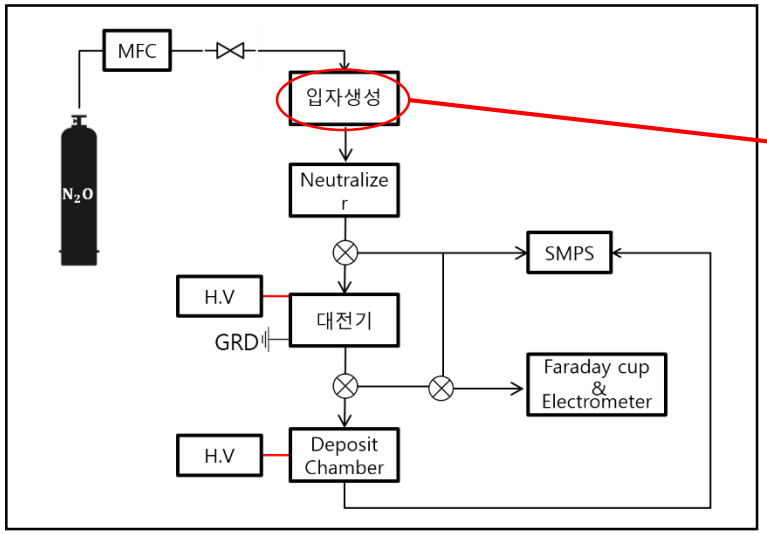
- 마이크로미터 크기의 입자 제조 (metal, ash-free coal, etc.)

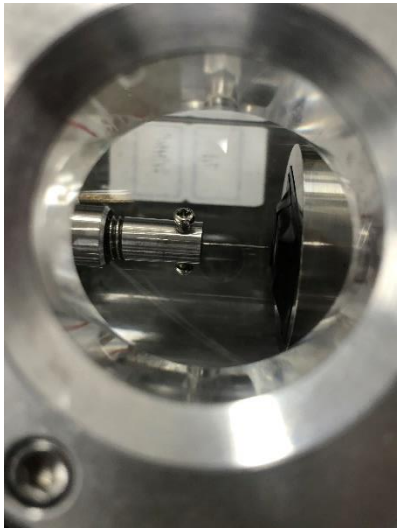


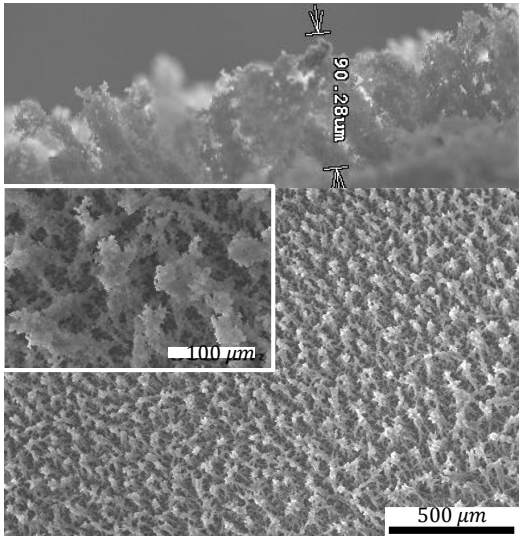




- 나노 입자 제조 및 부착층 형성

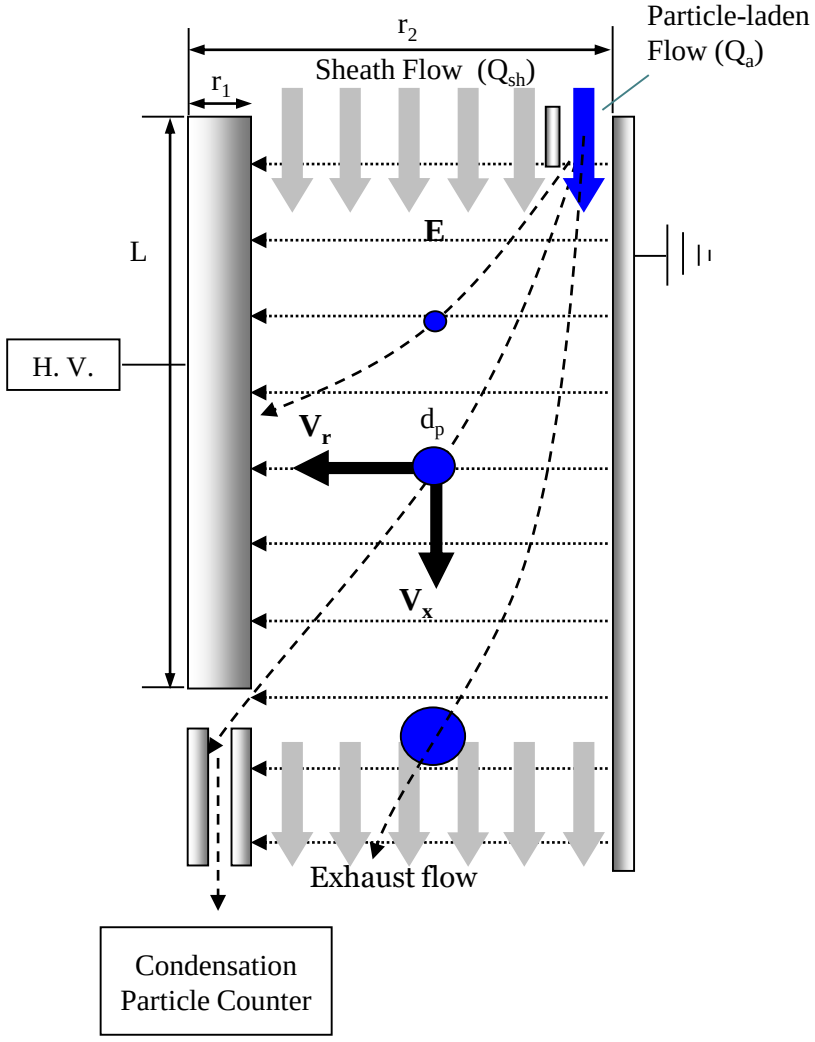




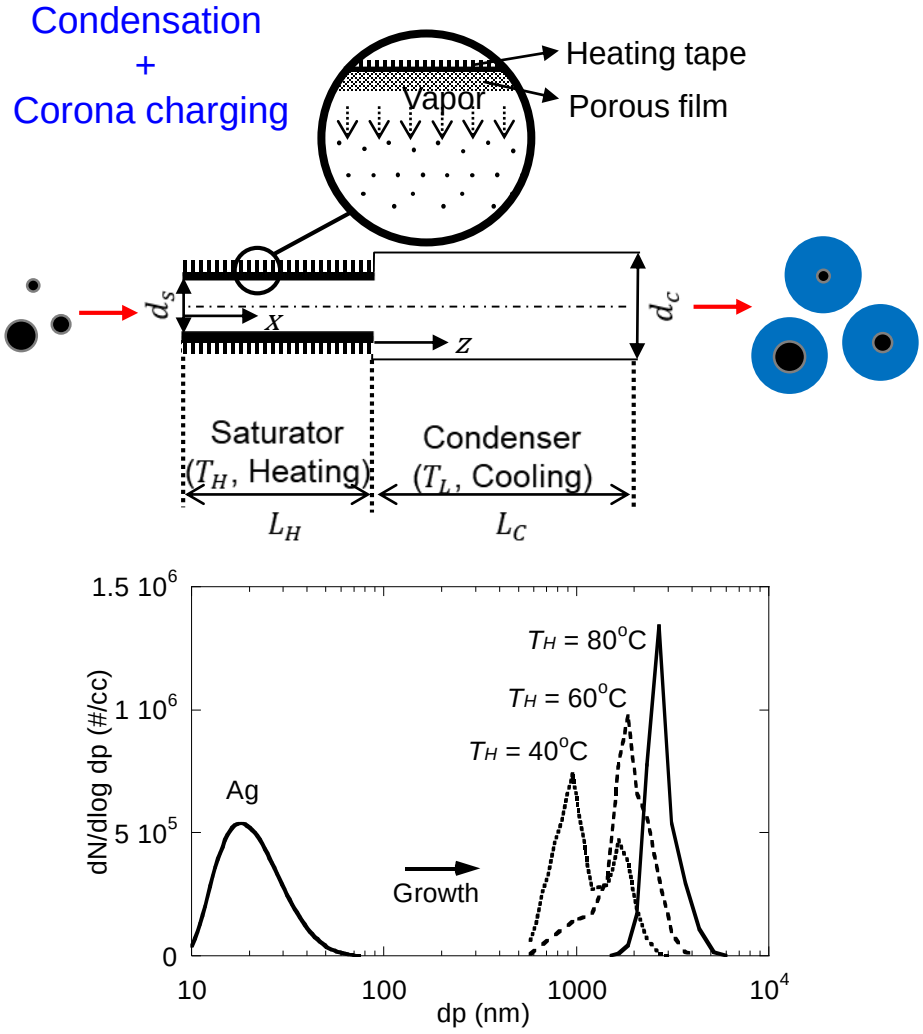


Production (2/2)

- 전기장 이용, 특정 크기의 나노입자 생산



- 응축성장 이용, 특정 크기의 나노입자 생산



Removal (1/4)

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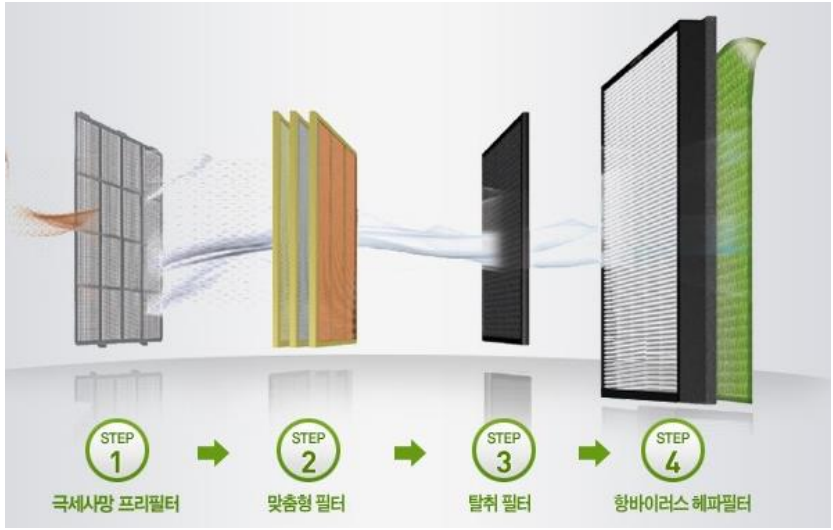
- 무필터 공기 정화장치 개발(PM2.5, 초미세먼지)

Filter-based

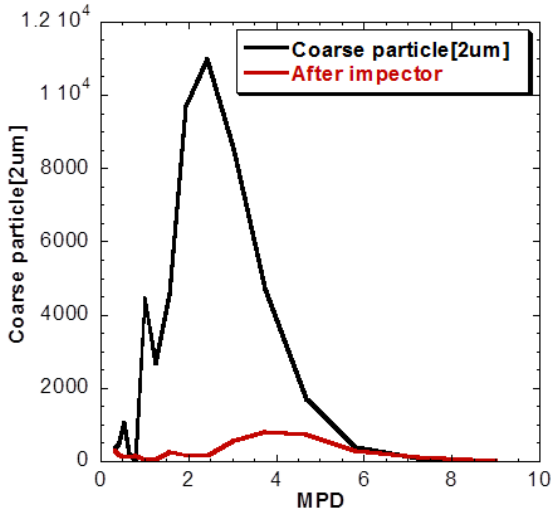


Filter-free

Saturator
- Bubbler
- Ultrasonic transducers
- Water injection nozzle

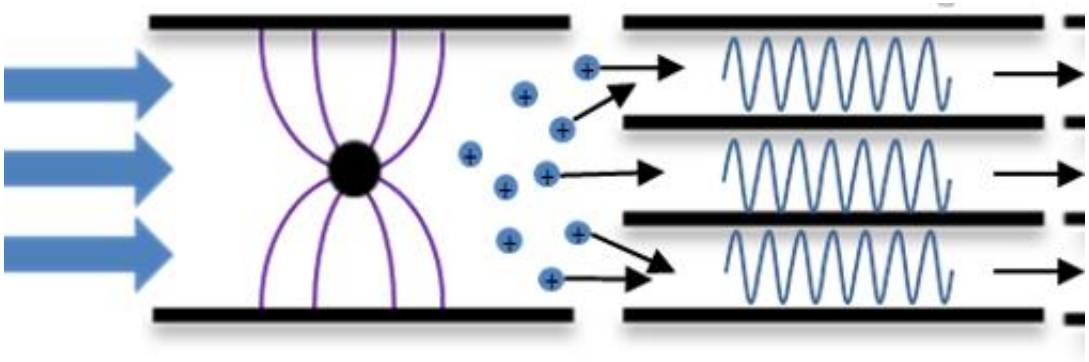
Condenser
- Water-cooled plate heat exchanger
- Adiabatic expansion & cooling

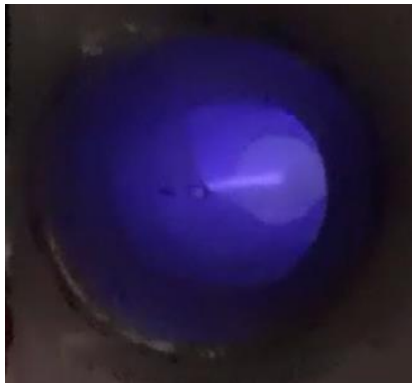
Impactors
- Multi nozzle-impactors assembly
- Porous metal foam or sheets of meshes



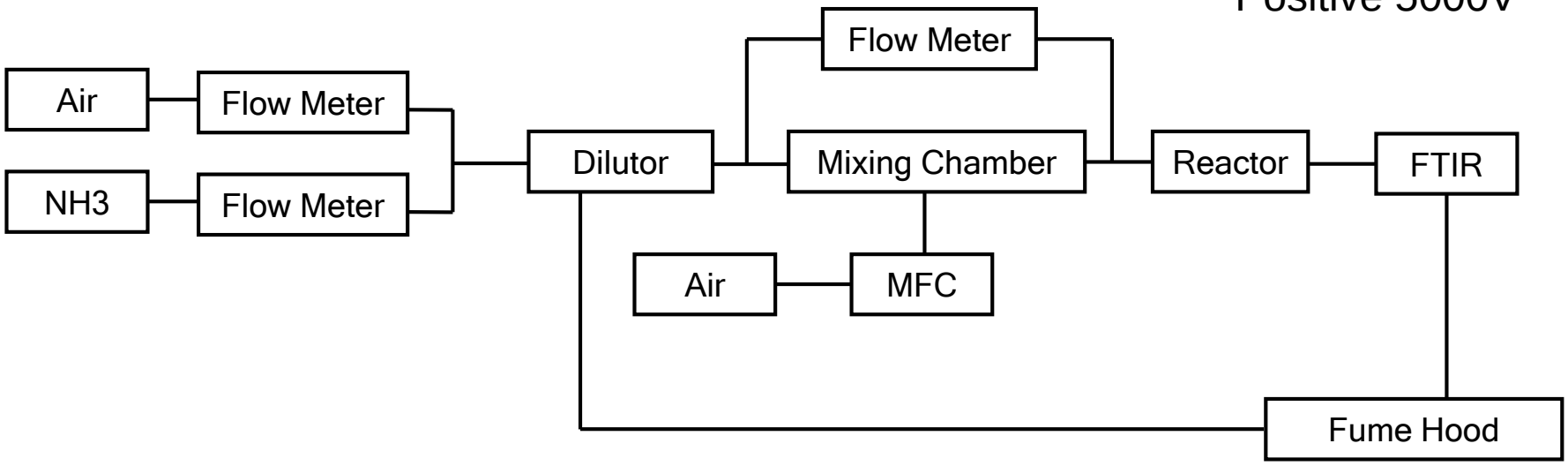
Removal (2/4)

- **Nonthermal plasma를 활용한 대기오염물질(Particle, Nox, Sox) 제거**





Positive 5000V



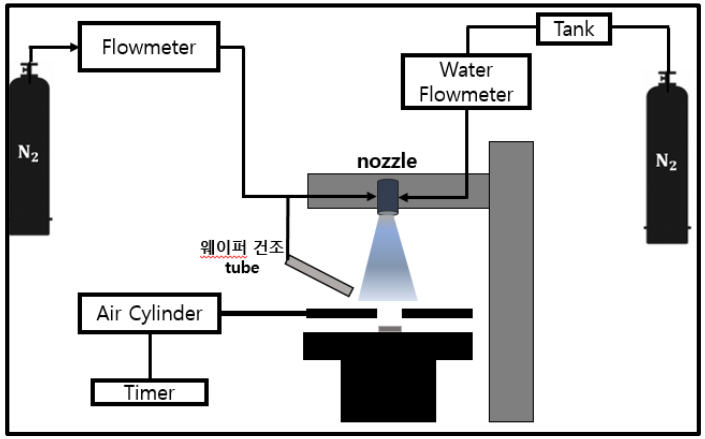
➡ **오염가스와 미세입자를 동시에 제거할 수 있는 미래 지향적인 공기정화 핵심 기술**

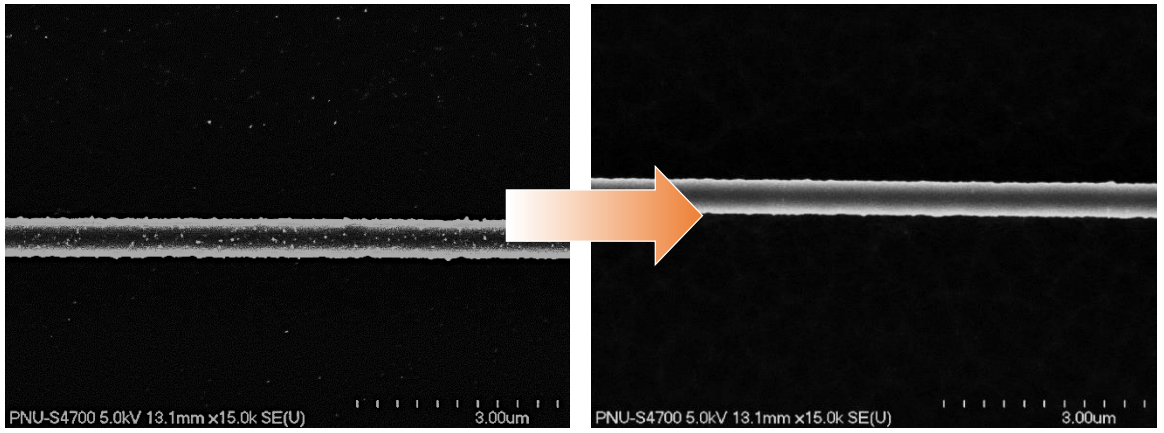
Removal (3/4)

- 반도체 회로 선폭 감소 → 작은 크기의 오염 입자도 문제의 원인이 됨

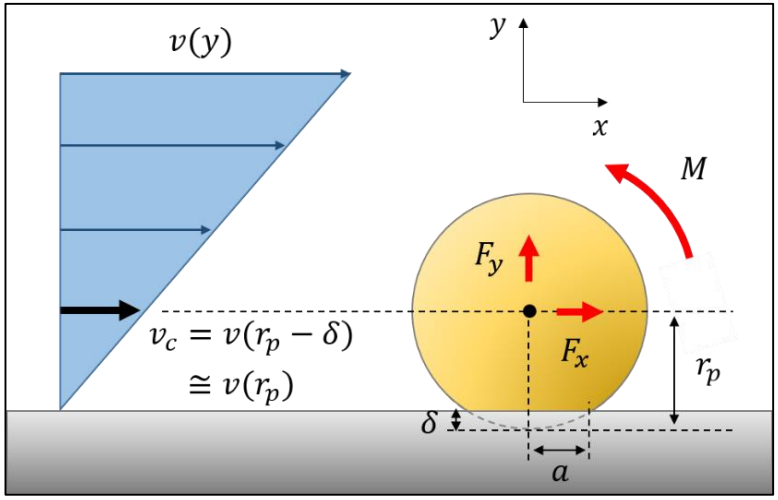
  → 10 nm급 오염 입자의 dry cleaning

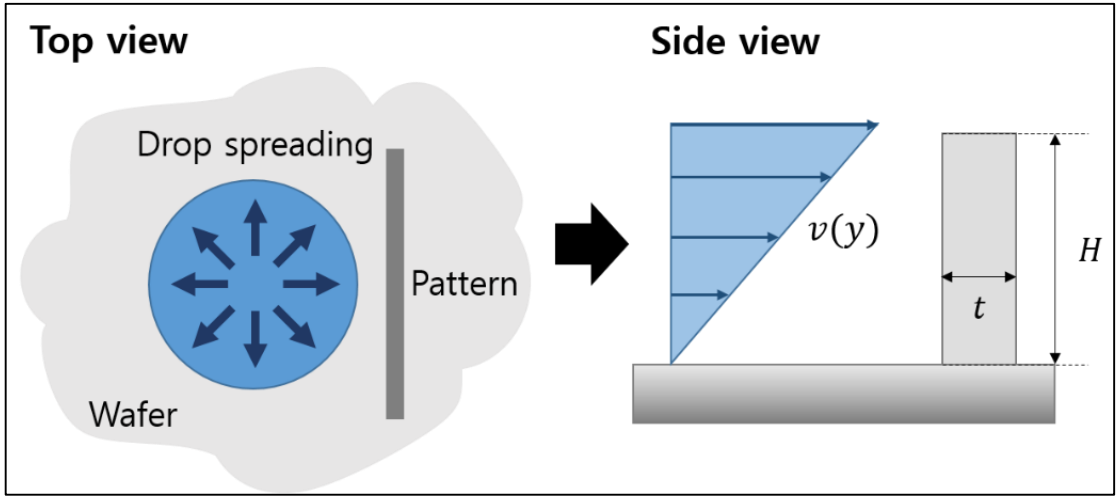
- **반도체 오염 입자(Ti, Cu, …) 제거**





- **반도체 입자 탈착 / 패턴 손상 모델링**

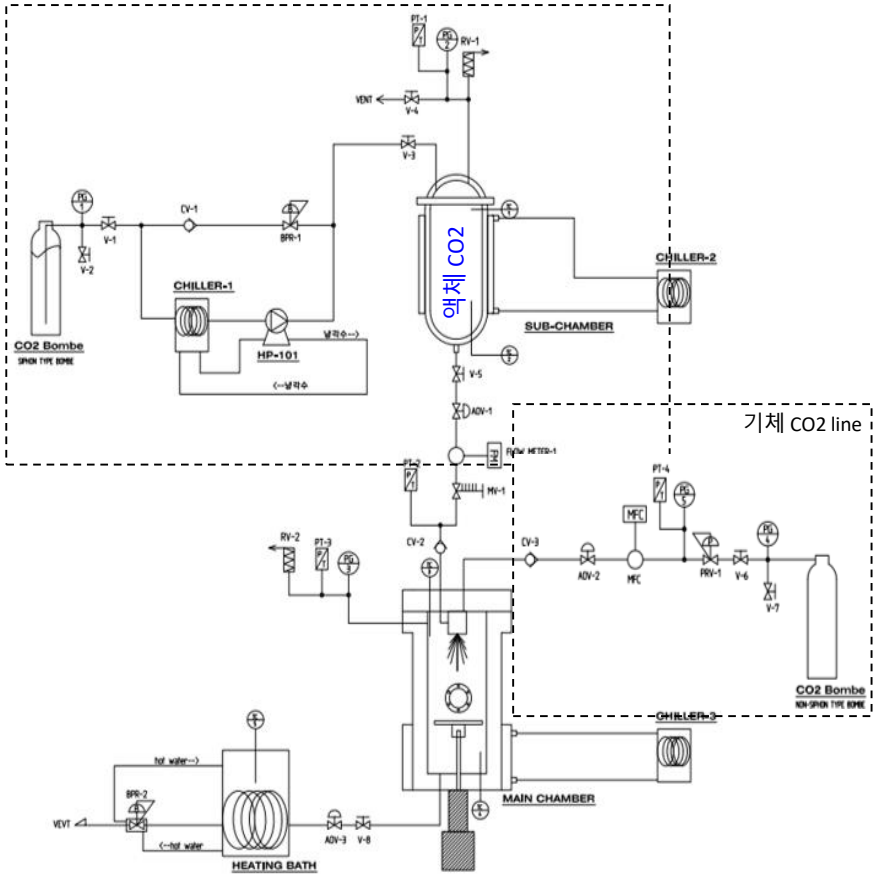




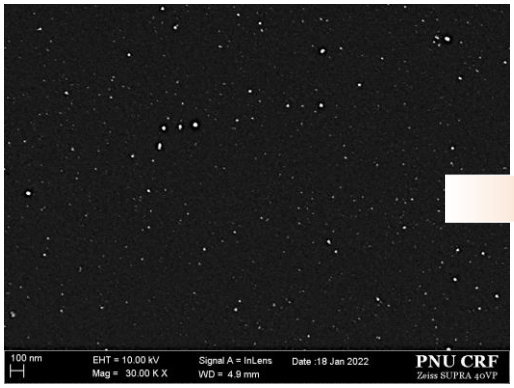
모델링 개발을 통해 입자 탈착 효율 및 패턴 손상 정도를 예측

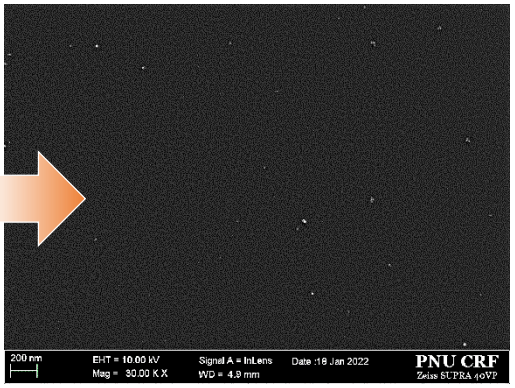
Removal (4/4)

- 노즐 분무형 dry cleaning system



- CO_2 dry cleaning





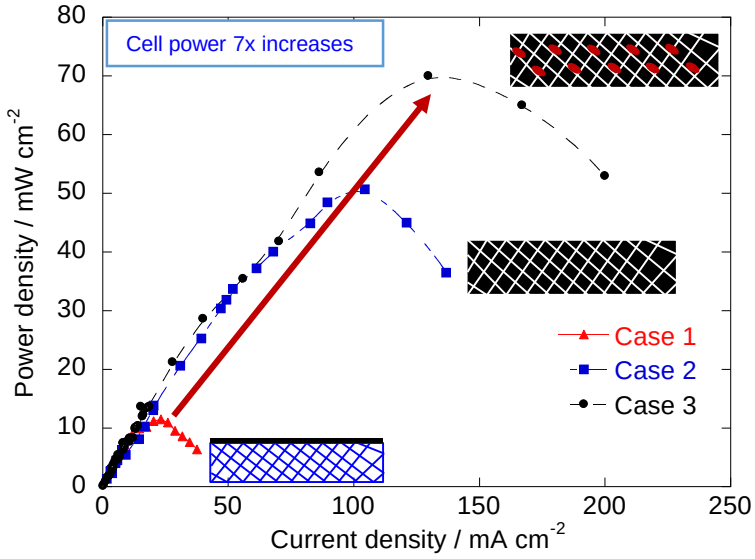
Application: Fuel cell

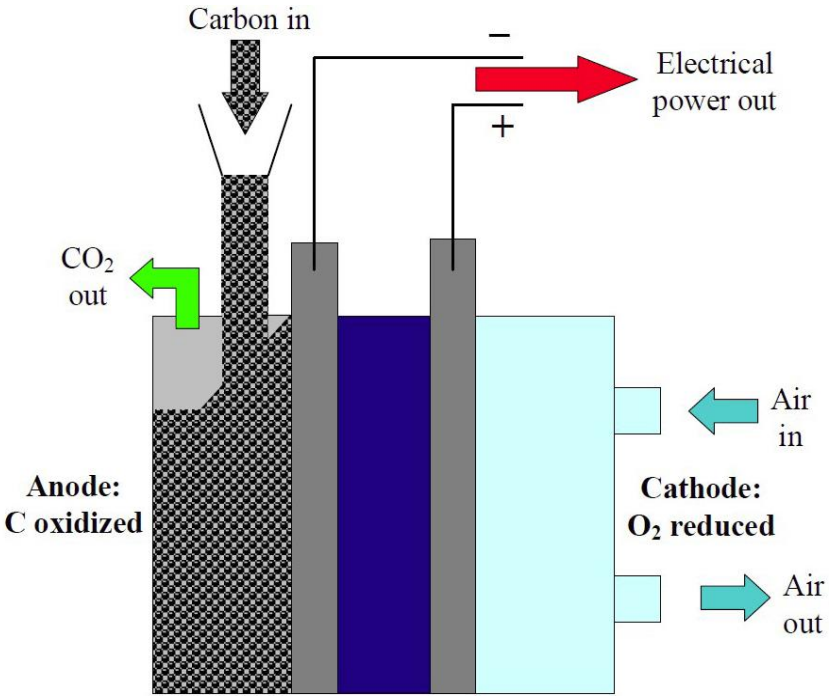
- **DCFC (Direct Carbon Fuel Cell)**

Anode : $C + 2CO_3^{2-} \rightarrow 3CO_2 + 4e^-$

Cathode : $O_2 + 2CO_2 + 4e^- \rightarrow 2CO_3^{2-}$

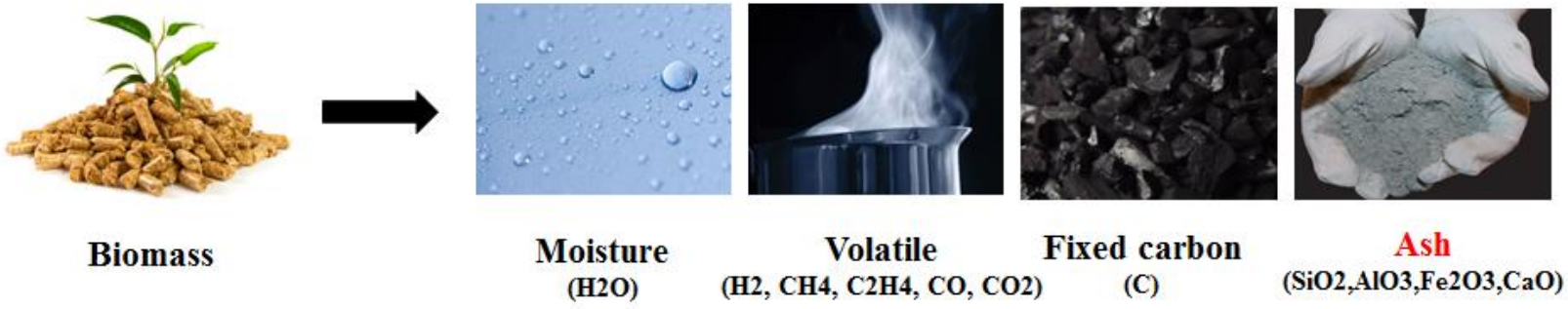
Net reaction : $C + O_2 \rightarrow CO_2$





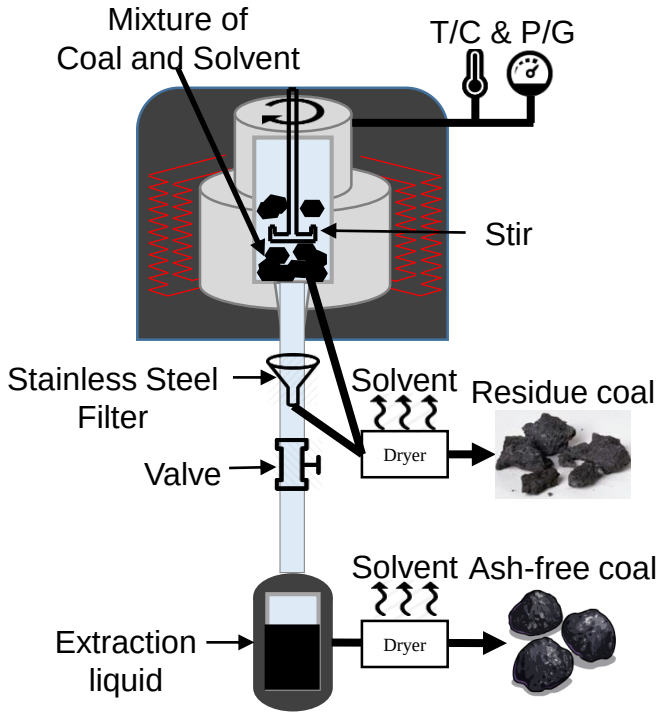
Application: Ash-free coal

- **Ash-free coal**

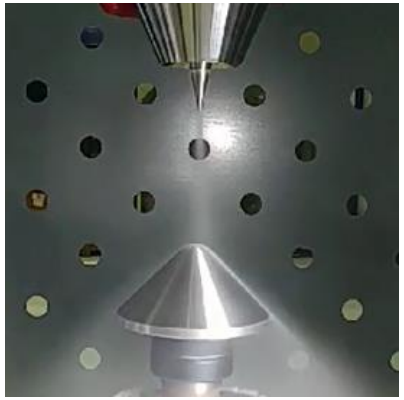


- **무회탄 추출 수율 평가**

- **용매를 이용한 무회탄 추출 시스템**

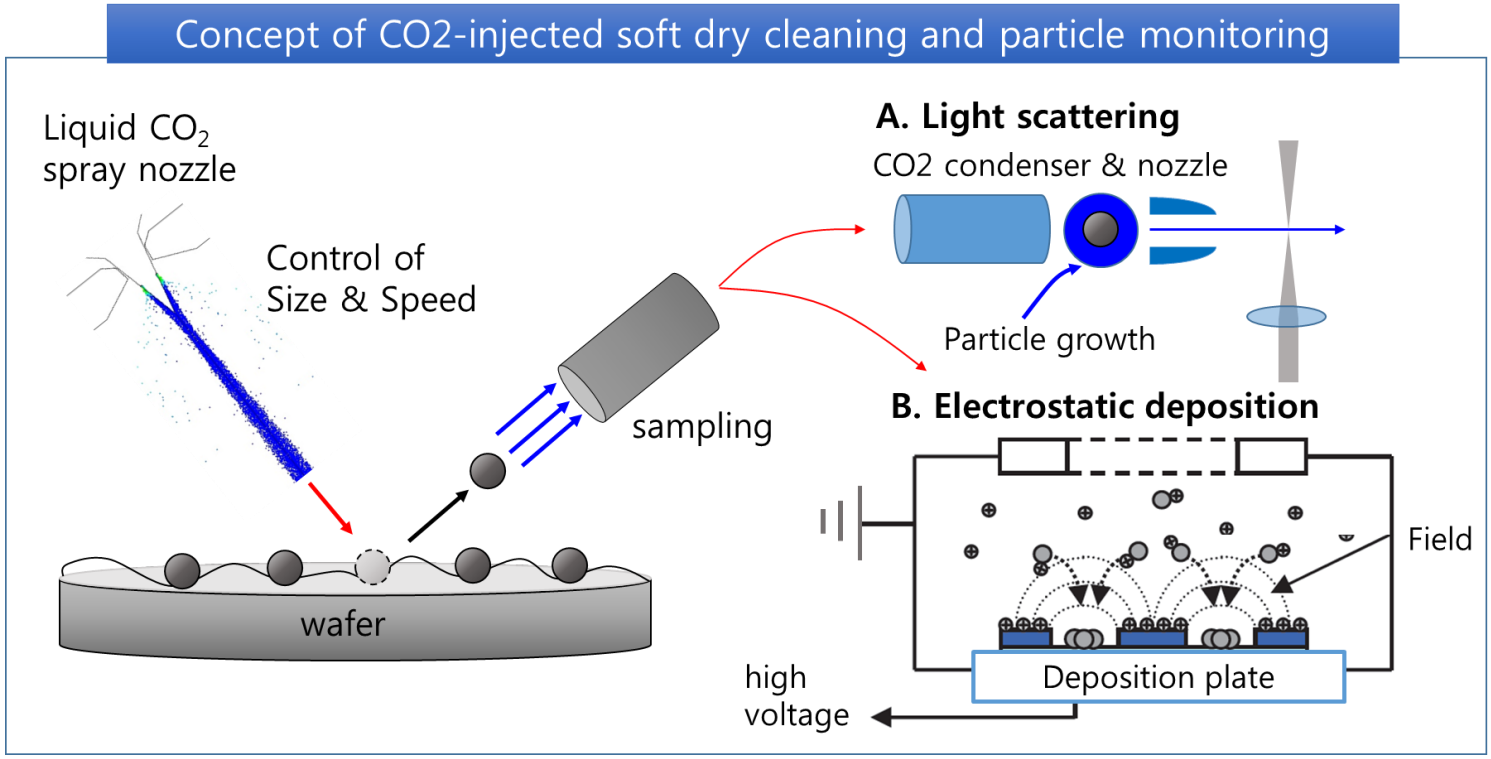


- **무회탄 용매 건조 및 회수**



Application: Contaminant monitoring

- **반도체 cleaning에서의 실시간 모니터링 기술**
  - 반도체 생산 공정 중 발생하는 10 nm급 나노입자의 오염도 측정
  - Cleaning 과정을 통해 제거한 오염 입자를 수집 및 분석할 기술 개발
  - Challenging point: low number concentration of the nanoparticles 극복 필요



최근 연구 실적

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1. Jeonggeon Kim, Juhwan Shin, Donggeun Lee, 2022, "Microstructral transition of nanoparticle deposits from multiple dendrites to compact layer", **Journal of Aerosol Science**, vol. 159, pp. 105876.

2. Dong Yeop Kim, In-Duck Cheon, Jeonggeon Kim, Donggeun Lee, 2021, "Desulfurization characteristics of fuel-born alkali and alkali earth metal compounds in coal ashes from lab-scale experiment to real-scale monitoring of CFBC and PC boiler", **ACS Omega**, vol. 6, pp. 5962-5971.

3. Rashed Kaiser, Songkil Kim, Donggeun Lee, 2020, June, 8, "Deep data analysis for aspiration pressure estimation in a high-pressure gas atomization process using an artificial neural network", **Chemical Engineering and Processing: Process Intensification**, vol. 153, pp. 107924. [PDF]

4. Chengguo Li, Seongyong Eom, Gyungmin Choi, Tae-Youl Choi, Donggeun Lee, 2020, March 3, “Intrinsic solid-state reaction characteristics of coals and chars in a direct carbon fuel cell: with focus on significance assessment of fuel-borne factors”, **Energy and Fuels**, vol. 34, pp. 4129-4138.

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6. Jeonggeon Kim, Yong-Rack Goo, Indae Choi, Songkil Kim, Donggeun Lee, 2019, Mar. 19, "Toward high-accuracy and high-applicability of a practical model to predict effective thermal conductivity of particle-reinforced composites", **International Journal of Heat and Mass Transfer**, vol. 131, pp.863-872.

7. Yoohyun Ock, Jeonggeon Kim, Indae Choi, Dae Seong Kim, Mansoo Choi, Donggeun Lee, 2018, May 18, "Size-independent unipolar charging of nanoparticles at high concentrations using vapor condensation and its application for improving DMA size-selection efficiency", **Journal of Aerosol Science**, vol. 121, pp. 38-53.

8. Min Young Hur, Donggeun Lee, Sangsun Yang, Hae June Lee, 2018. Jan. 31, "Numerical modeling of nano-powder synthesis in a radio-frequency inductively coupled plasma torch", **Applied Science and Convergence Technology**, vol. 27, pp. 14-18.

9. Rashed Kaiser, Chengguo Li, Sangsun Yang, Donggeun Lee, 2018, March 28, "A numerical simulation study of the path-resolved breakup behaviors of molten metal in high-pressure gas atomization: with emphasis on the role of shock waves in the gas/molten metal interaction", **Advanced Powder Technology**, vol. 29, pp. 623-630.

최근 5년이내 졸업생 배출 현황

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성명	졸업년월	취업현황
신**	2016.2	LG Chemistry (LG화학)
이**	2016.2	Korea South-East Power Co. (한국남동발전)
옥**	2016.2	SK Hynix (SK하이닉스)
표**	2016.8	KAI (한국항공우주산업)
최**	2017.2	LG Hausys (LG하우시스)
정**	2017.2	Lotte Chemical Corporation (롯데케미칼)
천**	2017.2	KAI (한국항공우주산업)
손**	2017.2	KAI (한국항공우주산업)
이**	2017.8	EM-Tech (이엠텍, 전문연구요원)
이**	2018.2	LG electronics (LG전자)
박**	2018.2	Alink (알링크)
전**	2019.2	LG Energy solution (LG에너지솔루션)
한**	2019.2	Samsung electronics (삼성전자)
라**	2020.8 (Ph.D)	KAIST, Postdoctoral researcher
박**	2022.2	KCC (케이씨씨)

THANK YOU