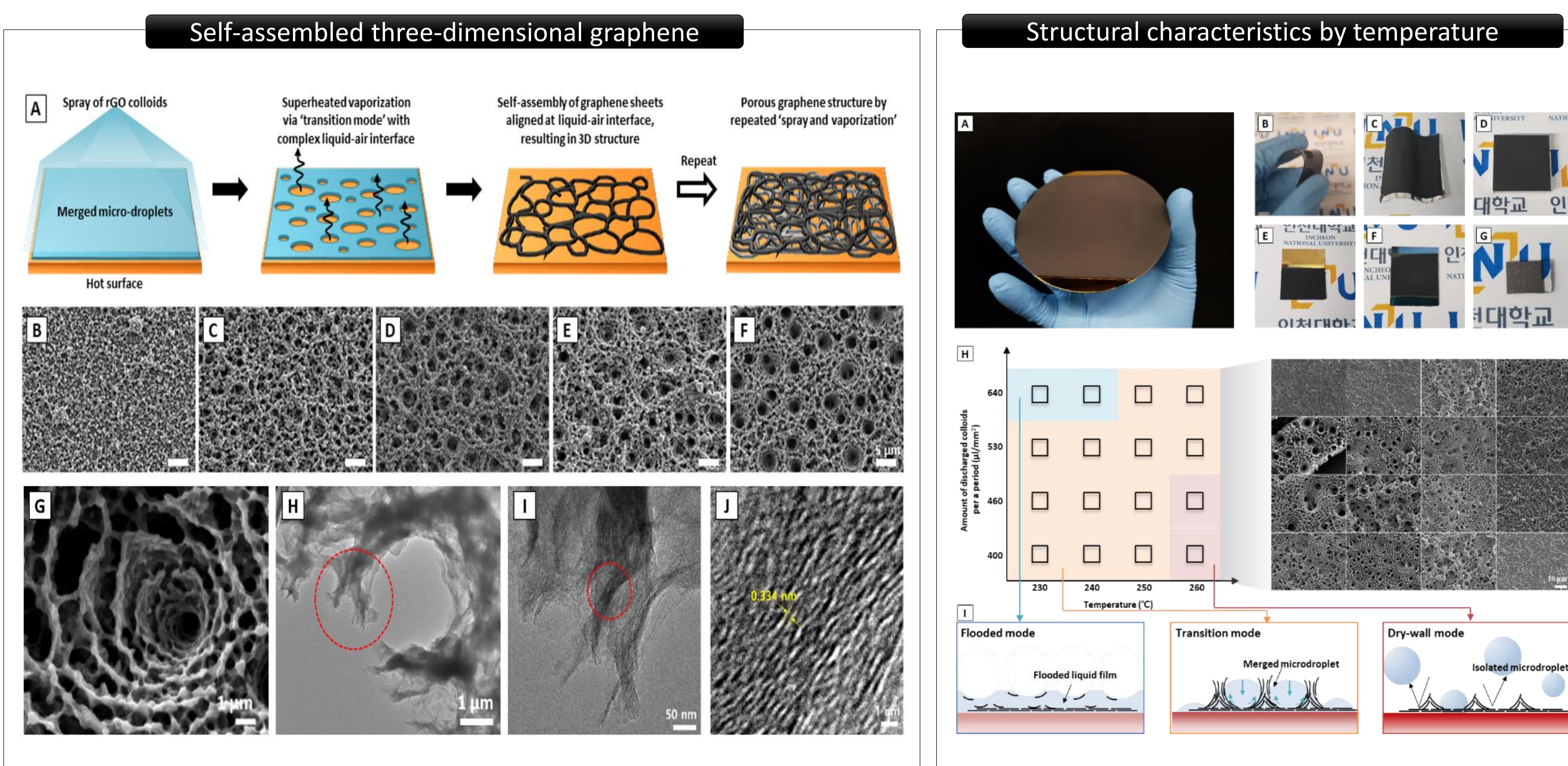
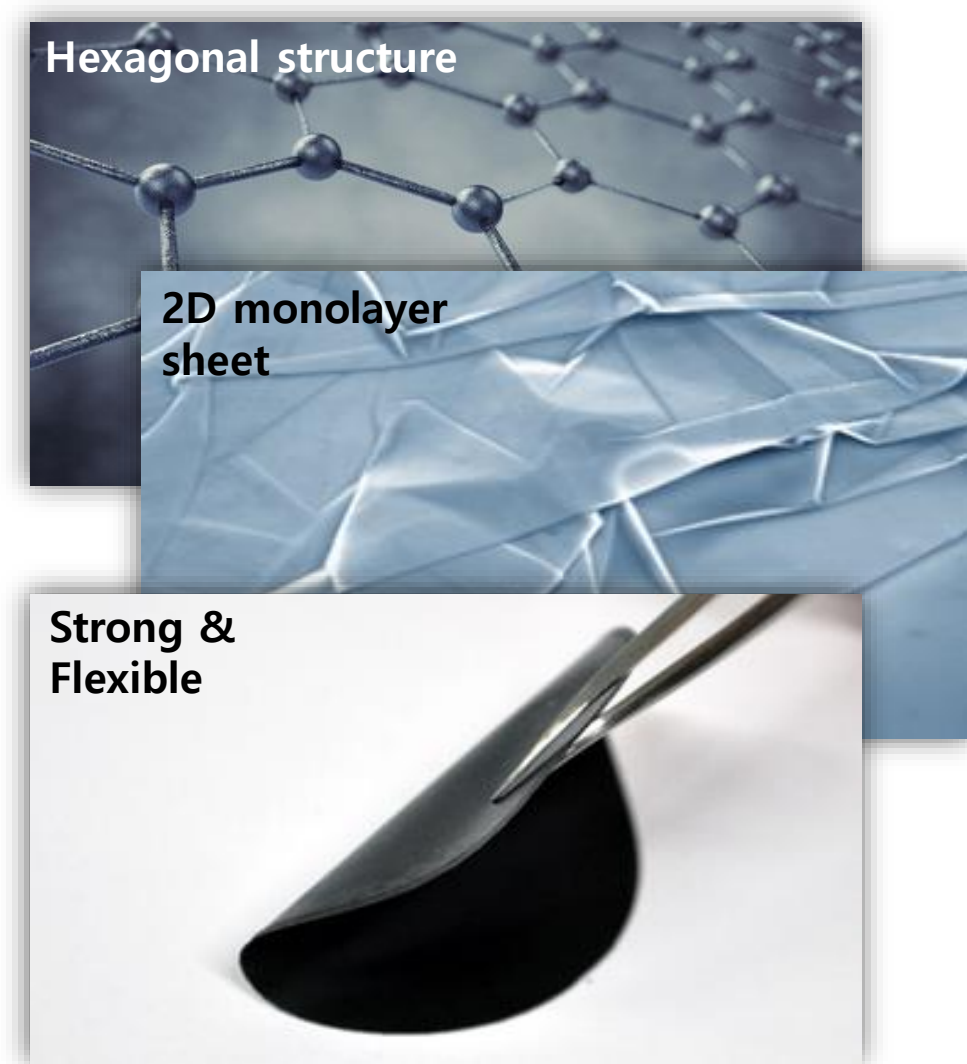


### Research Field

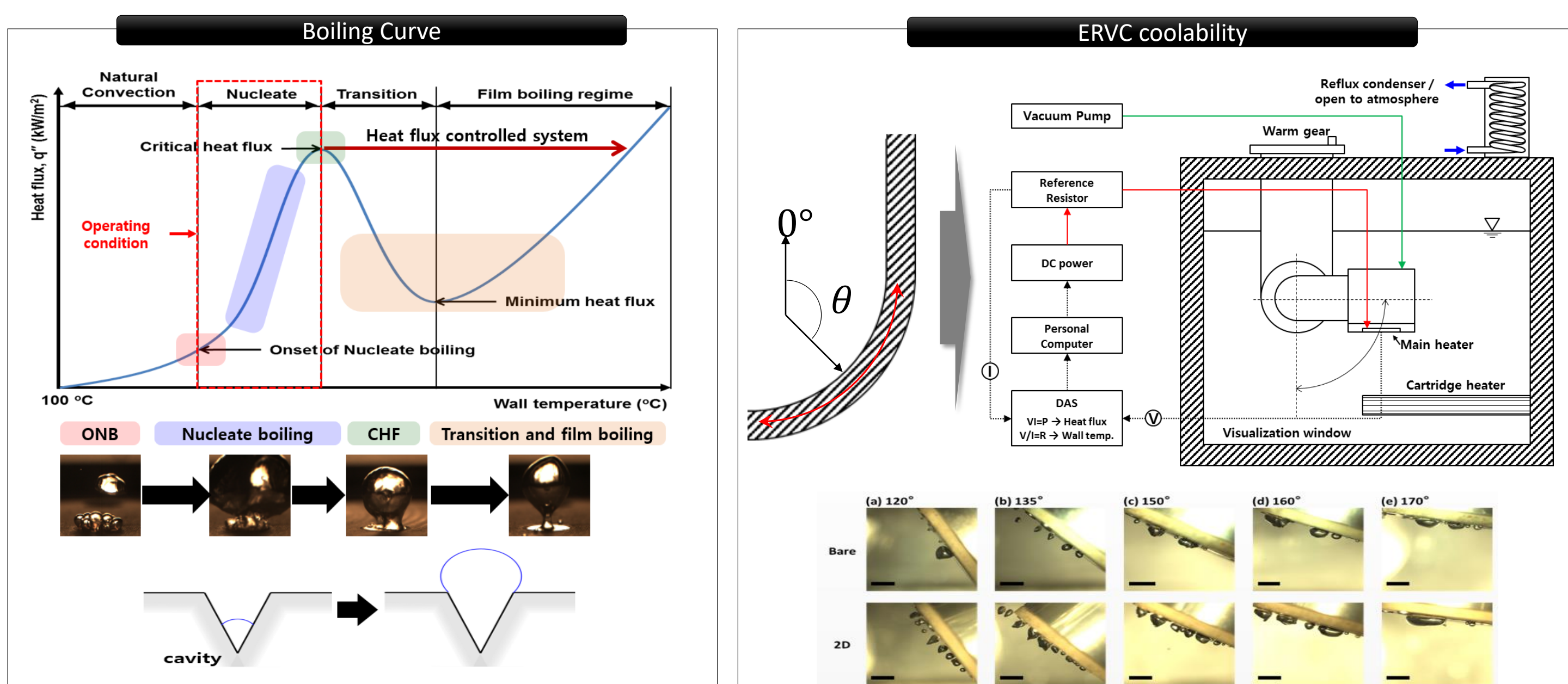
#### 3D graphene synthesis

- Graphene, a 2D carbon isotope, gains massive interests for next-generation material due to its novel properties, e.g. electrical & thermal conductivity and high strength.
- Graphene flakes can be self-assembled due to superheat evaporation of graphene colloids with spray discharge. (The idea is registered as patent.)
- The 3D graphene matrix can be fabricated on various surface such as silicon wafer, ITO, and metal surface. Also, the technique has wide versatility because the morphology and pore characteristics of 3D matrix can be controlled, corresponding its usage and application.

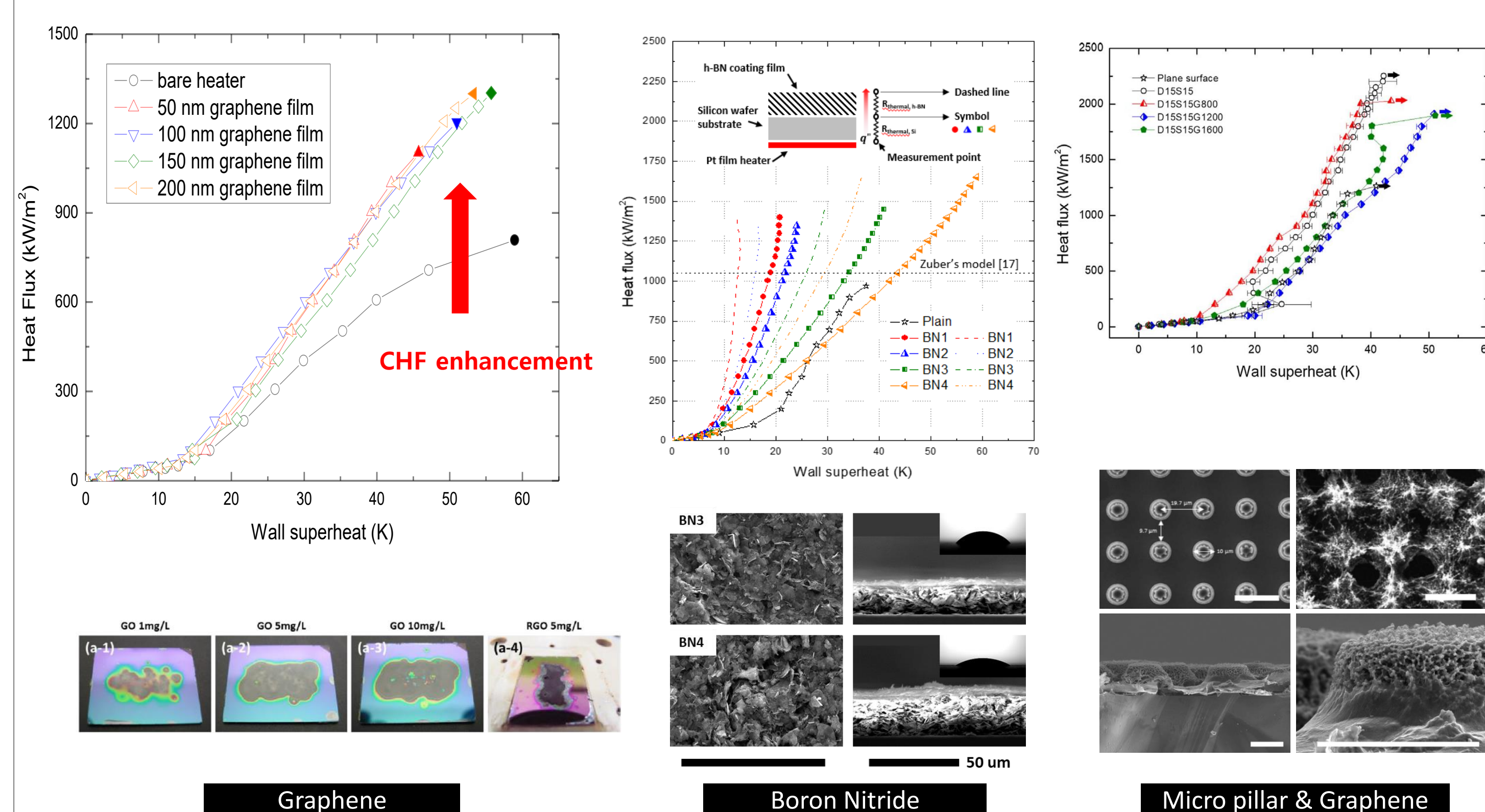


#### Pool Boiling

- The boiling phenomenon is the most efficient heat transfer mechanism, in which bubbles are formed and grown in the microscopic pores (cavity) on the heating surface.
- We are working on improving the critical heat flux through various attempts such as graphene, boron nitride coating on the surface of heater, micro pillar structure through MEMS, heater angle setting, Nanofluid and applying it to various engineering fields.
- The high thermal conductivity of the material during surface coating and the high hydrophilic surface structure contribute to the enhancement of the critical heat flux.



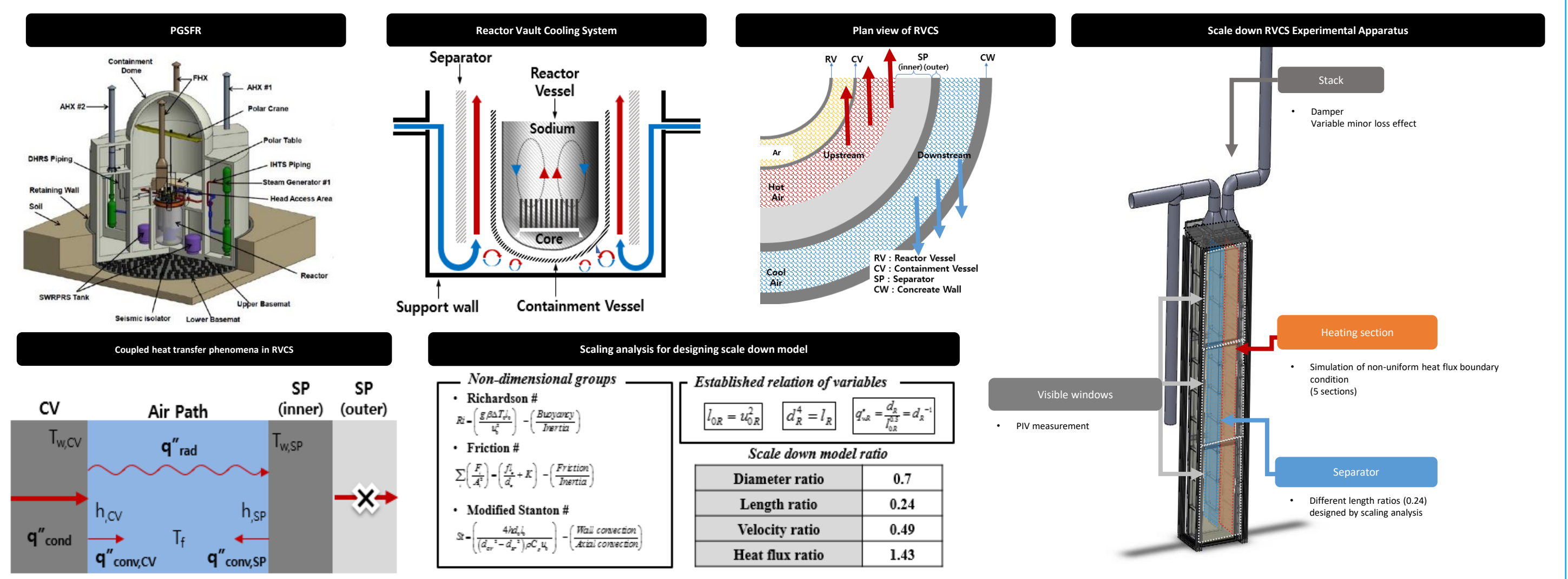
#### CHF enhancement by surface improvement



#### Nuclear Safety

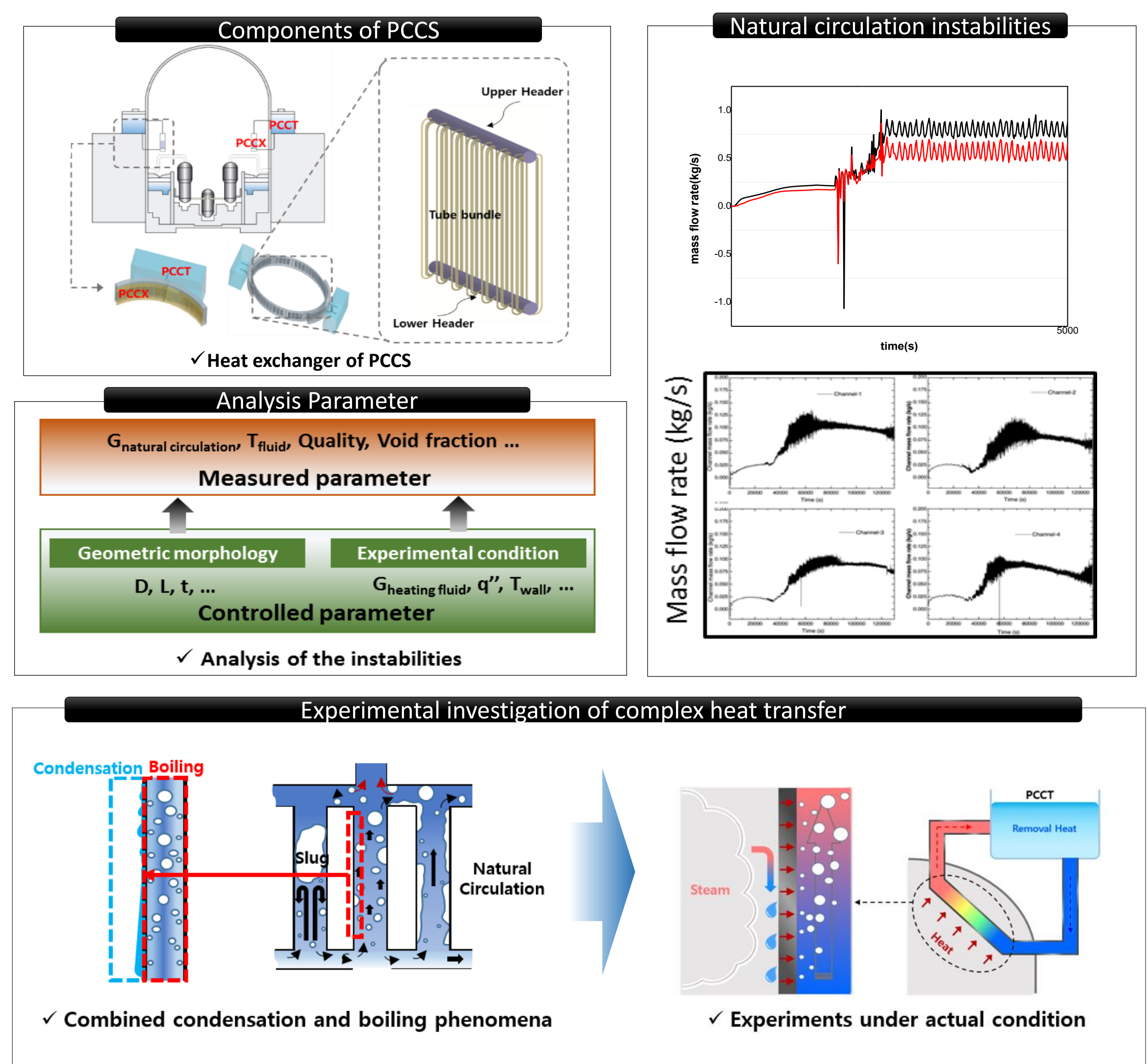
##### PGSFR

- PGSFR is one of Gen-IV next generation nuclear reactors aiming at commercialization until 2030 and is being design by the Korea Atomic Energy Research Institute. It has various advances such as high economic efficiency, stability, low radioactive waste and nuclear proliferation resistance.
- The importance of Passive Cooling System, which can cool itself in the situation of Station Blackout (SBO) caused by Severe Accident such as Fukushima accident, is emphasized
- We are conducting research on the RVCS internal heat transfer phenomena with the aim of defense in depth by improving cooling performance through analysis of cooling performance of PGSFR-RVCS.



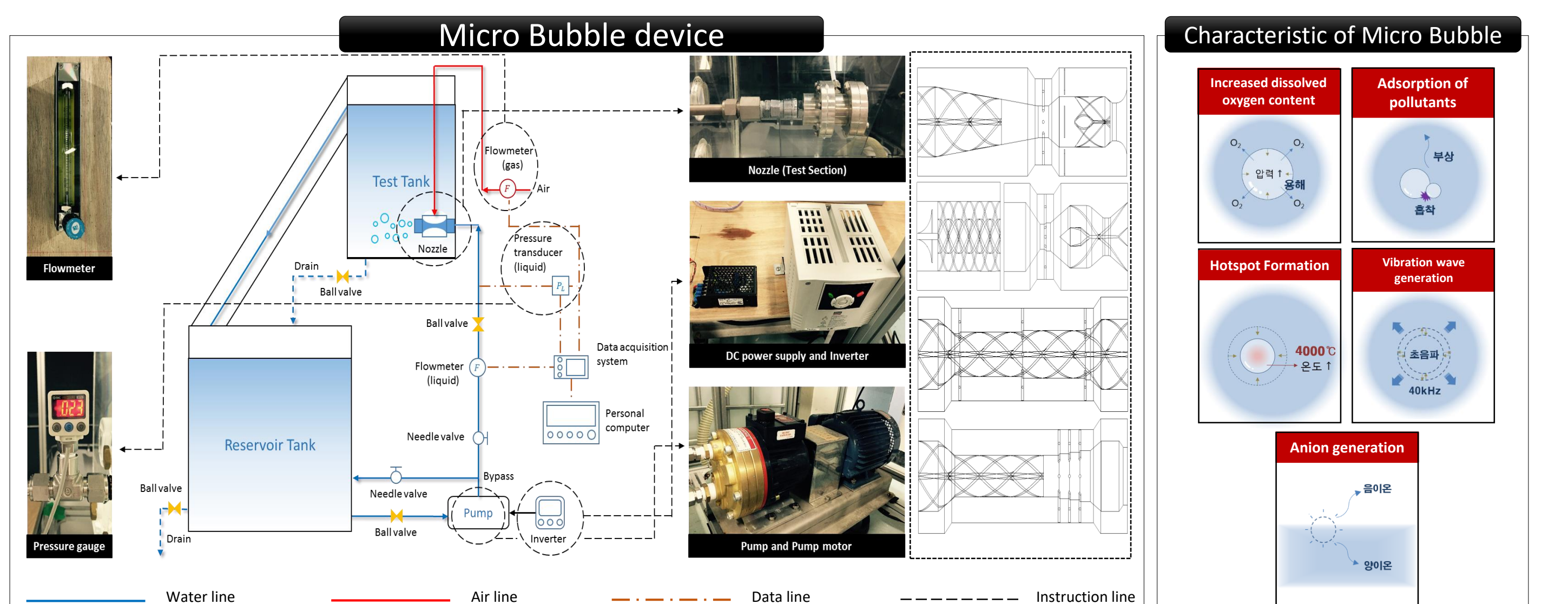
##### PCCS

- PCCS is a safety system of nuclear power plants that prevents overpressure of containment without leakage of radioactive materials when the severe accident occurs.
- Condensation occurs outside of tube shaped heat exchanger and boiling occurs inside of tube shaped heat exchanger when the coolant flows by natural circulation to remove heat.
- This study analyzes various physical factors to understand these complex heat transfer phenomena.



#### Micro Bubble

- The micro bubble is a bubble having a diameter of 50  $\mu\text{m}$  or less. A typical bubble explodes after it floats in water due to buoyancy, but micro bubbles are not affected by buoyancy and are not floated, but are reduced or eliminated by surface tension themselves.



# Advanced Heat transfer and Nanotechnology Laboratory

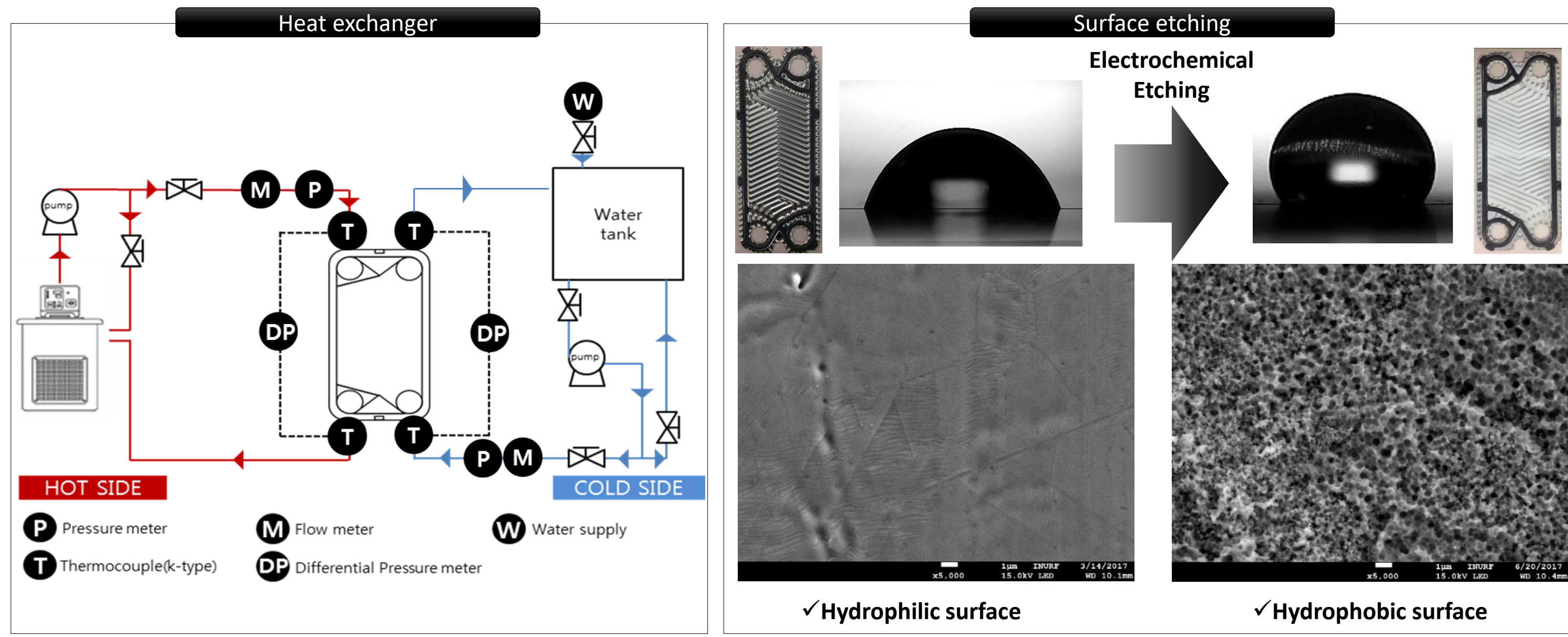
## 첨단 나노 열전달 연구실

http://ahnlab.inu.ac.kr Tel) 032-835-4540 8A-261

### Research Field

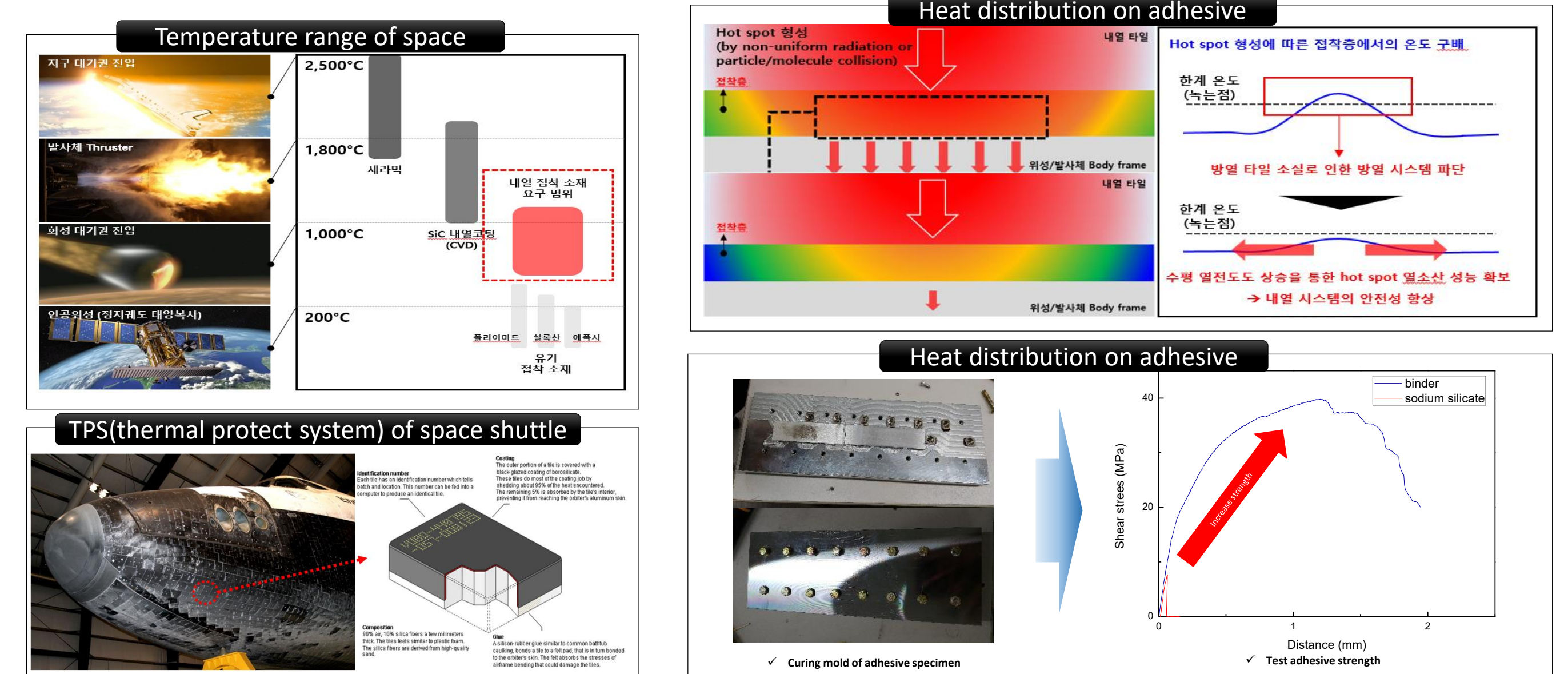
#### Development of high-performance heat exchanger through surface modification

- ❖ **Heat exchanger** is an energy transfer device that exchanges heat by the temperature difference between two fluids between a plate (or a tube) and a **performance drop due to fouling** (scale, etc.) during heat exchange occurs.
- ❖ In order to develop a **fouling-inhibited heat exchanger**, research is underway to convert the surface of the heat exchanger to hydrophobic through electrochemical etching using aqua regia to prevent fouling.



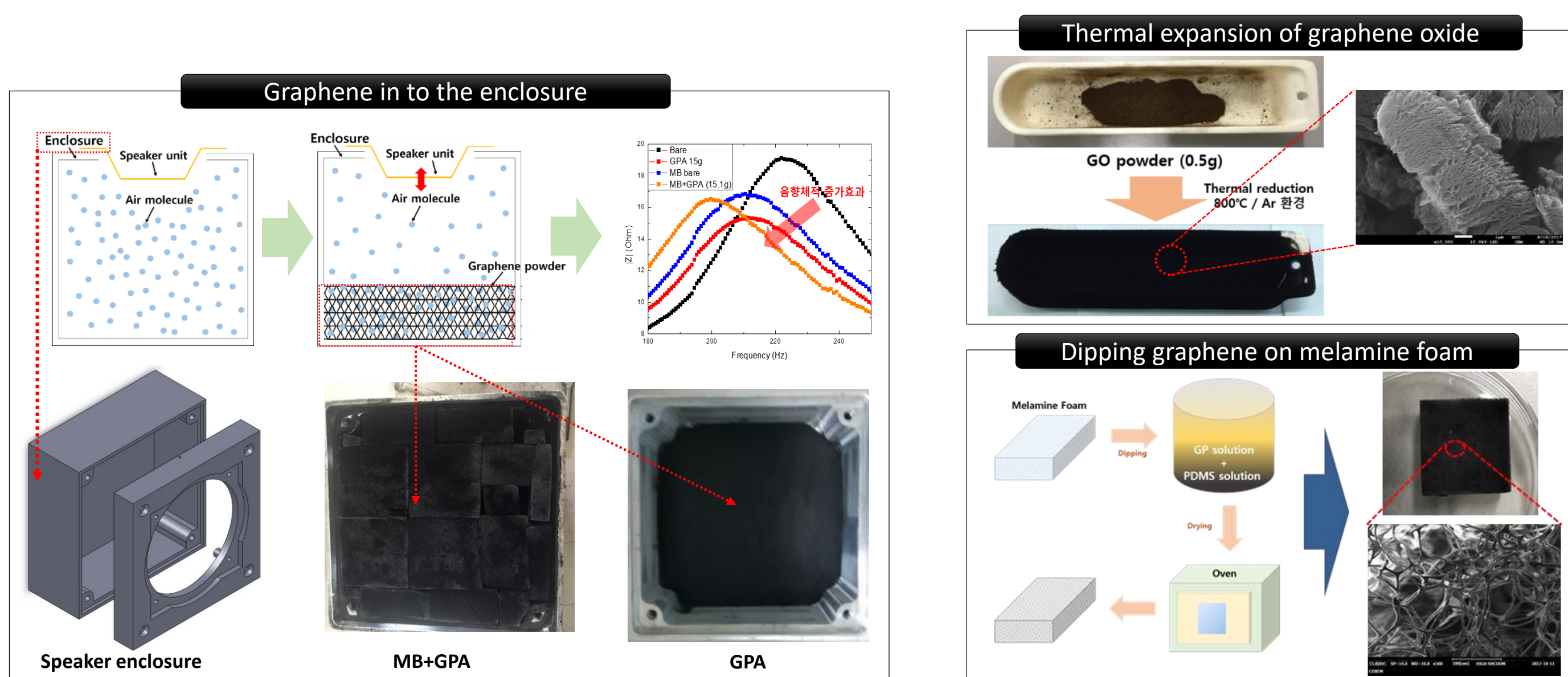
#### Inorganic silicate based adhesive

- ❖ Spacecraft and satellites exposed to the **extreme space environment** use thermal protection system (TPS) to protect heat by adhering heat-resistant tiles to the outer wall of the hull to secure heat resistance.
- ❖ **Inorganic-based adhesives** have low heat-resistant temperature range, so we are developing **inorganic silicate-based bonding materials** suitable for heat resistance, and are studying to improve the performance of TPS and heat-radiating coatings by analyzing graphene filler dispersion and horizontal orientation mechanism.



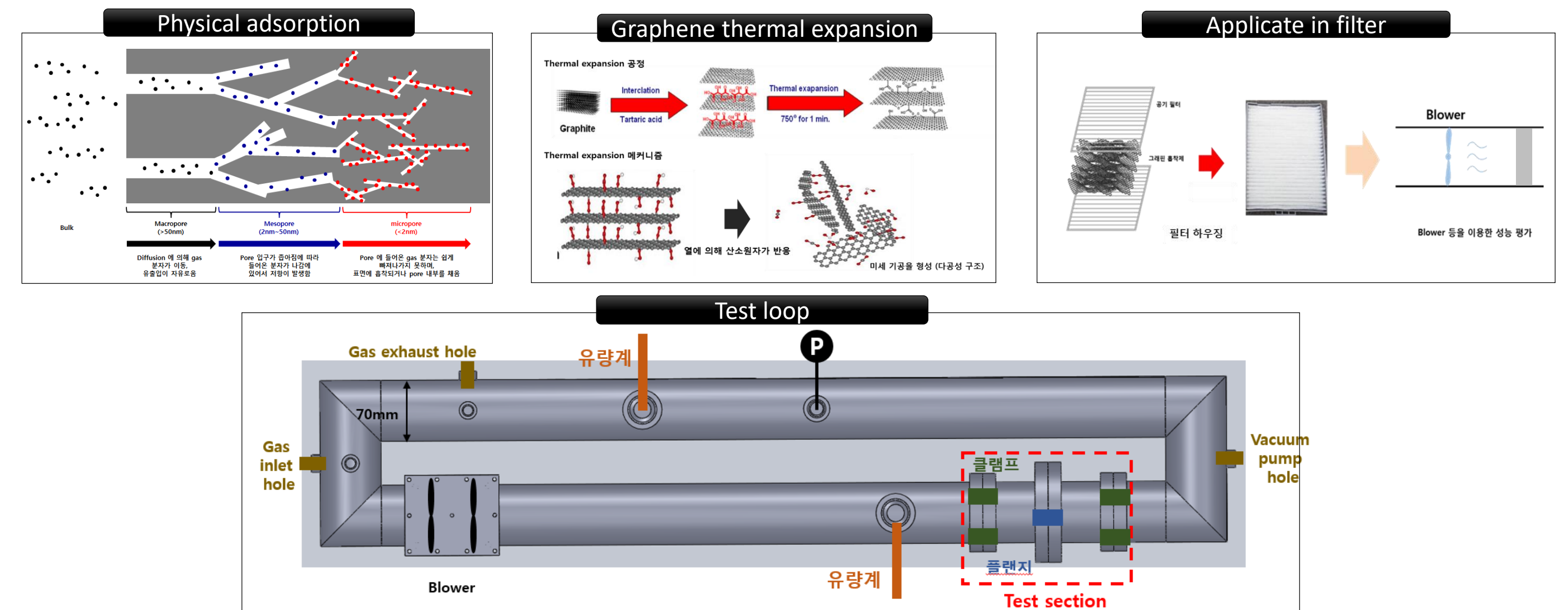
#### Speaker enclosure

- ❖ **Speaker unit's low-frequency** capability depends on largely on the size of the enclosure, and most speakers implement this by placing a sound **absorbing material inside the enclosure**.
- ❖ The material of complex structure increases the adsorption rate of air molecules, and is excellent as a sound absorbing material that achieves excellent performance in low sound performance.
- ❖ **Porous graphene material** manufactured by our laboratory **ensure the volume increase of more than 40%** and mass production possibility.



#### Graphene based VOCs degassing adsorbent

- ❖ **Volatile Organic Compounds (VOCs)** is a generic term for organic compounds that are easily evaporated into the atmosphere due to their low boiling point like a Benzene, toluene, xylene, etc. **VOCs cause chronic diseases such as cancer, kidneys and liver** when exposed at low concentrations below 100 ppmv.
- ❖ The **graphene-based porous material** has the advantages of **high specific surface area** and **easy chemical modification** compared to activated carbon commonly used in conventional filters, which is advantageous for the adsorption of VOC gas. It also improves the adsorption performance of the filter.



### Research Results & Achievement

#### Paper

SCI	Domestic
57	8

#### Patent

No.	Patent name
1	"튜브의 내부 표면 양극산화 장치 및 방법 & Apparatus and Method for Anodizing Inner Surface of Tube", Korea & PCT
2	"비등을 이용한 폼형상 그래핀 구조의 생성방법 및 이를 이용한 폼형상 그래핀 구조 & Method for producing foam-shaped graphene structure by boiling, and foam-shaped graphene structure using same", Korea & PCT
3	"스프레이 분사를 이용한 3차원 그래핀 구조체의 합성방법", Korea
4	"스프레이분사를 이용한 슈퍼커패시터용 3차원 그래핀 전극의 제조방법", Korea
5	"임계열유속의 발생을 제거하면서 효율성이 증진된 그래핀을 이용한 핵비등 열전달 시스템", Korea
6	"활성그래핀을 이용한 냄새제거 필터의 제조 방법", Korea
7	"마이크로 버블 발생장치", Korea

### Project

#### Government

- ❖ Enhancement of boiling heat transfer and mechanical property of 3 dimensional graphene structure using nanoparticle-graphene colloids (National Research Foundation of Korea)
- ❖ Development of heat resistant bonding material with high thermal conductivity based on modified silicate for aerospace (National Research Foundation of Korea/Ministry of Science and ICT)
- ❖ Research on the boiling-assisted flow under natural convection conditions in a tube bundle geometry (National Research Foundation of Korea/Ministry of Science and ICT)
- ❖ Research on Reactor Vessel Exterior Cooling Analysis for the Total Loss of Decay Heat Removal Systems in NPPs (National Research Foundation of Korea/Ministry of Science and ICT)
- ❖ Development of graphene-based high performance adsorbent for removing low-concentration volatile organic compounds VOCs gas (Ministry of Environment/Incheon Green Environment Center)

#### Corporation

- ❖ Research and development of graphene-based acoustic absorbent and scaffold configuration in loudspeaker enclosure for increased acoustical volume (SAMSUNG)

### Laboratory member

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