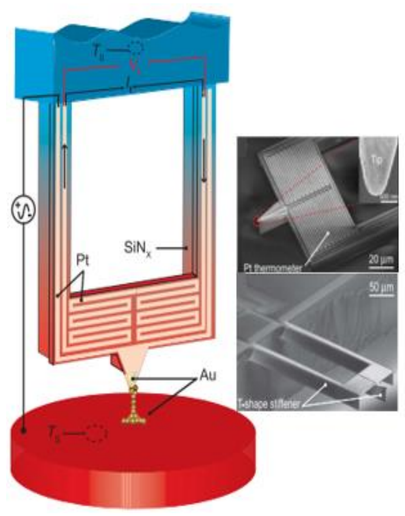
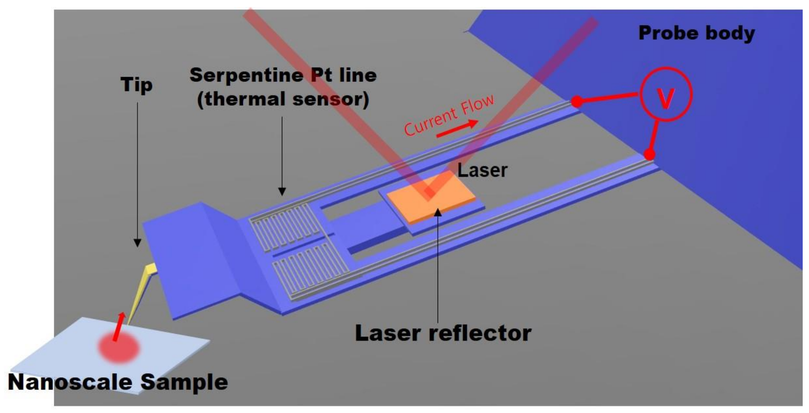
Nano-scale Energy Transport Lab

The Nano-scale Energy Transport Lab, headed by Prof. Kyeongtae Kim seeks to understand energy transport at the nano & atomic scales. Towards this goal, we have developed several experimental approaches that enable us to investigate heat transfer, energy transport, and thermoelectric effects in nanoscale.

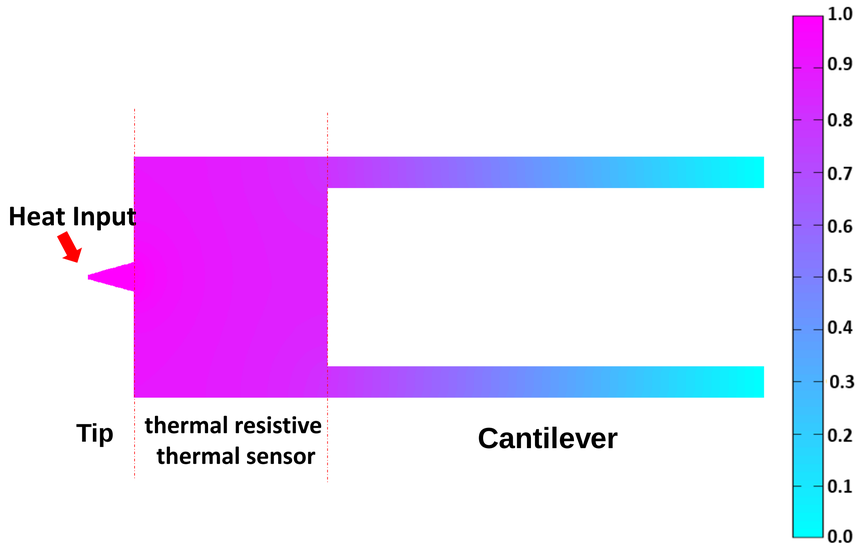
Pico-watt resolution thermal probe



(a) STM probe



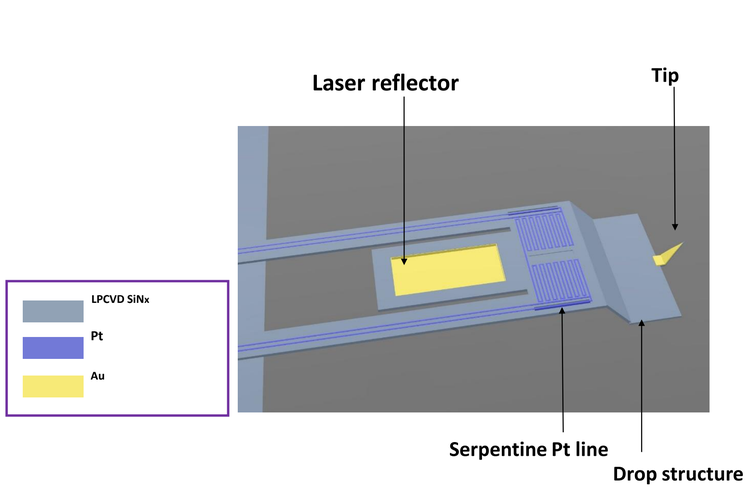
(b) pico-watt resolution thermal probe

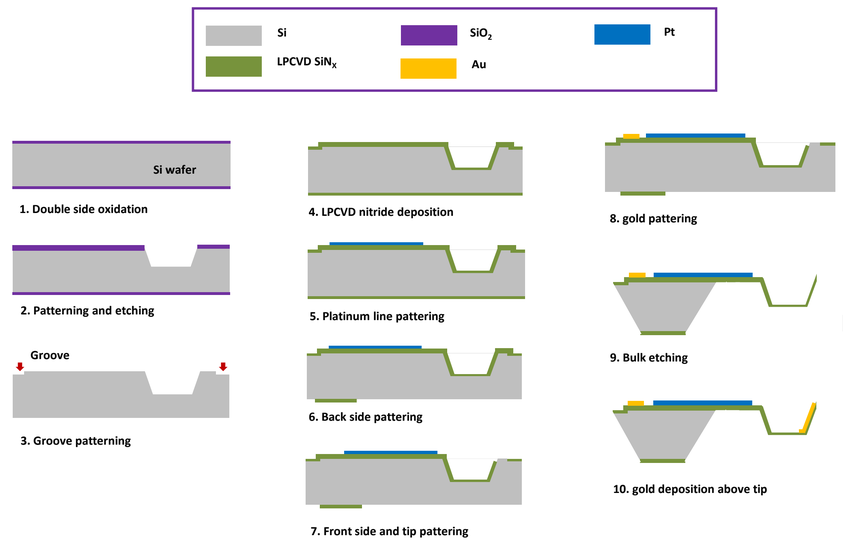


(c) Theoretical Heat profile of probe

(a) Recently, scanning tunneling microscope (STM) probe capable of measure a heat of ∽25pW/K level has been developed to measure heat transferred through the gold atom channel.
(b) But, In the case of (a), It just can measure non-oxidized metal such as gold and platinum, We will develop a pico-watt scanning thermal microscope(based atomic force microscopy) probe capable of measuring the ~10pW level of heat.
(c) When heat is applied through the probe, more than 90% of the heat is limited to the thermal resistive sensor due to the cantilever, which has a high thermal resistance, allowing the thermal sensor to measure the heat.

Probe fabrication





Schematic of probe

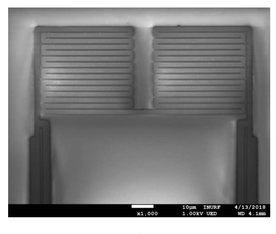
- Mechanically design & thermally design
- Minimize of Heat effect through laser source
- Serpentine platinum line which has ∽1um width can measure heat by confirm electrical resistance difference.

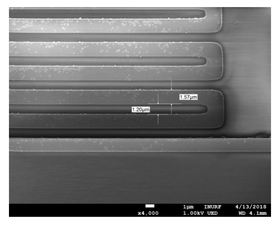
Probe fabrication process.

- 6 inch silicon wafer
- Fabrication very thick serpentine line using Stepper aligner
- Fabrication Drop structure through silicon wet etch

Thermal resistive sensor

(a)

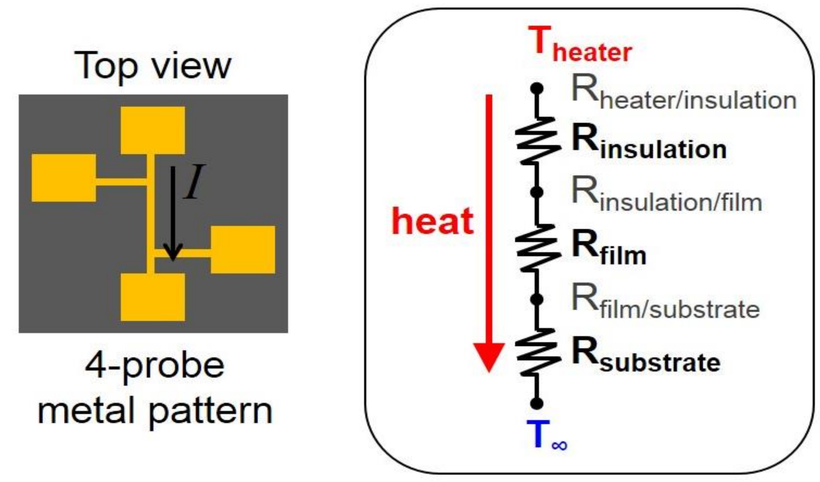




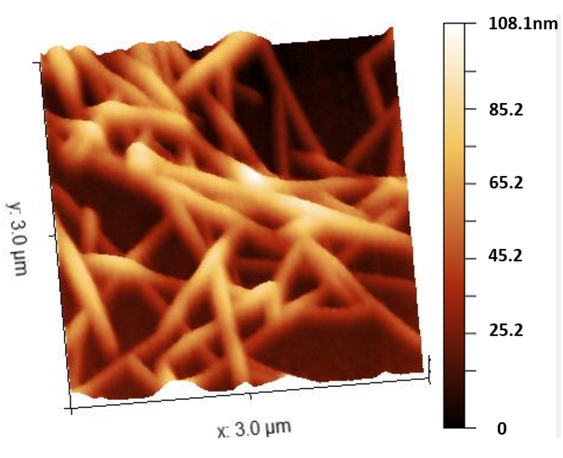
(b) (c)

(a) Optical microscope image of thermal resistive sensor(platinum thin film)
(b) Scanning electron microscopic image of platinum serpentine line
(c) platinum line is measured by using SEM.

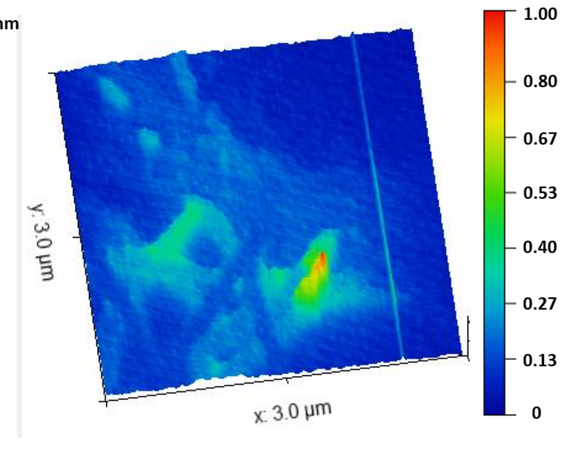
Improved 3ω method



Ag nanowire network thermal profiling



Topography image



Thermal image

- We are studying for Ag nanowire network thermal property
- In the nanowire network, heat is generated in the place where electric current flows, and other wire can be heat sink.

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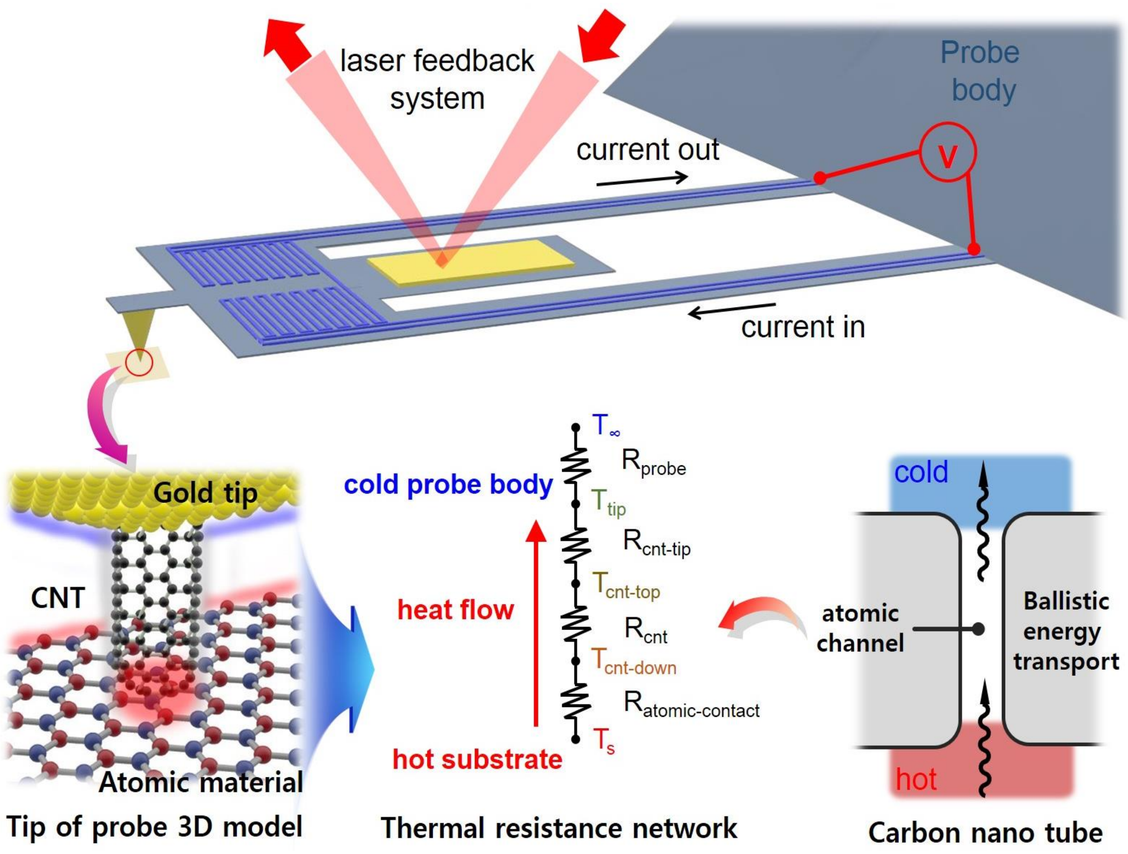
Atomic Contact – Scanning Thermal Microscopy



Development of pW scanning heat microscope probe

- **Ultra-sensitive Picowatt scanning heat-microscope probe capable of measuring below 10pW (10-11W)**

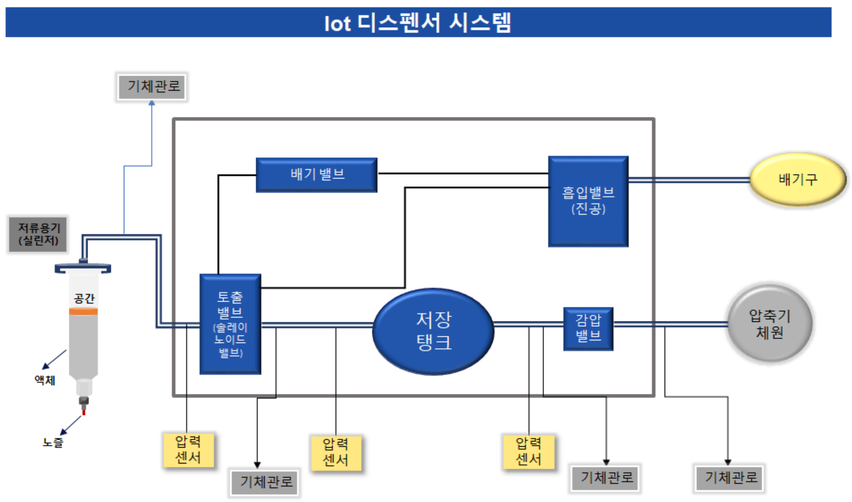
Picowatt develops a scanning thermal microscope system capable of calorimetry in a highly vacuum environment.

- **By using a 4-axis piezo scanner system, atomic scale accessibility is improved and micro calorimetry becomes possible.**

Developed the world's first atomic contact-scanning thermal microscope probe using nanotubes.

- **Utilizing carbon nanotubes with high mechanical strength, structural stability and excellent heat transfer properties for atomic contact.**

Dispenser



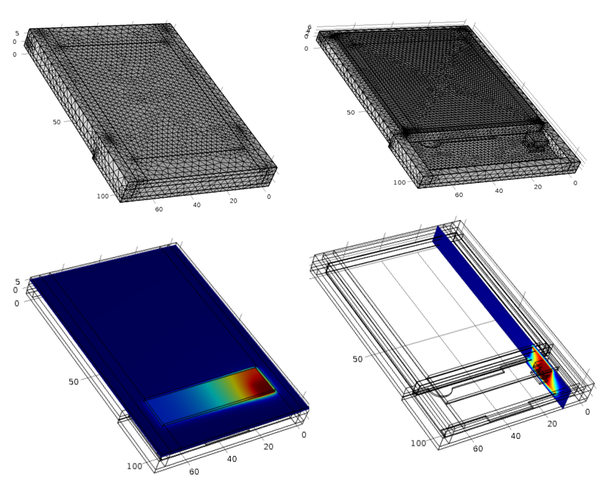
Localization of dispenser and equipment development.

- **Structural design using domestic parts**
- **Development of precision instrument using fluid mechanics**

Integrated dispenser system

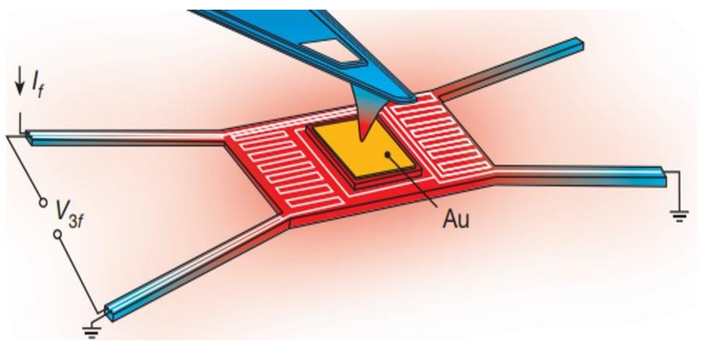
- **Established management system through new channels**
- **Remote control of instrument and abnormal detection**

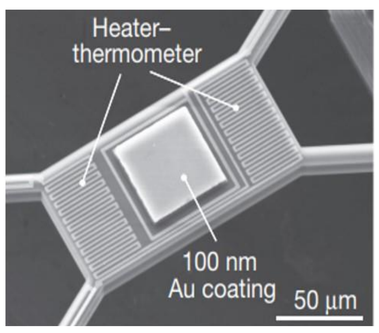
Heat transfer Modeling

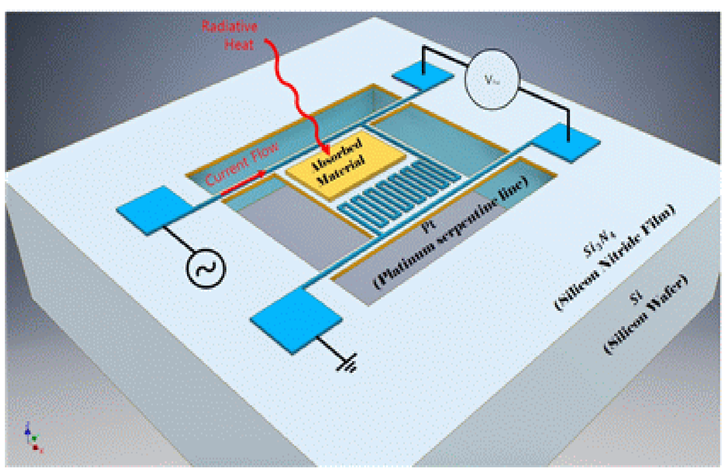


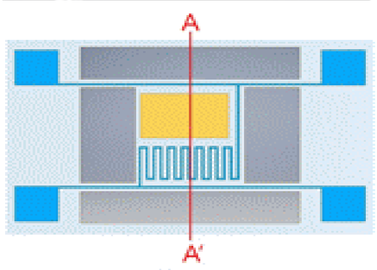
- **Analysis of heat generation by surplus space inside the auxiliary battery and size of PCB board through modeling.**
- **Thermal design and treatment with heat sink to ensure efficiency of secondary battery which is reduced by heat generation**

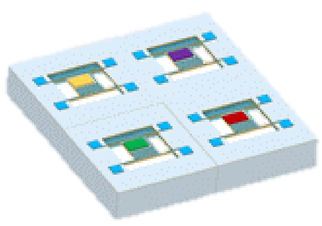
Radioactivity - calorimeter











To develop a simply structured – high sensitive – low powered radiative calorimeter for real – time monitoring of spent nuclear fuel dry storage.

- **Stable operation in high temperature environments**
- **Fabrication of the subminiature radiative calorimeter operated with low power using semiconductor fabrication process**
- **Acquirement stability evaluation method of spent nuclear fuel through the measurement radiative heat energy**
- **Simultaneous measurement in real time of radiative heat energy and temperature storage cask**