기계공학부 대학원 연구실 소개

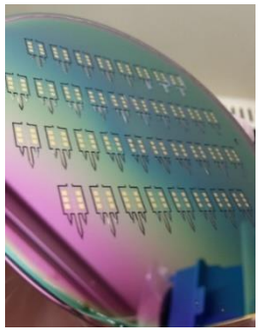
나노마이크로시스템 연구실
담당교수 이정훈 교수

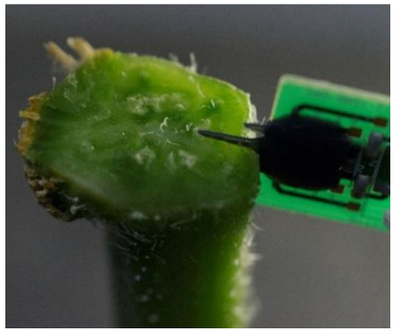
MEMS 공정기술 기반 스마트팜용 센서 및 시스템 연구

Sap flow sensor

Sap flow rate is an immediate response of a plant to the change in the environment. Thus far, application of sensors measuring sap flow rate has been limited to trees due to their large size and invasiveness. Here, we developed a MEMS-based sap flow sensor applicable to small and vulnerable plants.

MEMS fabrication of microneedles

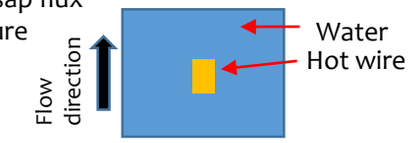




Concept

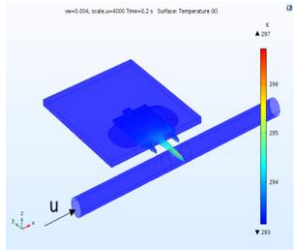
In 1985, Granier derived empirical relationship between sap flux density and temperature difference as follows,

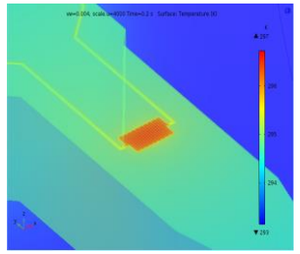
$$u = a \cdot \left(\frac{\Delta T_M - \Delta T}{\Delta T} \right)^b$$



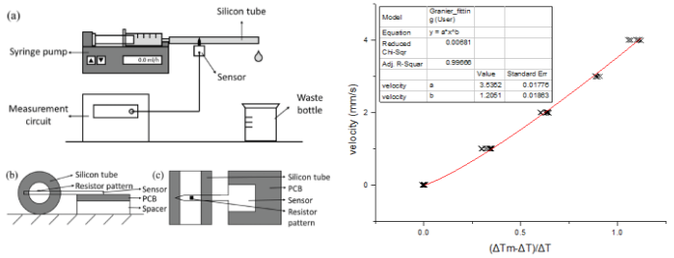
In equilibrium condition

Simulation and design

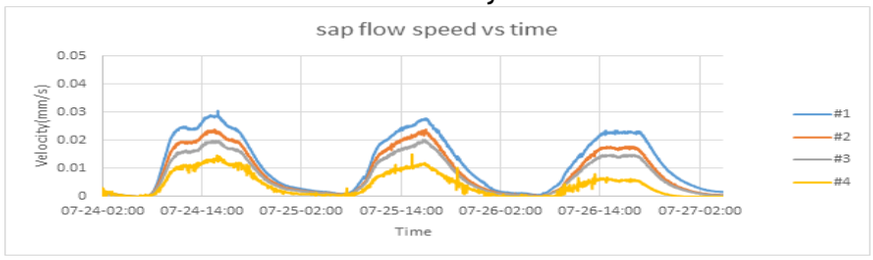




Calibration setup & result



Field test on cherry blossom tree



연구 배경

- MEMS 공정기술을 이용한 식물체 내 수액 속도 측정
- 개발 센서를 이용한 농업 모델 개발

연구 성과

- 식물체 내부 삽입 형 수액 속도 측정 센서 개발 및 상용화
- 측정된 수액 흐름 속도 기반 자동 관개시스템 구현

기계공학부 대학원 연구실 소개

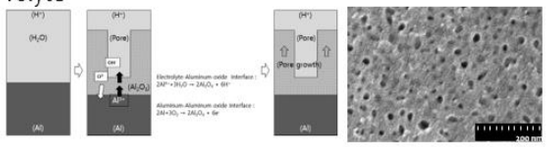
나노마이크로시스템 연구실
담당교수 이정훈 교수

식물체 water potential 측정 센서 및 시스템 개발

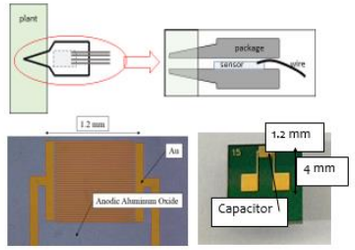
Water potential sensor

Stem water potential is the best measure of plant's hydration relative to growth, yield, and quality. It provides vital information on plant health and helps to decide schedules for irrigation and harvest.
Using nano/micro technology, we are developing a humidity sensor small enough to be inserted in the plant stem, where it can measure stem water potential directly from the xylem in real time.

Pore formation mechanism in acidic elect rolyte

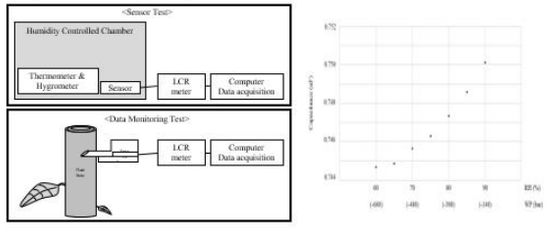


Sensor wire connection and details



RH (%)	WP (MPa)
100	0.0
98	-2.72
90	-14.2
50	-93.5
< 10	< -300

Experimental setup and calibration



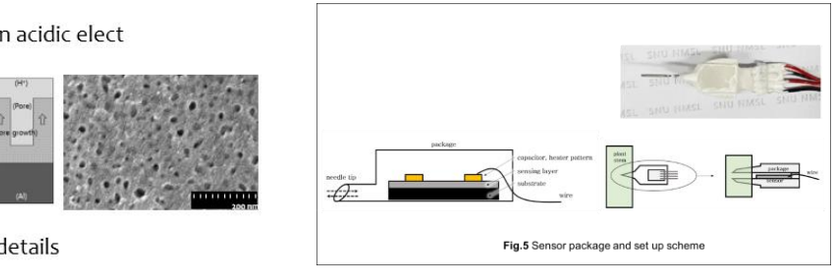
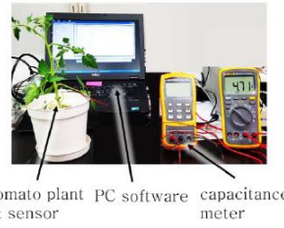
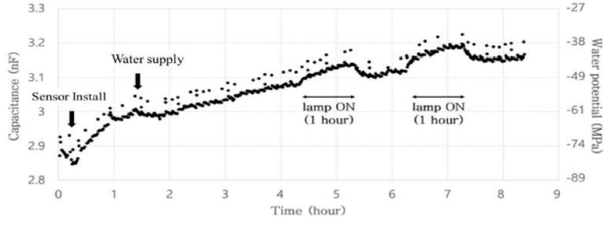


Fig.5 Sensor package and set up scheme





연구 배경

- 식물체의 수분스트레스 확인을 위한 수분 포텐셜 측정의 필요
- 기존 수분 포텐셜 측정 장비는 연속적인 모니터링에 제약이 있음

연구 성과

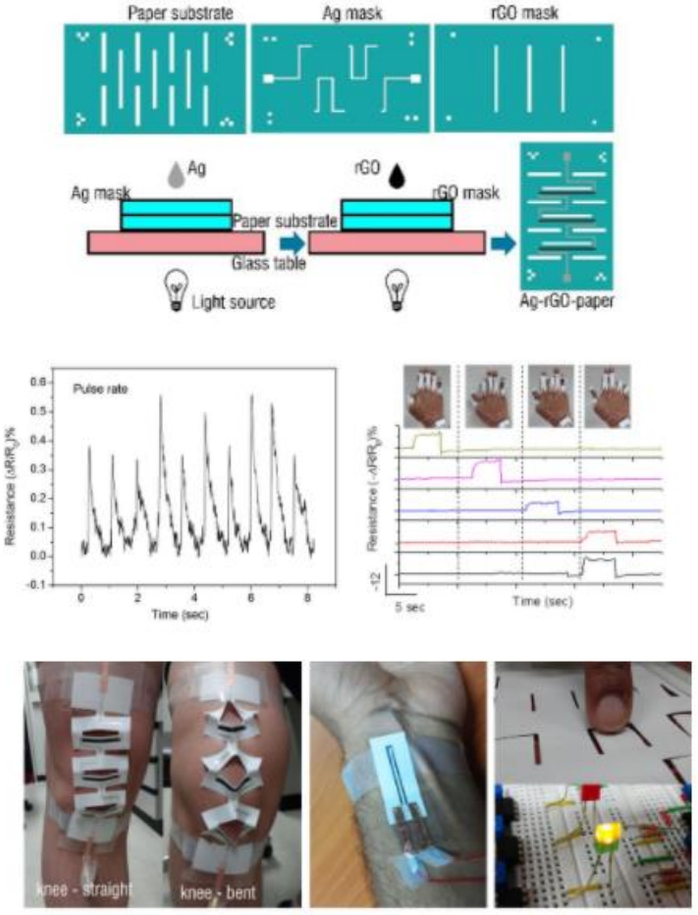
- 시제품 제작 및 장기간 센서 데이터 수집
- 상용 수분 포텐셜 측정 장비와 신호 비교 분석

기계공학부 대학원 연구실 소개

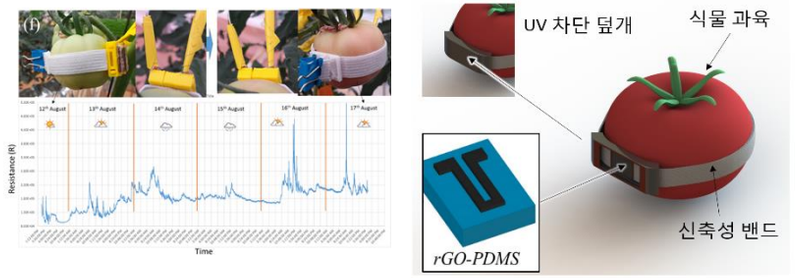
나노마이크로시스템 연구실
담당교수 이정훈 교수

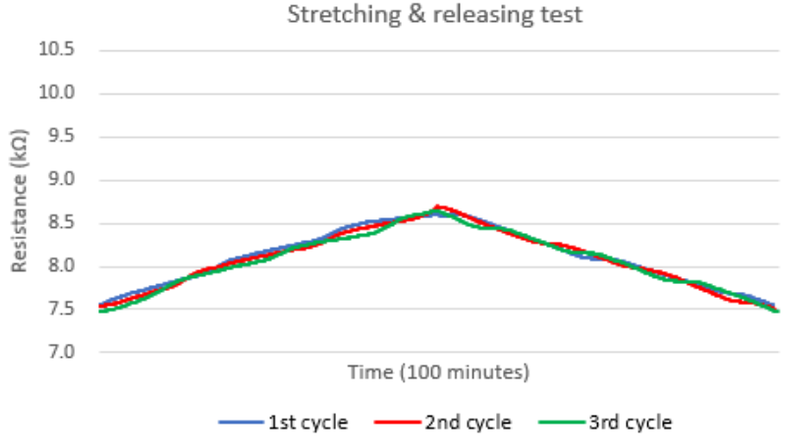
식물 생장 측정을 위한 flexible 소재 patterning 기술 개발

Graphene paper sensor



Dendrometer for plant growth measurement





연구 배경

- 과채류의 생장 및 생육 모델 개발을 위한 flexible 센서의 필요성 대두
- 대량 생산을 위한 저렴한 소재 및 공정 단가를 가지는 센서 개발 필요

연구 성과

- 전도성 물질 (그라핀, 액체류)을 이용한 종이 patterning 기술 개발
- Flexible 소재 기반 전극 패터닝을 통한 벤딩 타입 센서 개발중

기계공학부 대학원 연구실 소개

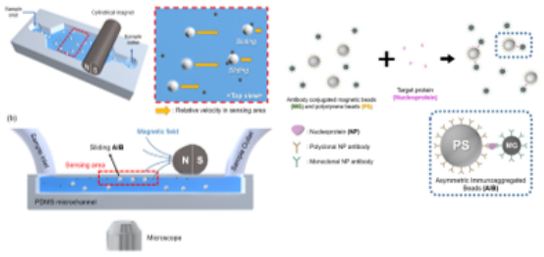
나노마이크로시스템 연구실
담당교수 이정훈 교수

MEMS 공정 기반 Microfluidics 기술 및 Biosensor 관련 기술 연구

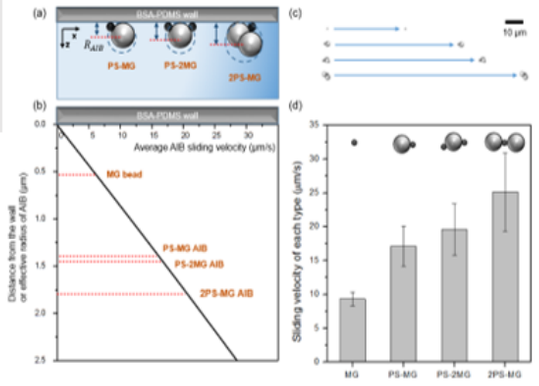
Microfluidics virus detection

Sensitive and quantitative detection of antigens is essential in disease diagnosis, environmental monitoring, and clinical and biological research. We have developed a reusable PDMS microfluidic immunosensor. The sensor utilizes optical and magnetic properties of asymmetric immunoaggregation of nano- and micro-beads for continuous, sensitive and fast detection.

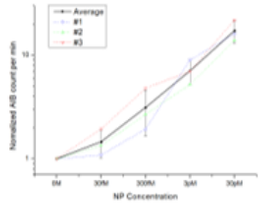
Concept



Analysis of sliding beads in microchannel



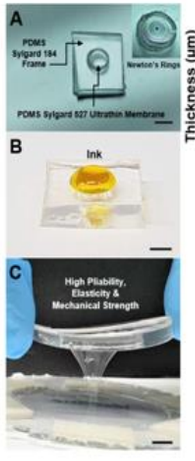
Sensitivity

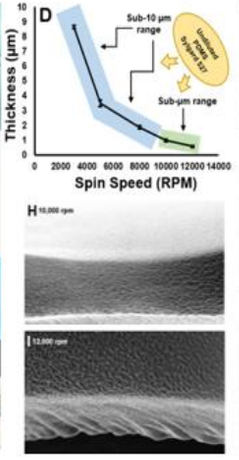


Ultra-thin membrane

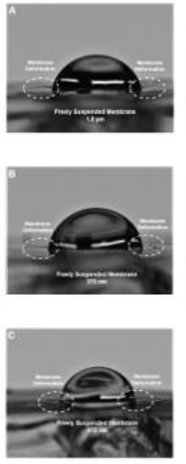
We fabricated a freely suspended ultrathin membrane (FSUM) having physiologically relevant thickness, relatively low elastic modulus similar to that of the vascular basement membrane, and sufficiently large area (~20 mm²) for cell culturing. FSUMs were developed using pure PDMS Sylgard 527 unlike the conventional PDMS Sylgard 184 solvent mixture-based approach. We tested the utility of our FSUMs as a culture substrate and evaluated the temporal cell response to change in compliance of the ultrathin membranes.

Fabrication of ultrathin membrane

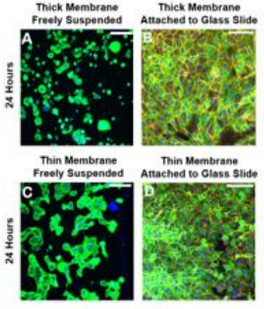




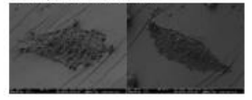
Contact angle test



Cells grown on the membranes



SEM picture of cells



연구 성과

- MEMS fabrication PDMS microchannel 제작을 통한 바이오 센서 개발 연구
- PDMS microchannel 물성 분석 및 세포 배양 특성 연구