나노 기술의 이해
(Understanding Nanotechnology)

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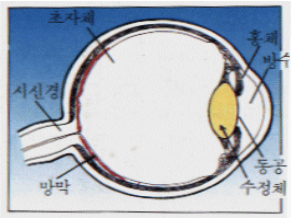
School of Mechanical and Aerospace Engineering
Seoul National University

Lecture 11. Nanotechnology applications (1)

Biomimetics

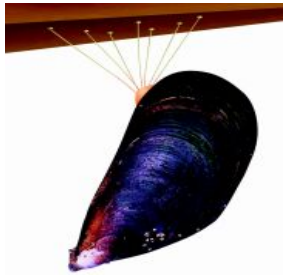
자연으로부터 배우기

눈의 구조



카메라

상어피부 돌기구조



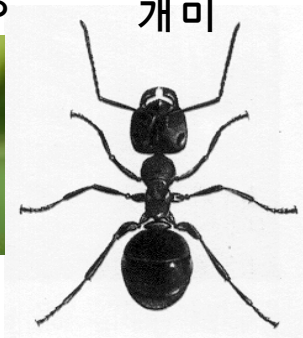
홍합 단백질 이용 접착제

엉겅퀴 씨앗

벨크로 테이프

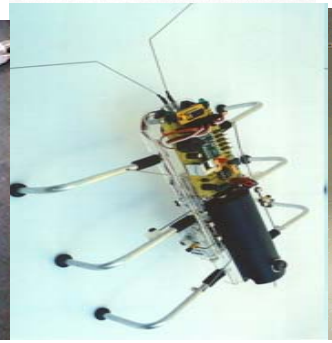
딱정벌레 껍질응용

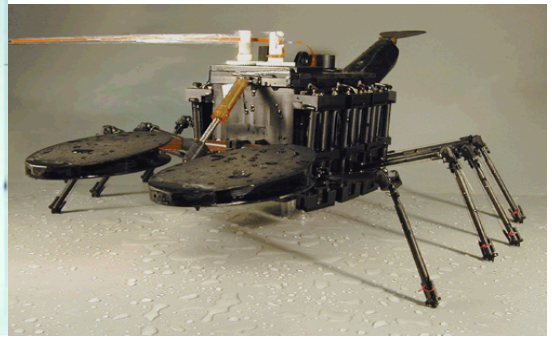
개미



자벌레

최적화된 구조와 기능

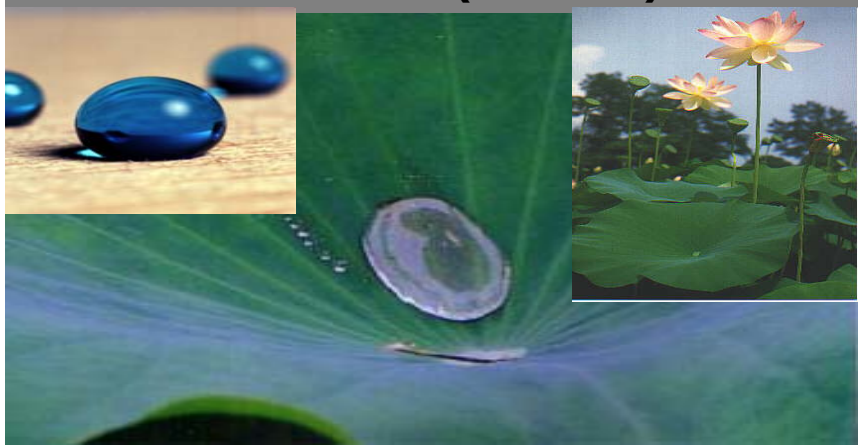




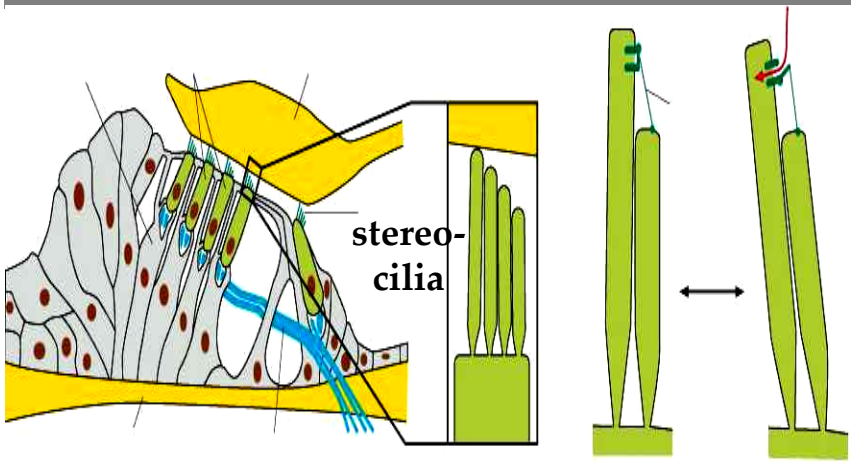
자연계의 나노구조 응용

Nano Hair (접착기능)

Nano Turf (자정기능)



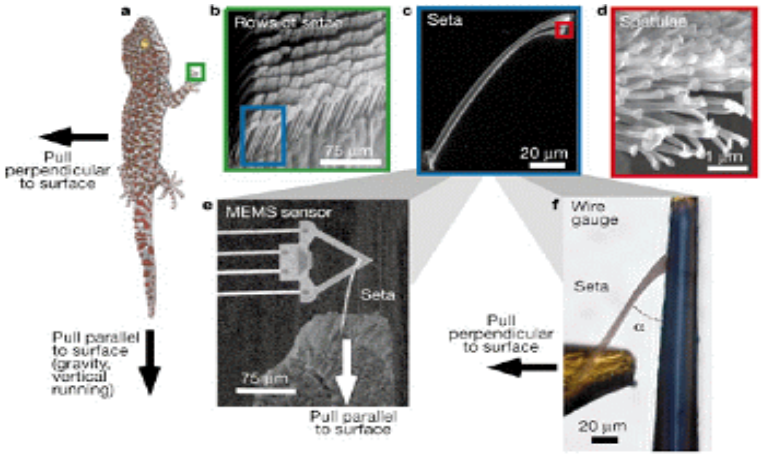
Nano Cilia (센싱기능)

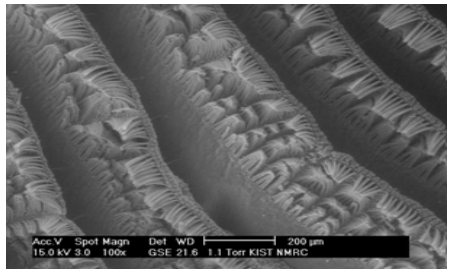


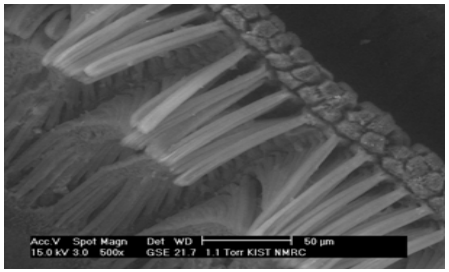
Nano Cilia (이동기능)

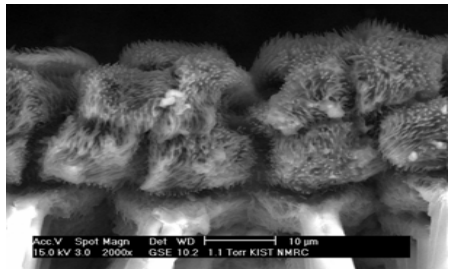
연구 동향 : Nano Hair

Tokay Gecko Foot-Hair





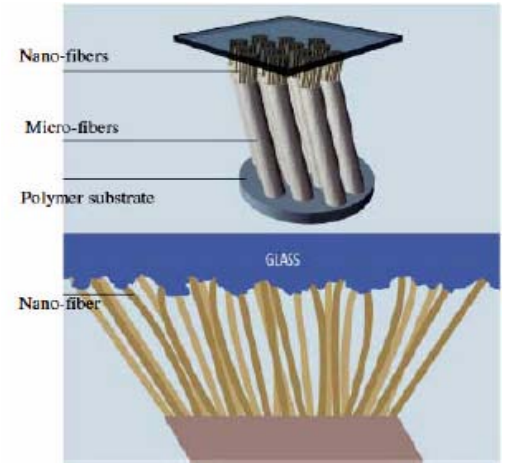


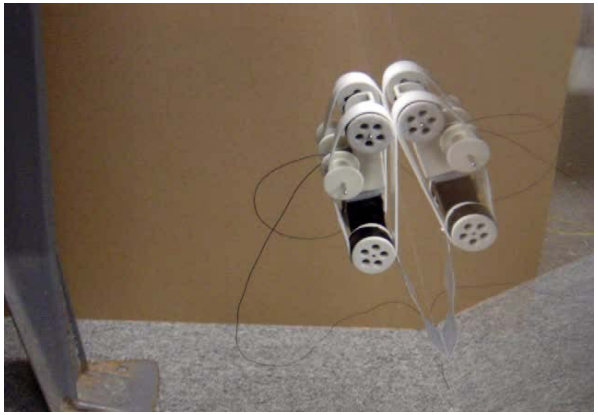


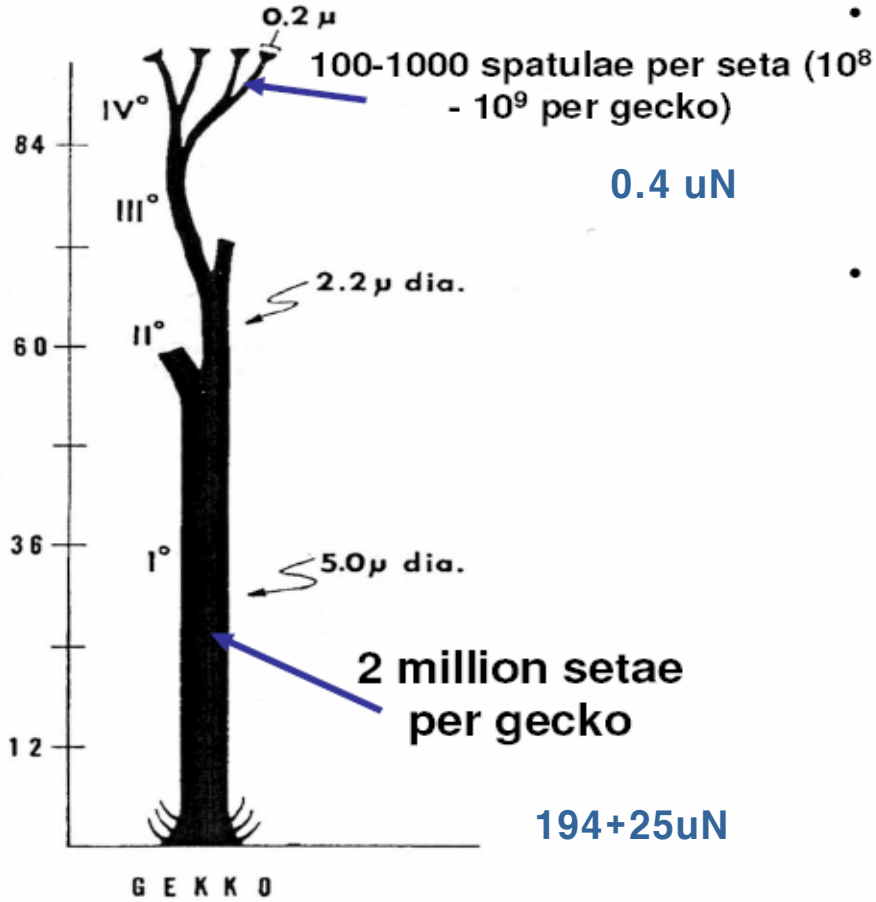
- 중력 방향에 제한 받지 않고 이동하는 원리 검증을 위한 연구
- 구조 및 형상 측정
- Adhesion force 측정

연구 동향 : Nano Hair

Tokay Gecko Foot-Hair

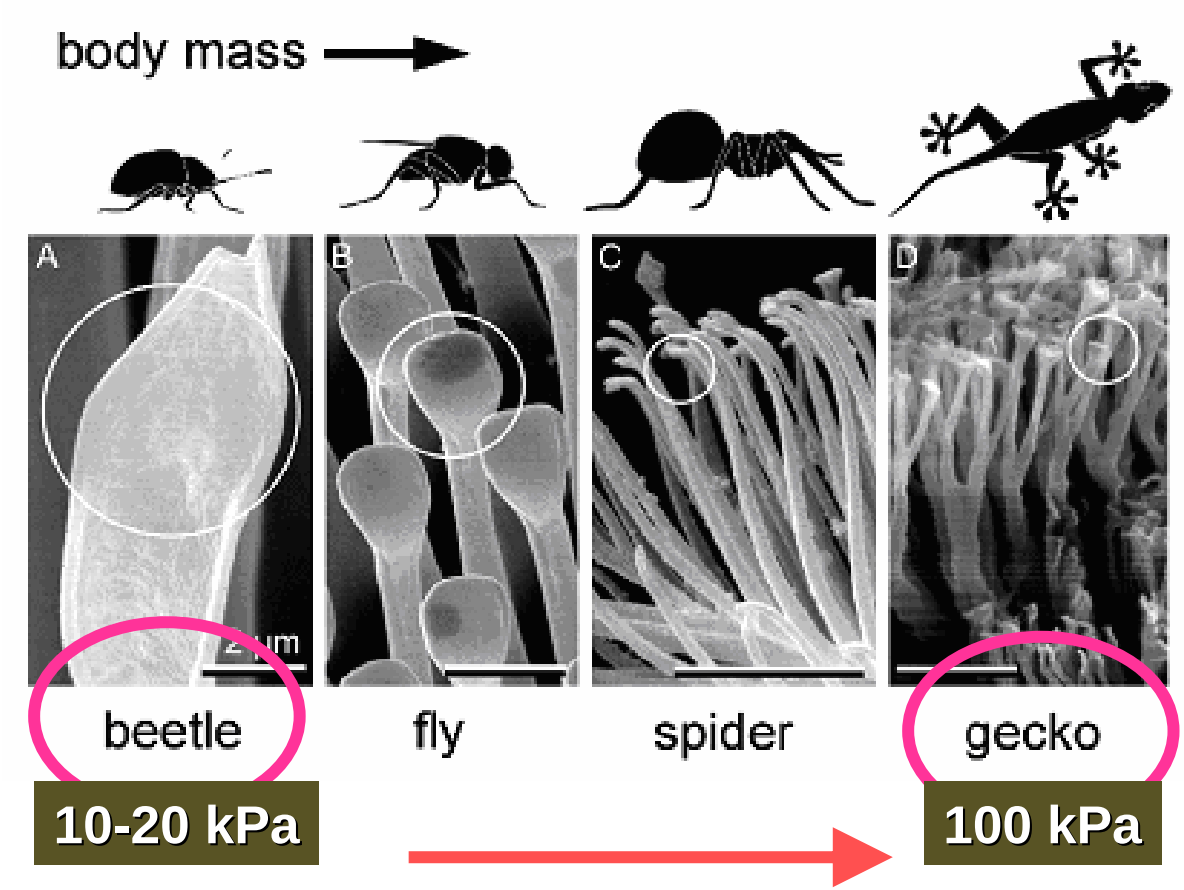






연구 동향 : Nano Hair

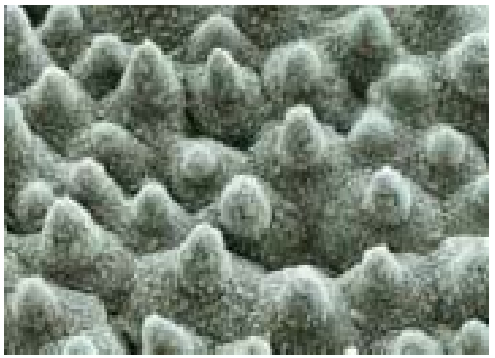
Micro / Nano-Fibrillar Structures as Adhesives for Various Animals

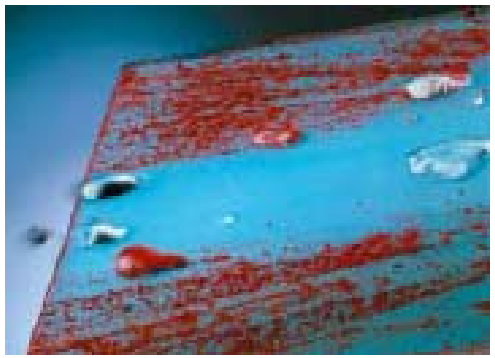


Higher hair density with smaller diameter

연구 동향 : Nano Turf

Lotus Leaf

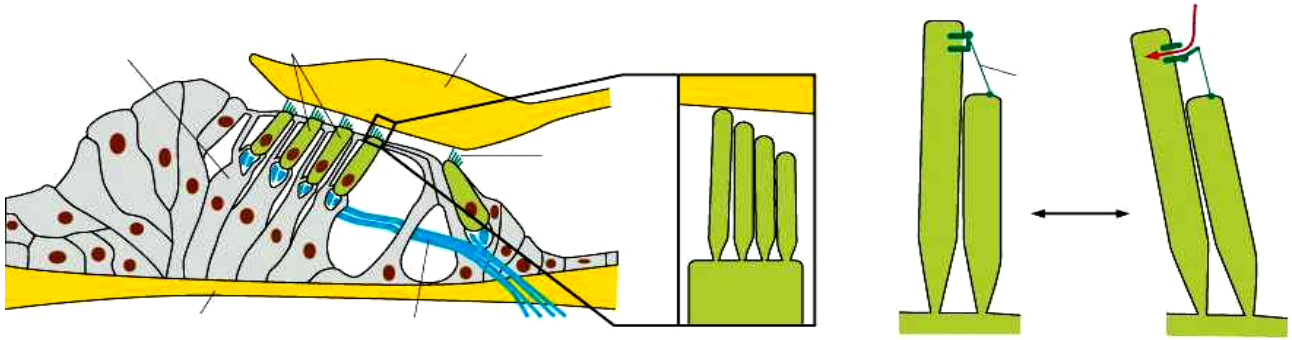




- Super Hydrophobic, Self-Cleaning
- Lotus-Effect
- Applications : Self Cleaning Flat Glass, 방수 넥타이

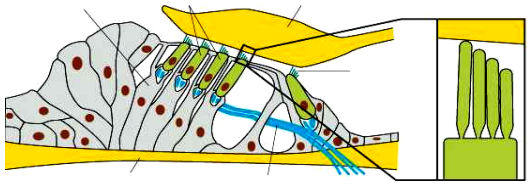
연구 동향 : Nano-Cilia

Stereo cilia



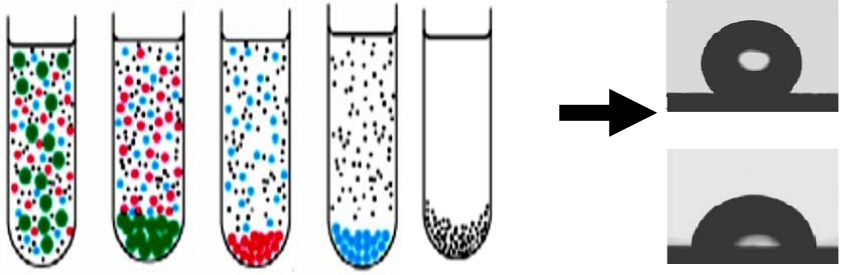
- 내이(耳), 물고기의 옆선, Hydra / Jellyfish , 동물의 전정기관
- Advantages : Extreme sensitivity, Compact, Directional Sensitivity,
- Applications : Acoustic/Flow/Tactile Sensor, Directional Hearing Aids

자연 나노 섬모 모사

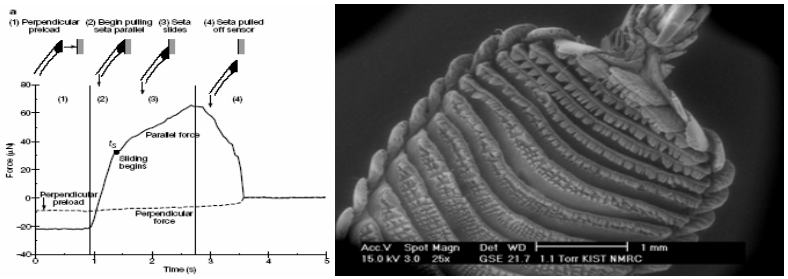


자연섬모의 기능 이해 및 관련 물성 해석

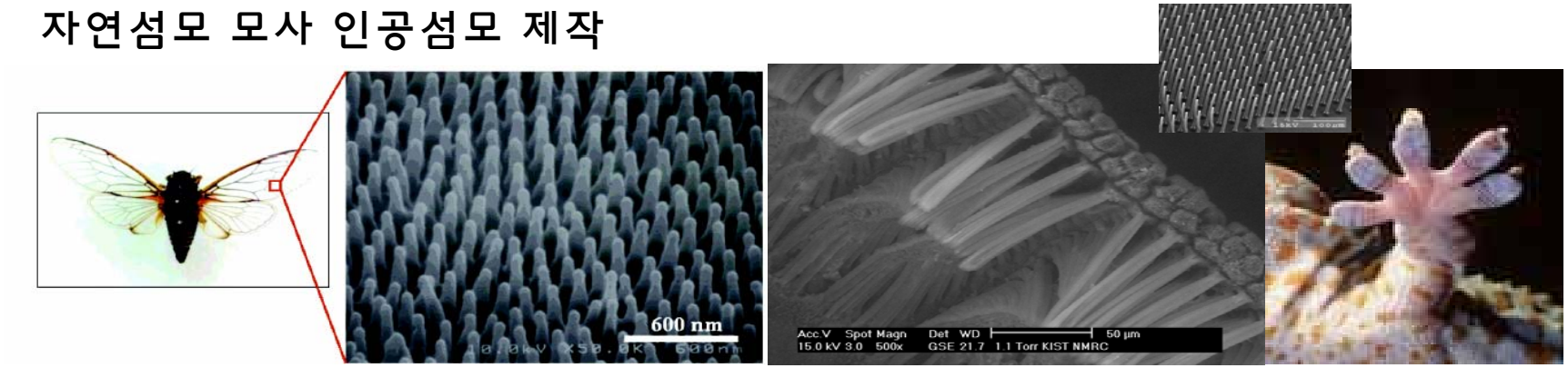
자연섬모 샘플링 및 배양



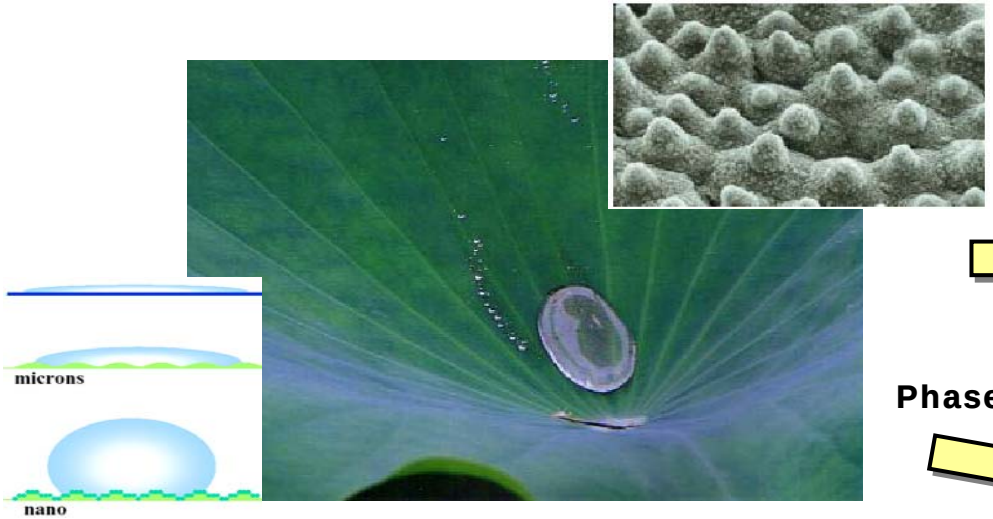
자연섬모 형상 및 물성값 측정



자연섬모 모사 인공섬모 제작



Bottom-up 방식을 이용한 연꽃잎 모사



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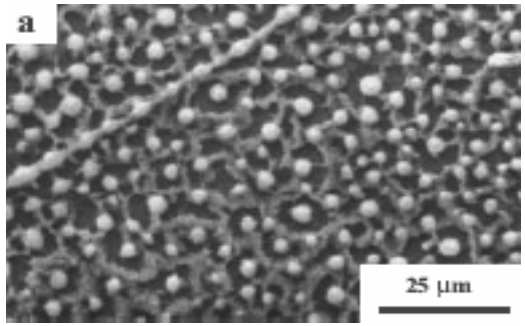
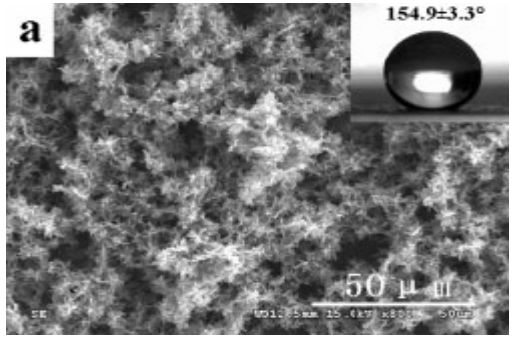


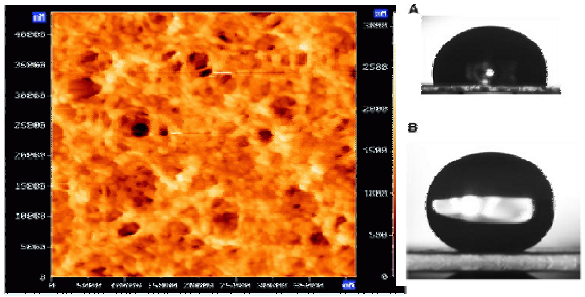
Adv. Mater. (2002)

Phase Separation



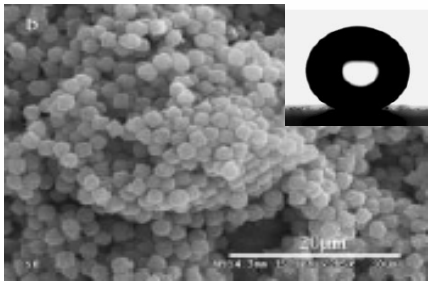
Macro. Rapid Comm. (2005)

Rapid solvent evaporation



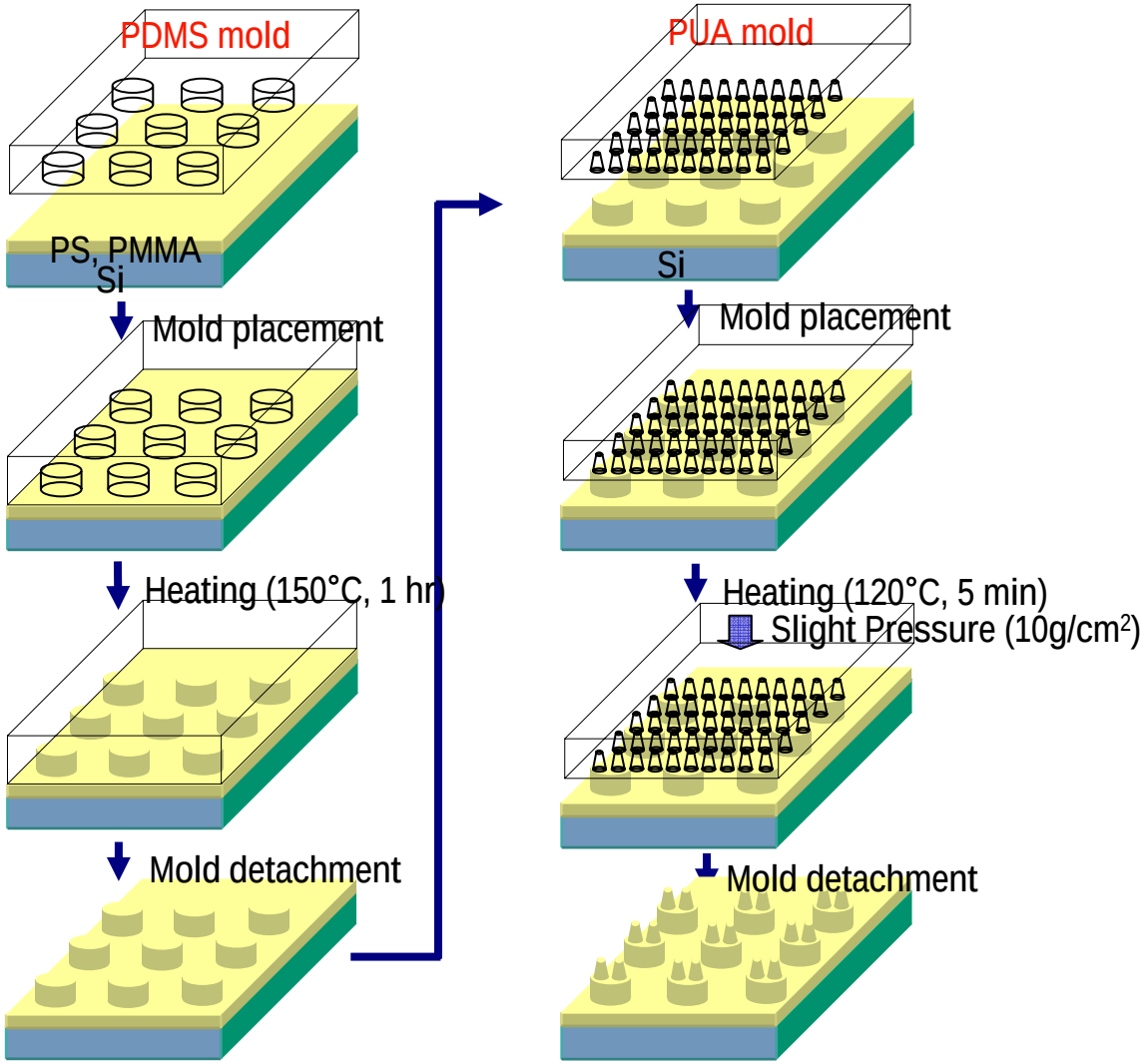
Science (2003)

Micelle aggregation



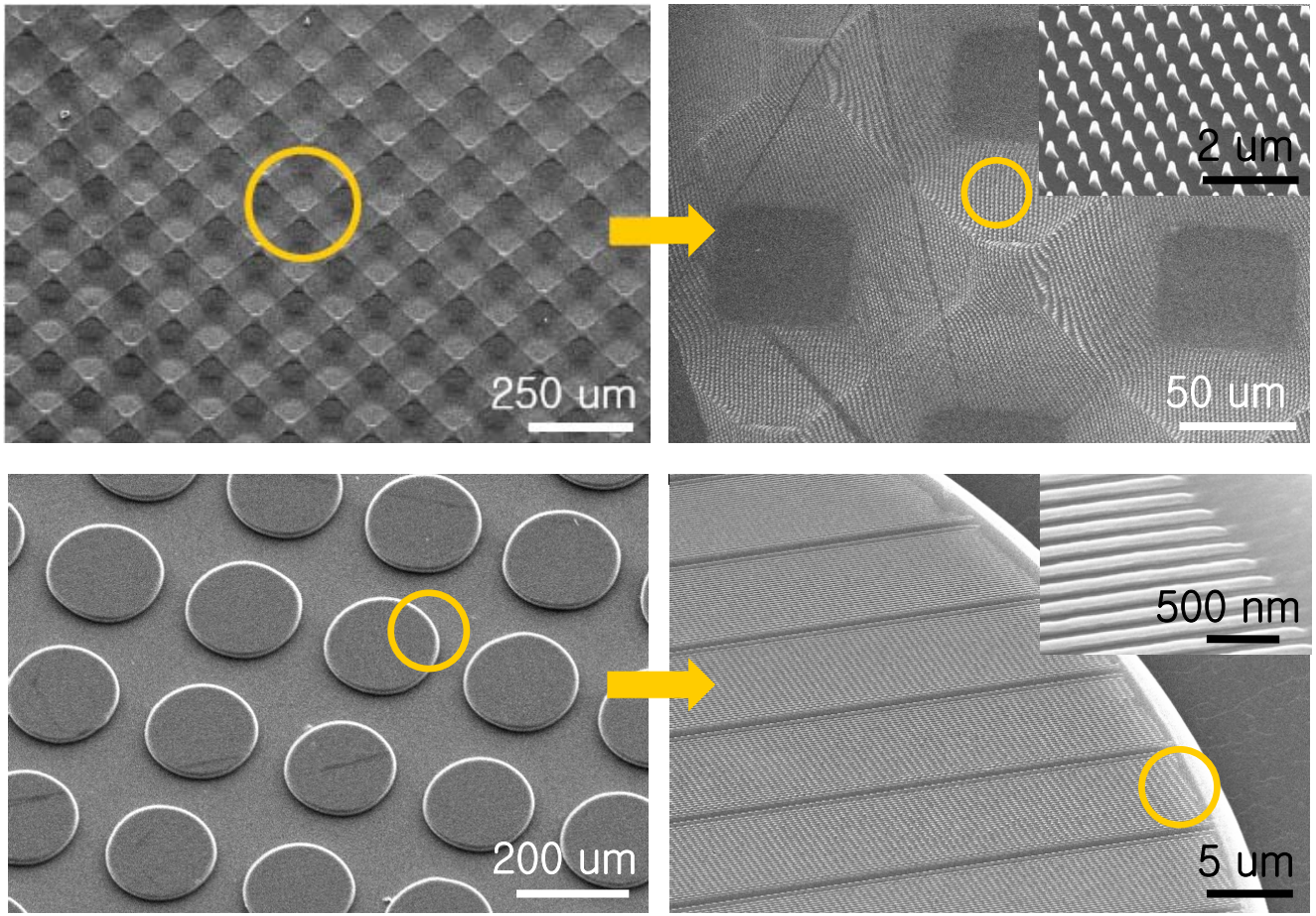
Adv. Mater. (2004)

Top-down 방식을 이용한 연꽃잎 모사

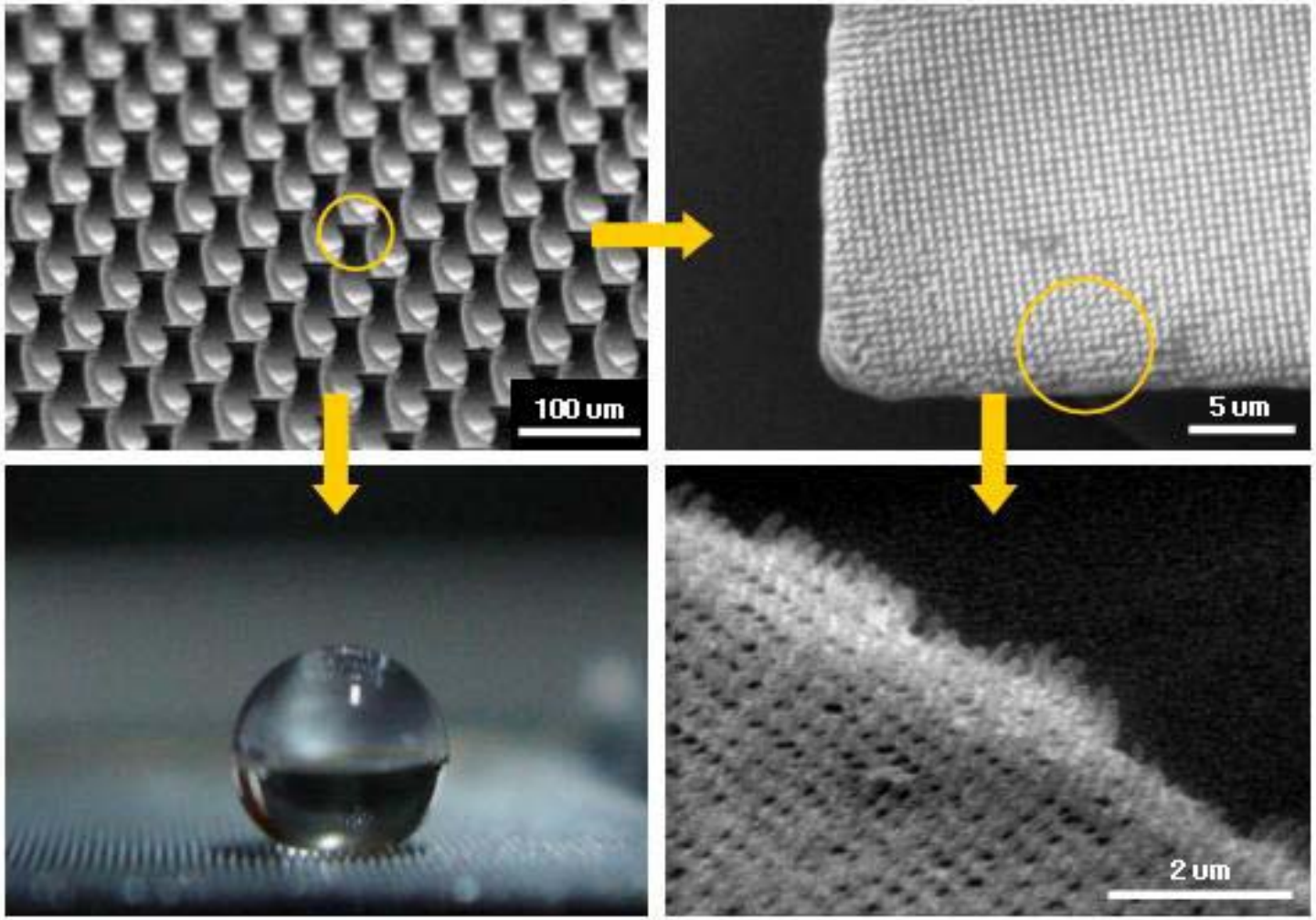


결과

다양한 마이크로/나노 구조의 계층적 구조

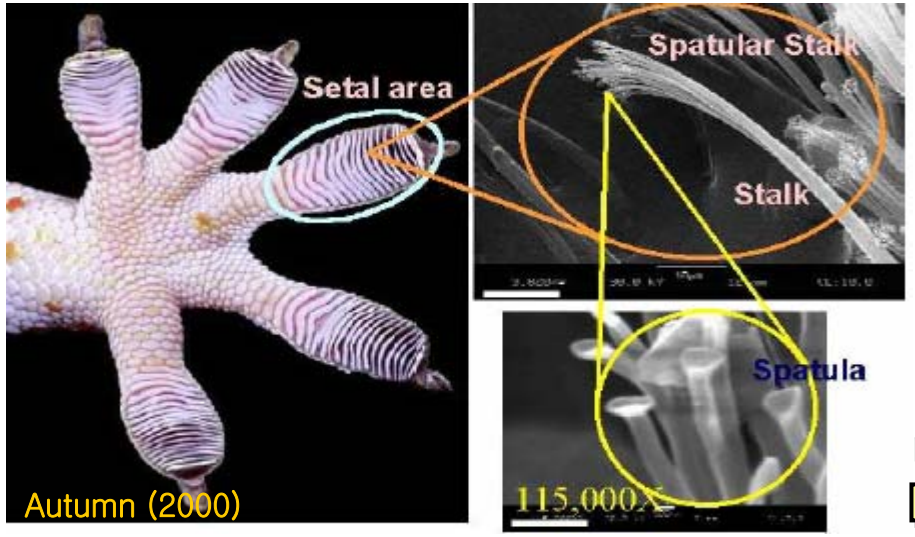


고분자를 이용한 초발수 표면 만들기

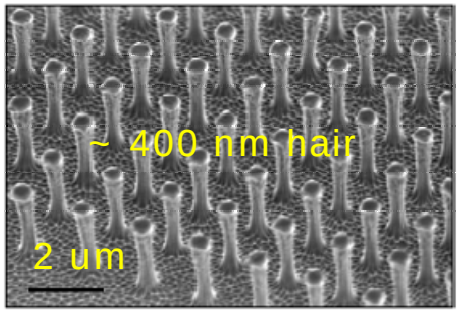


게코 발바닥 모사를 위한 이전 연구들

- gecko's foot (nanohair) : high aspect ratio nanostructures

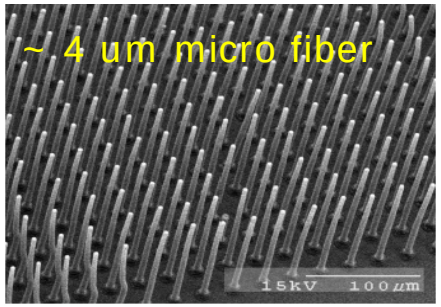


E-beam litho



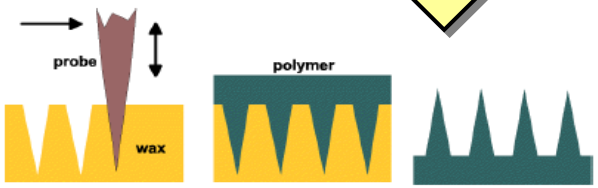
Nature Materials (2003)

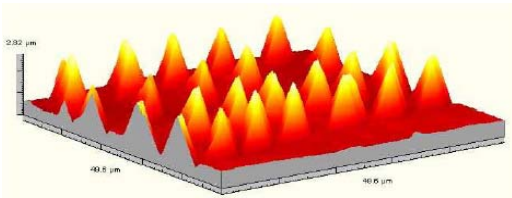
photolitho



M. Sitti, ROBIO (2004)

AFM litho

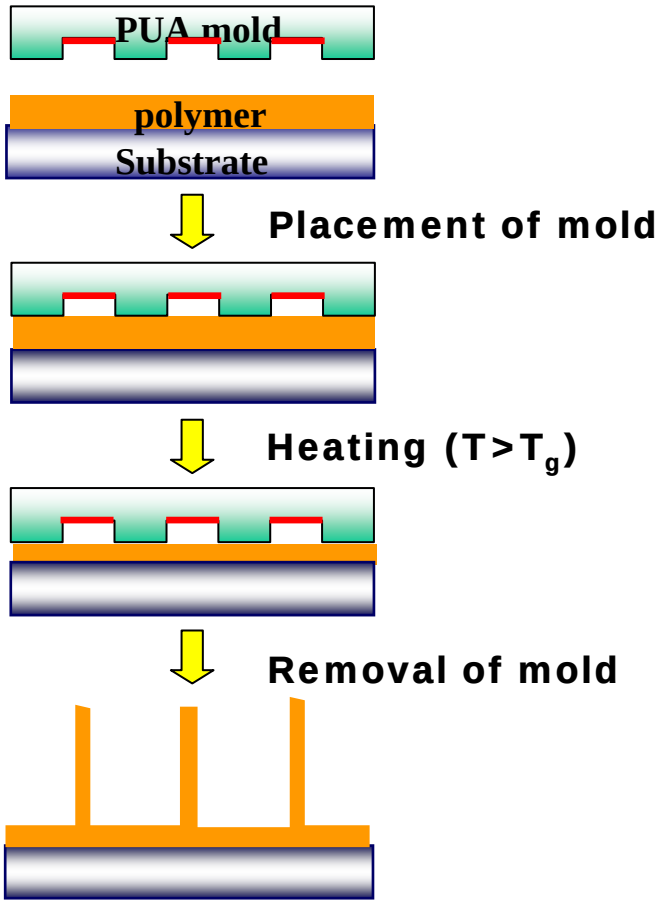




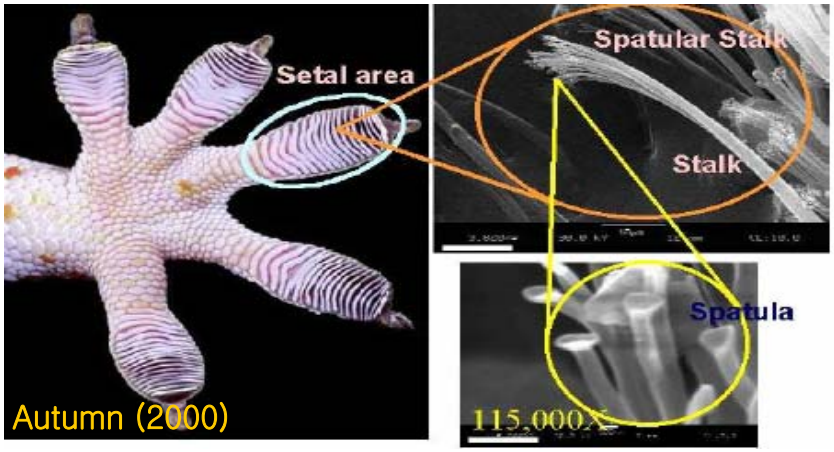
M. Sitti, Journal of Adhesion Science and Technology (2004)

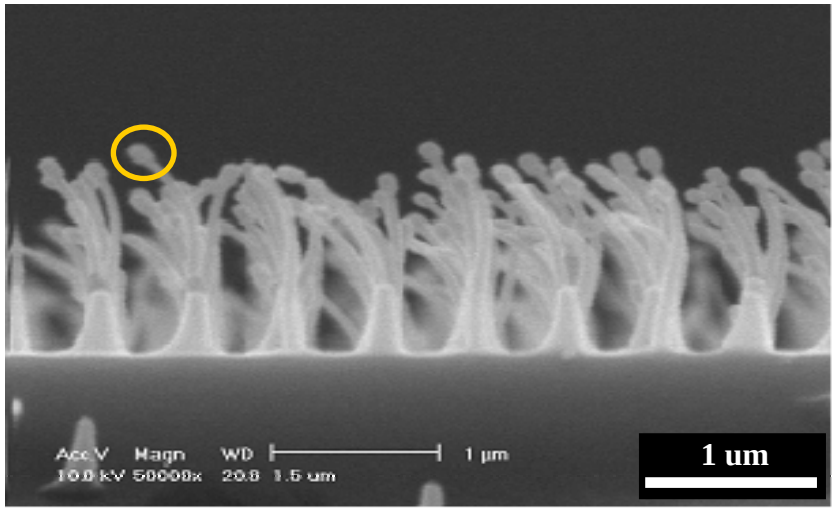
Mimicking gecko's foot : our approach

High aspect ratio nano structures (Nano-hair)

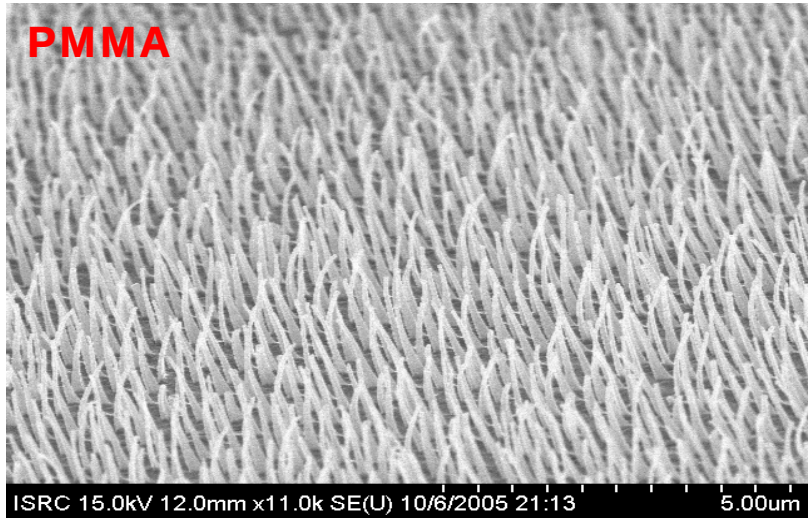


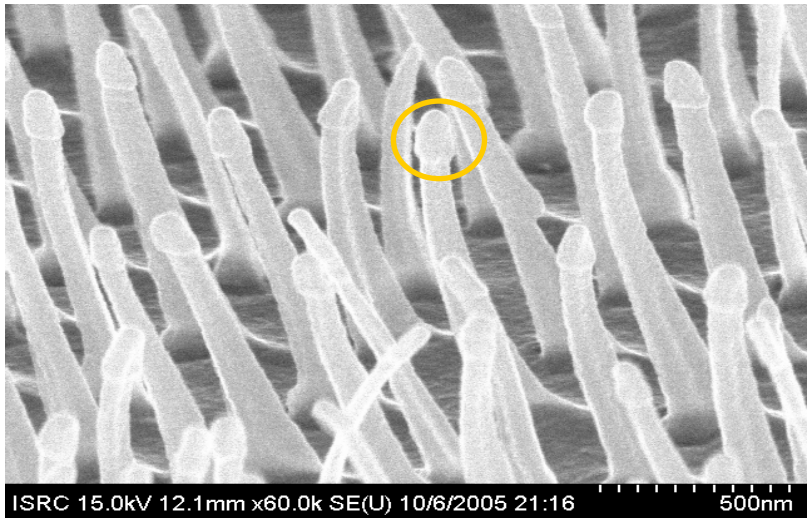
(Nanodrawing)

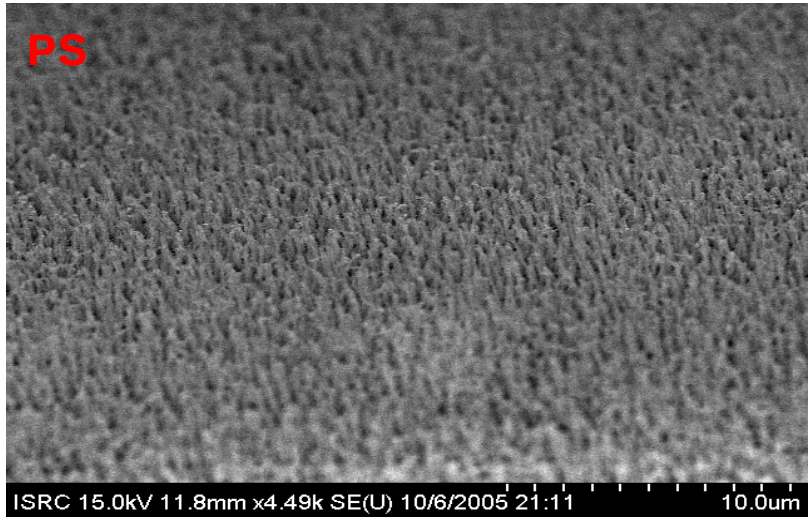


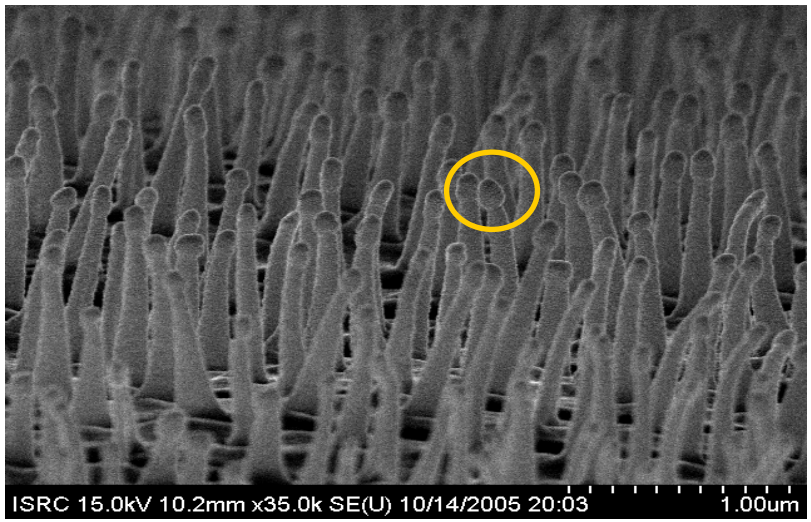


Results (on PET Substrate)

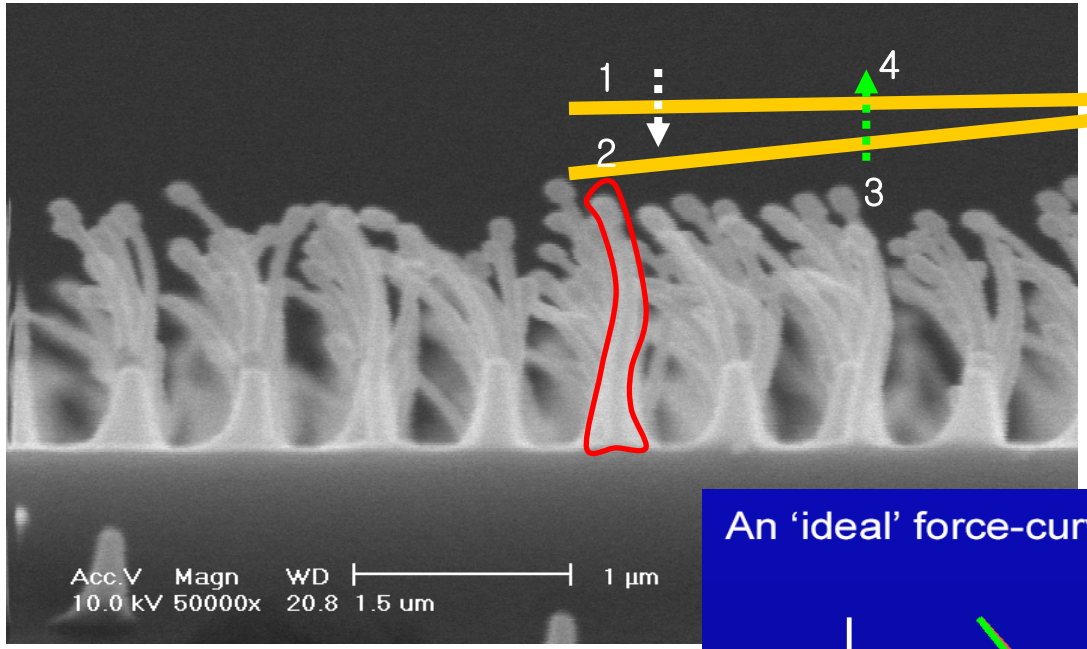




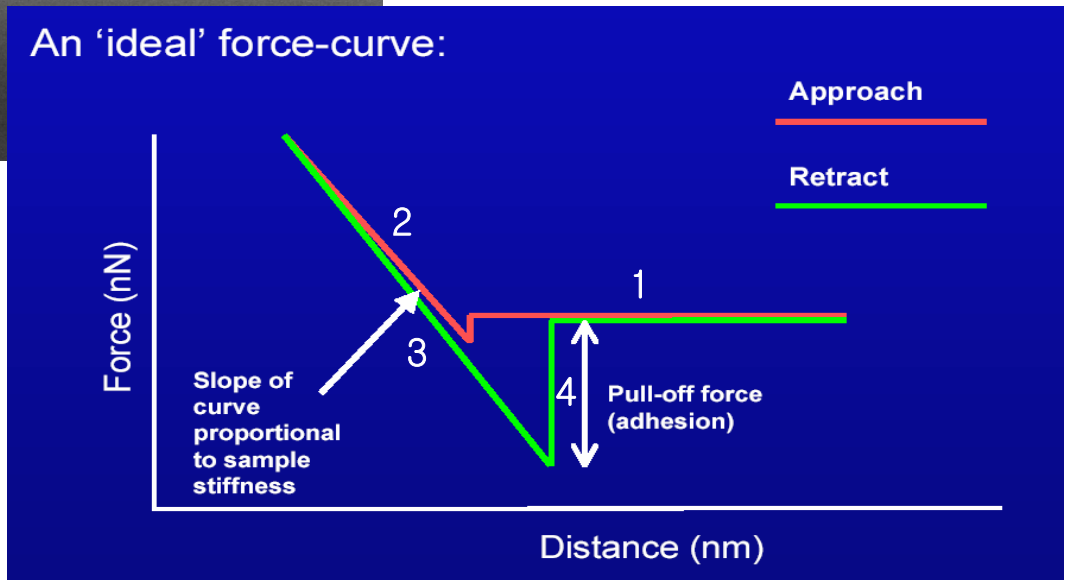




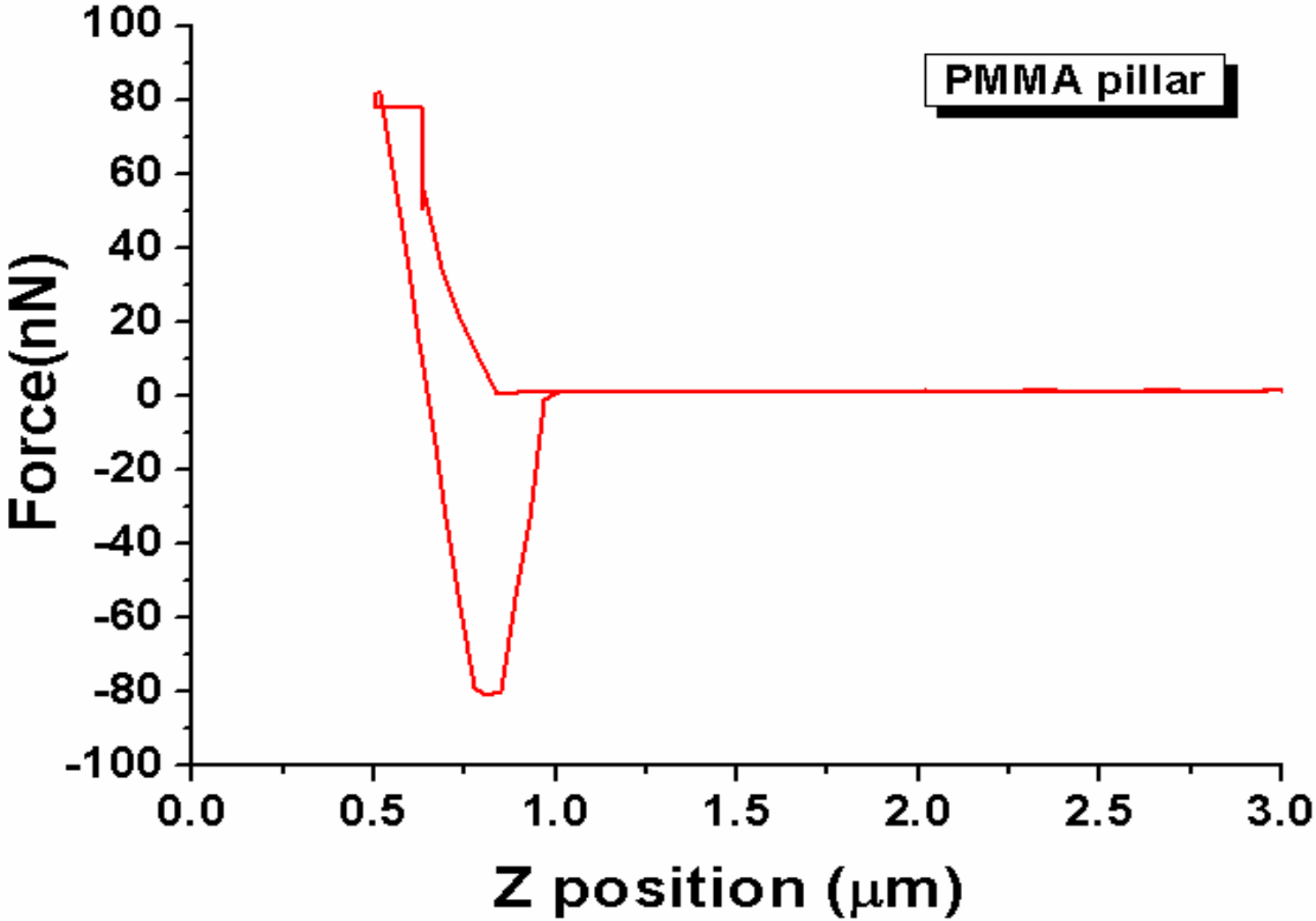
Adhesive force measurement using AFM



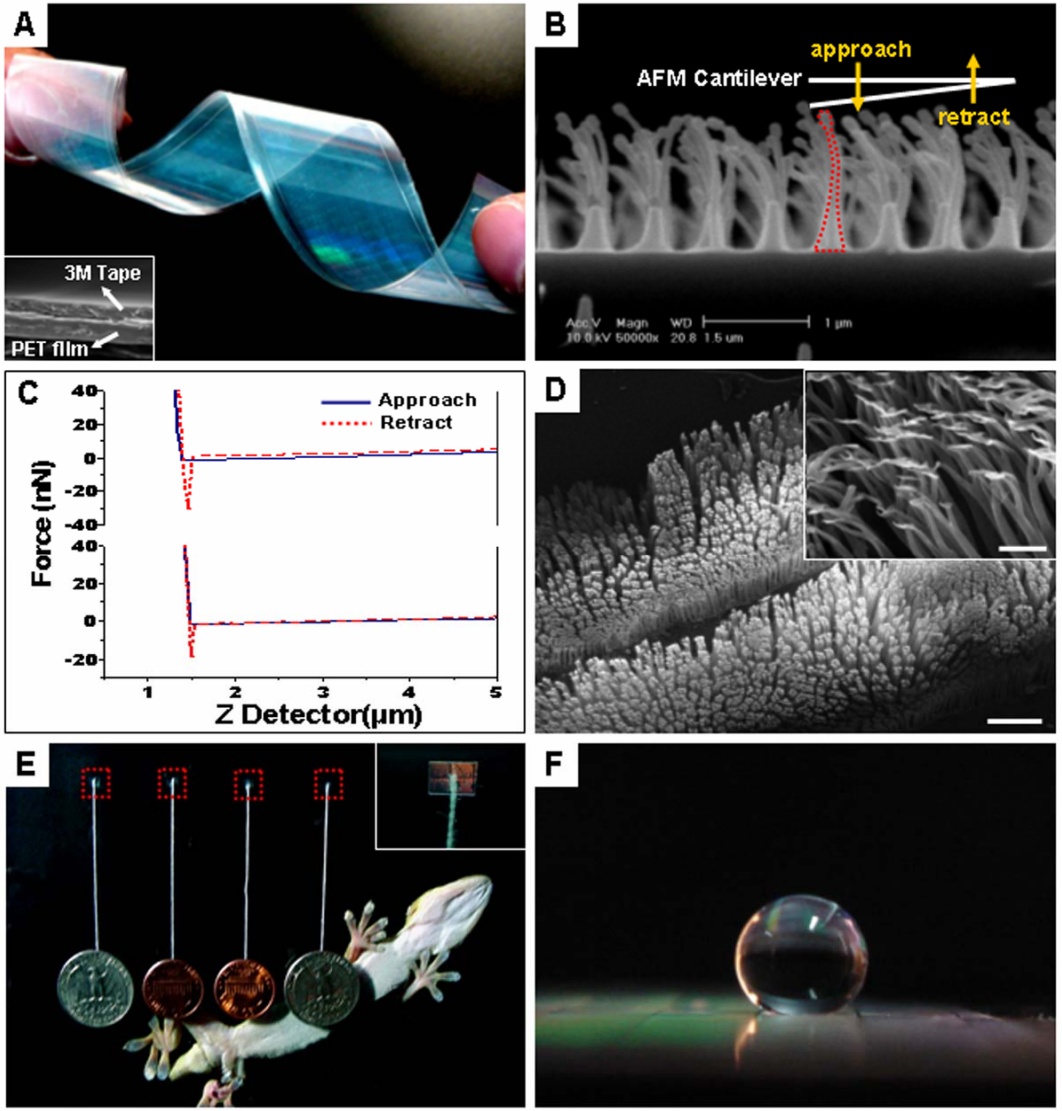
AFM Cantilever



TEST results



TEST results



Average load: ~ 4 N/cm²

cf. gecko: < 10 N/cm²

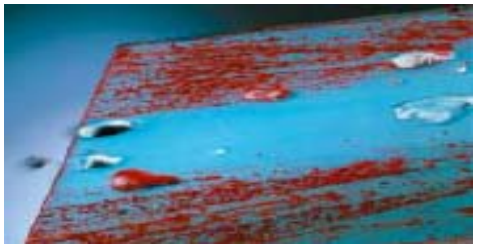
Output Images

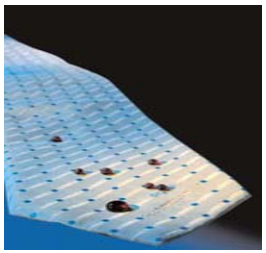
Gecko Nano-Hair

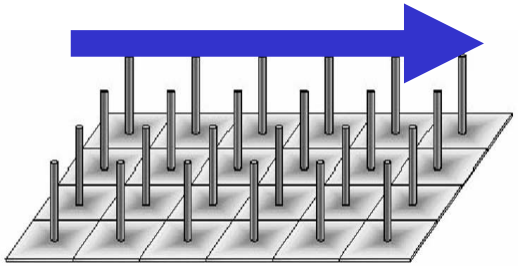
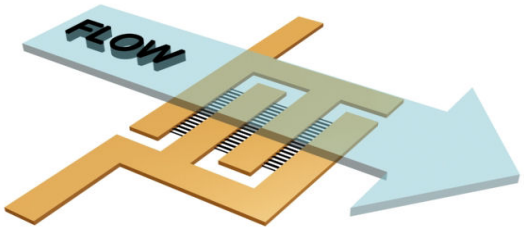
Mobile Robot Mechanism
& Spiderman
➔ Attach/Detach

Nano-Turf

Self-Cleaning Glass
Car Application
Textile Application
Low Flow Friction Surface





Stereocilia

Acoustic Sensor
Flow Sensor
Tactile Sensor