



21C Frontier R&D Program
Ministry of Science and Technology

Overview of Nanoscale Mechatronics & Manufacturing Technology in KOREA



Korea - U.S Nano Forum

2003. 10. 14 ~ 15

S. R. Lee



Center for Nanoscale Mechatronics & Manufacturing (CNMM)
[http:// www.nanomecca.re.kr](http://www.nanomecca.re.kr)



Center for Nanoscale Mechatronics & Manufacturing (CNMM)

Contents



Technology Definition



Introduction of CNMM Program



R&D Results for the 1st year



Closing Remarks

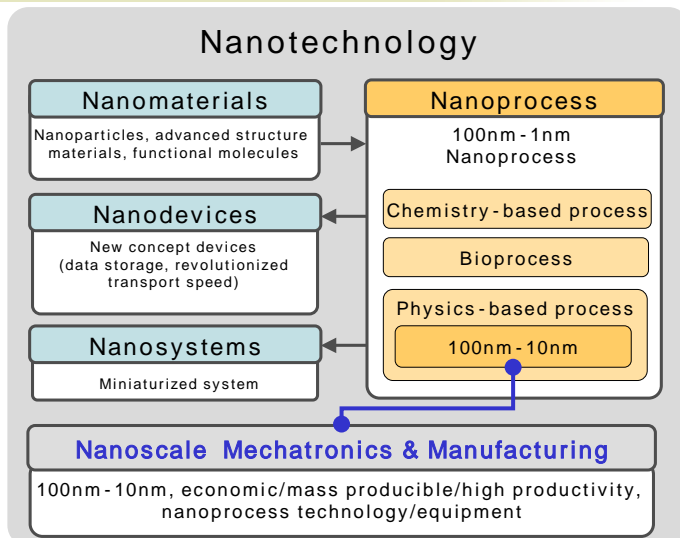




Technology Definition

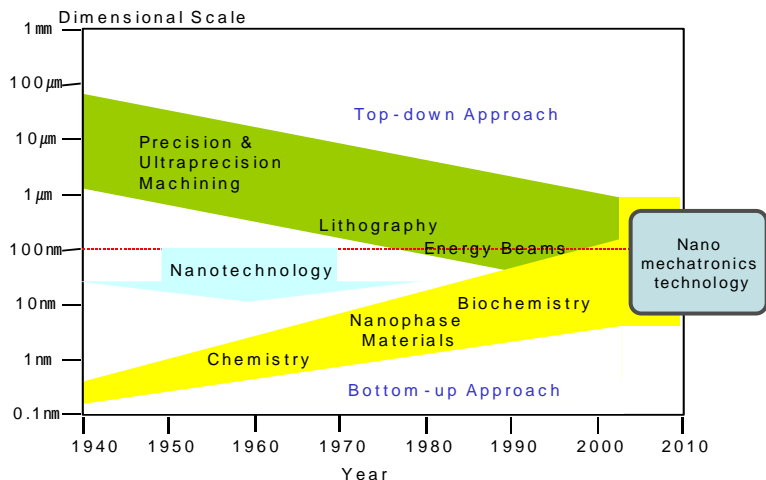


Definition





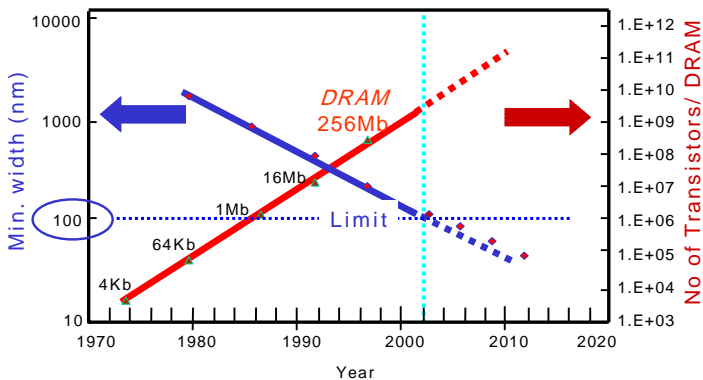
R&D scope for Nanomechatronics Tech.



Roger, "Nanotechnology", Ingenia, 2001



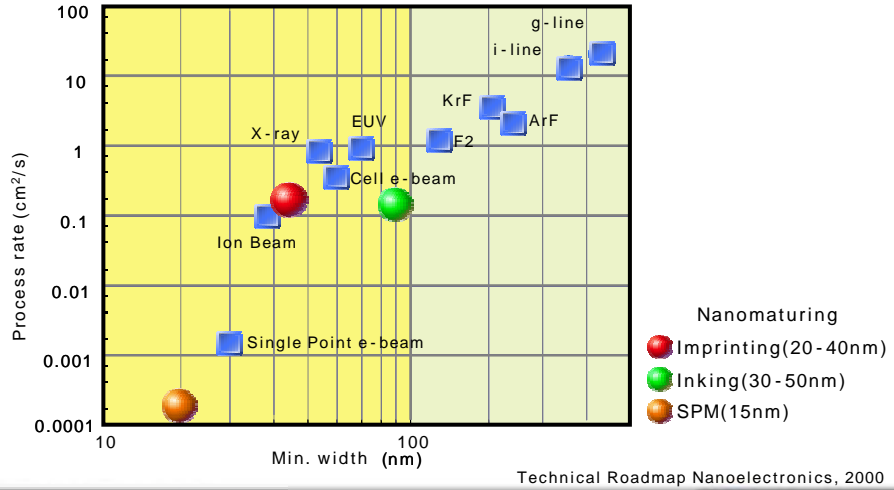
Cont'd



Christie, "From Microelectronics to Nanoelectronics", DARPA Tech 2000

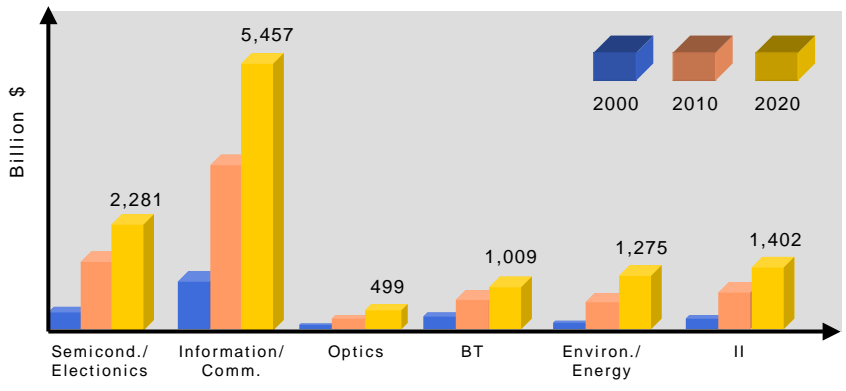
Cont'd

■ Current technology



Market Prediction

■ 7.7% increase every year, and reaches about 7.7 trillion \$ (at 2010)



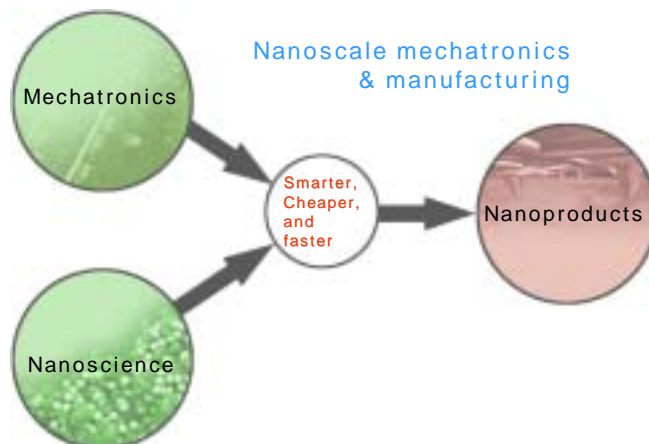


Introduction of Program



Outline

The development of nanoscale mechatronics and manufacturing process/equipments for the industrialization of nanotechnology





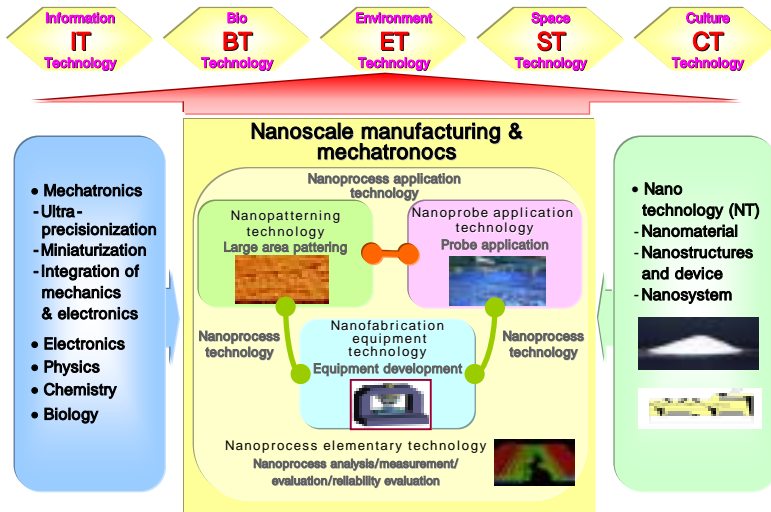
Objectives

To develop technologies on nanoproceses, nanofabrication equipments, and nanoscale analysis/design/control/measurement to manufacture commercial nanoproducts smarter, cheaper, and faster

- Fabricating 2D/3D shapes composed of 100-10nm level nanowire, dot, and structure
- Fully 3D shape nanofabrication
- Nano-applications (Nano-wireless communication parts and Nano-biosensors etc.)
- 5nm level 3D fabrication equipment
- Analysis/control/measurement of nanostructures

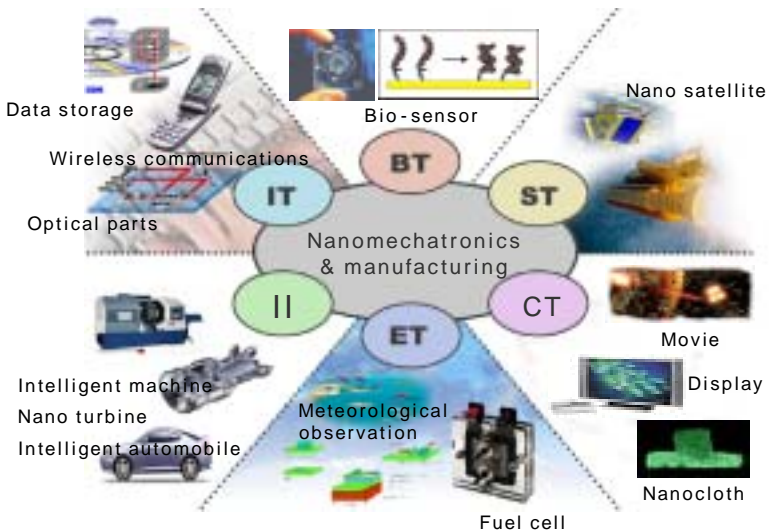


Implementation system

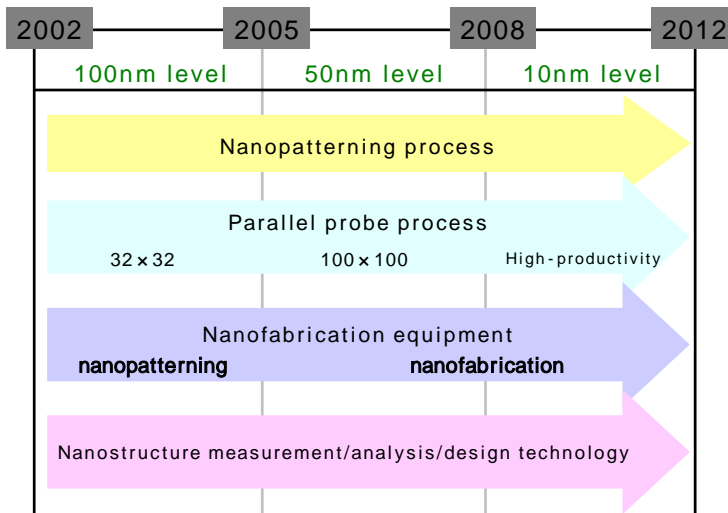




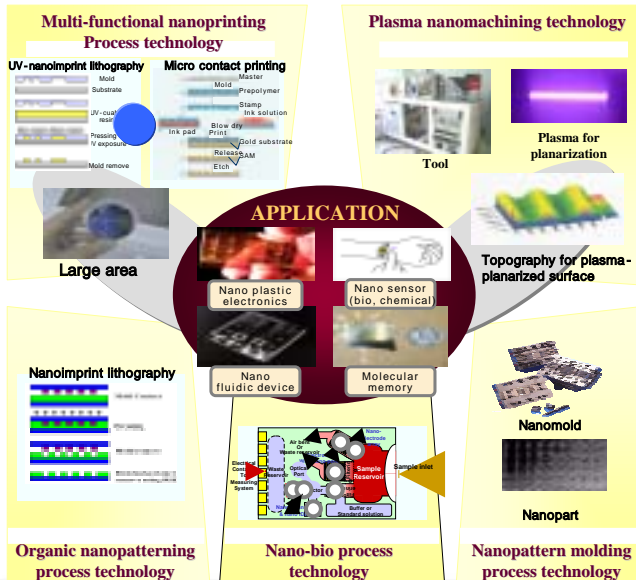
Applications



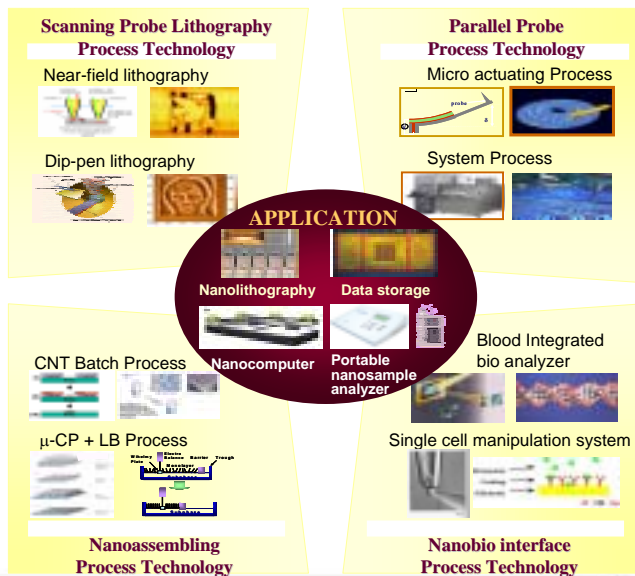
Technology roadmap

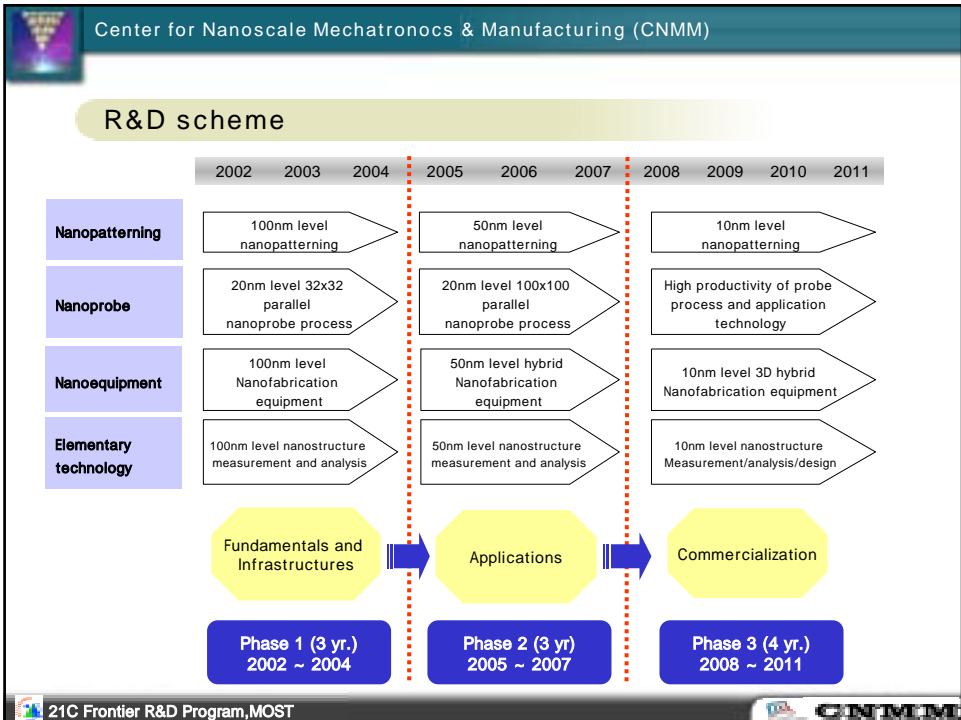


Nanopatterning process technology



Nanoprobe Application Technology





Center for Nanoscale Mechatronics & Manufacturing (CNMM)

Major R&D Projects for the 1st phase

Nanopatterning process technology	<ul style="list-style-type: none"> • Multi-functional nanoprinting process technology • Plasma nanomachining process • Development of organic thin films • Development of process technique for medical nanoscale blood analysis system • Replication process technology of nanopatterns
Nanoprobe application technology	<ul style="list-style-type: none"> • Development of nanoprobe process • Nanocomponent assembly and parallel probe technology • Nanointerface process technology
Nanoprocess equipment technology	<ul style="list-style-type: none"> • Development of the nanopatterning equipment technology • Nanodrive and control technology
Nanoprocess elementary technology	<ul style="list-style-type: none"> • Analysis simulation technology for nanomanufacturing process • The measurement and evaluation technology of nanoscale materials properties for nanoprocess

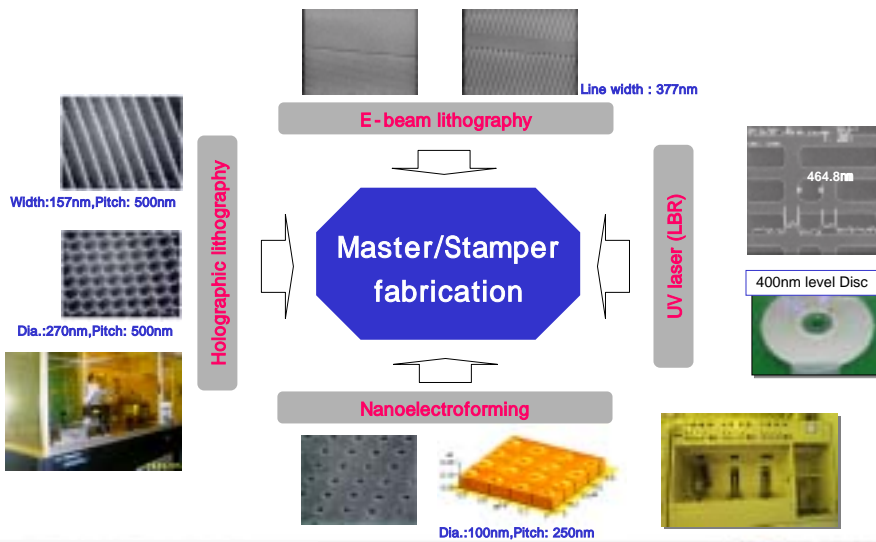
21C Frontier R&D Program, MOST



R&D Results for the 1st year



Nanopatterning process technology

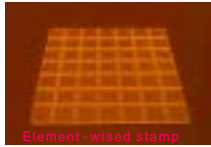




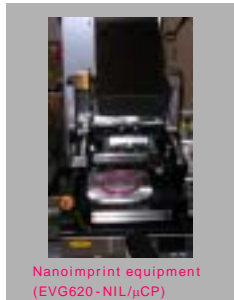
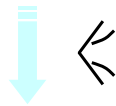
Nanopatterning process technology

Results of Pattern Transfer

1. UV Imprinting



Element-wise stamp

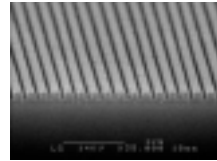


Nanoinprint equipment (EVG620-NIL/μCP)



TSR820 UV Curable polymer
Si wafer

2. Grating pattern transfer by Thermal imprinting



200nm grating pattern on mri-8020 polymer



Nanopatterning process technology

Results of Pattern Transfer

3. Contact Printing



Printed line

- Coating of Au on Cr-coated Si wafer
- Printing process using PDMS stamp
- Achieve 400nm nanopatterns after Au etching

4. Thin Film Printing



- Line straightness: $\pm 2\mu\text{m}$
- Circle: $5\mu\text{m}$
- Line width: $10\mu\text{m}$
- Depth: $0.5\mu\text{m} - 5\mu\text{m}$

Master Pattern

-Off-set printing of PR on Cu substrate

5. Nanomolding



Hole pattern (200nm dia.)



Pillar pattern (100nm dia.)



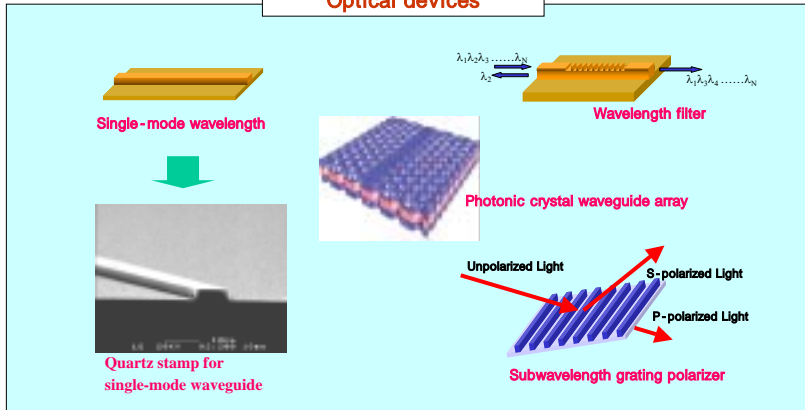
Nanomolding machine



Nanopatterning process technology

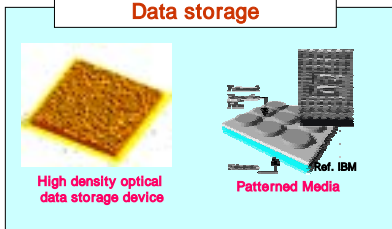
Application Technology Development

Optical devices

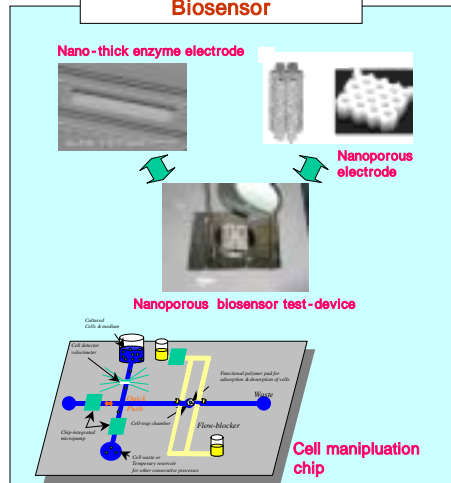


Nanopatterning process technology

Data storage

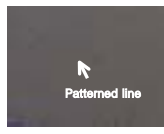
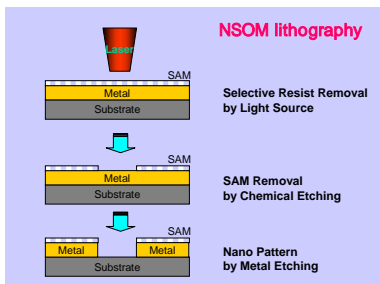
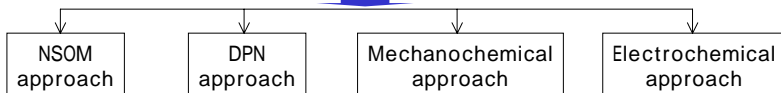


Biosensor

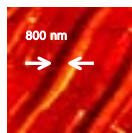


Nanoprobe Application Technology

Probe-applied patterning (Preliminary study)

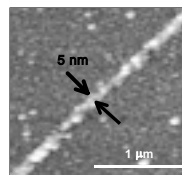
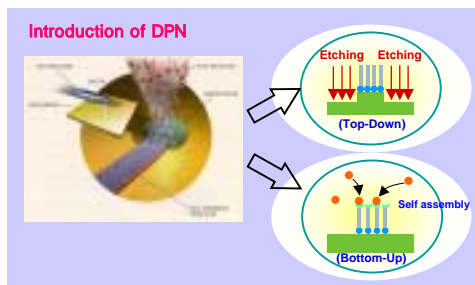
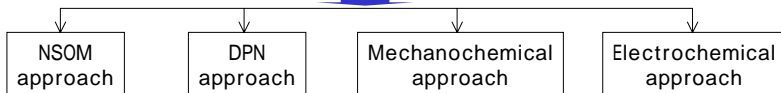


Thin Chrome Film Patterning on Au substrate (using NSOM Probe Coupled Femtosecond Laser)



Nanoprobe Application Technology

Probe-applied patterning (Preliminary study)



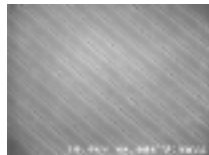
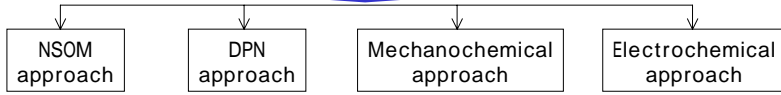
Au line fabricated through HDT molecular patterns

HDT Pattern
 Tip 1
 Condition : RH = 55 %, T = 22 °C
 Tip Scan : 12 nm/s, 40 times
Au wire
 Au diameter = 5 nm
 Time = 60 h

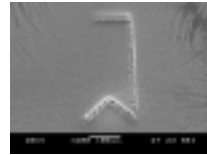


Nanoprobe Application Technology

Probe-applied patterning (Preliminary study)



Patterns on FDS / Si
(Pattern width ~300 nm)

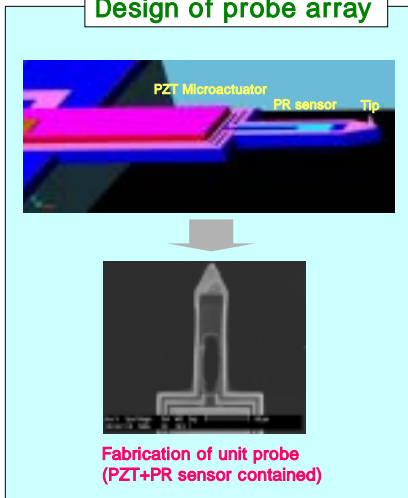


Patterns on SS 304 in H₂SO₄
(Pattern width ~300 nm)
Pulse= 1 μs, Voltage=3.5V

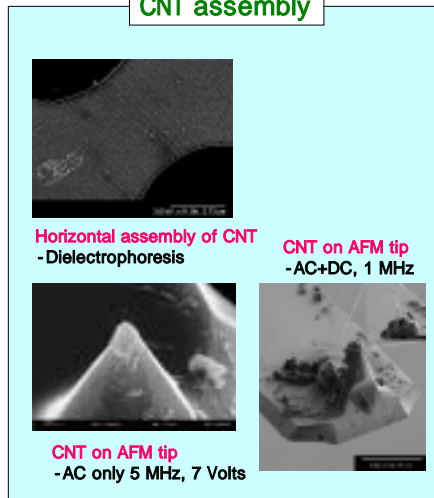


Nanoprobe Application Technology – SPL system

Design of probe array



CNT assembly



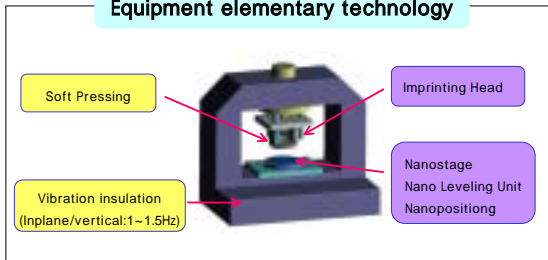


Nanoprocess Equipment Technology

Mechanism development for UV nanoimprint



Equipment elementary technology



1st V. of Nanopatterning Equipment



General comments for the 1st year's R&D results

- Papers : 124
- Patents : 22
- Ensure of possibility for R&D successes in the field of nanofabrication equipment
- Nanoprocess measurement is expected to be a viable technology in view of commercialization
- R&D for fusion technology (NBT, NIT) is performed, which suggests new challenging areas for nanomechatronics technology
- Ensure of potential significance for nanomechatronics technology in various applications



Closing Remarks



Strategy for R&D Thrust in CNMM

- Organize **collaboration system** among industries, universities, and research institutes
- Promote **International cooperation and collaborations**
- Emphasize conducting **self-motivated, interested, and valuable researches**
- **Multi-disciplinary networks**
 - Encourage creative and innovative ideas of all researchers
- Construct **effective communicating systems** between research teams on a basis of reliability and cooperation
- Maximize research outputs through **adaptive management system**





International Collaboration & Exchange Activities

■ Thrusts for International Collaboration Projects

- U.C. Berkeley, USA
- Purdue Univ., USA
- MIT, USA
- Stanford Univ., USA
- National Academy of Science of Belarus, BERALUS

■ Ongoing Strategic International Collaboration for CNMM

- Northeastern Univ., USA
- Purdue, USA

■ The 1st International Nanomechatronics Symposium

- To be held in Feb. 5-6, 2004 at Hoam Convention Hall, SNU
- International Experts (from USA, Japan, EU) invited



Thanks!





Acknowledgements ;

- Min. of Sci. & Tech., KOREA
21C Frontier R&D Program



<http://www.nanomecca.re.kr>