



Nanoimprint Technology for Large Area Patterning and Its Applications

Korea Institute of Machinery & Materials

Nano-Systems Research Division

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Outline

- **Introduction of CNMM program**
- **Key issues for Nanoimprint lithography**
 - UV & Thermal NIL processes
 - Imprinting Mechanism
 - Overlay & Alignment System
- **Stamp Fabrications**
 - *E-beam lithography*
 - *Interference lithography*
- **Applications**



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JikJiShimKyung : 1st Metal printing mold (1377) in the world
Gudengerg : 1447



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Objective of CNMM


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


↑

Final Goal

- ❖ Fabrication technology of 2D/3D shapes composed of 100~10nm level nanowires, dots and structures
- ❖ Fully 3D shape nanofabrication
- ❖ Nano-applications : Nanoelectronics, RF communication components, bio sensors, etc
- ❖ 10nm level nanopatterning equipment
- ❖ Analysis/control/measurement of nanostructures





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Nano Imprint Lithography Technology

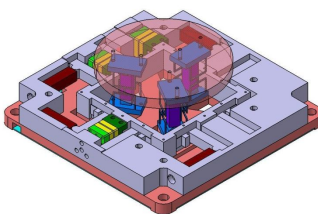
- ◆ UV Nano Imprint Lithography (UV-NIL)
- ◆ Thermal Nano Imprint Lithography (TH-NIL)



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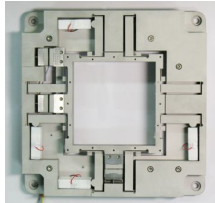

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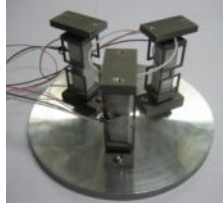
Nanostage for Overlay/Alignment in NIL



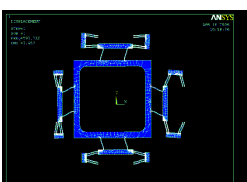
6 DOF Nanostage

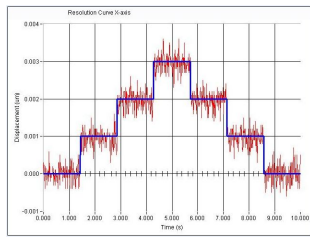


XYθ Stage






θxθyθz Stage





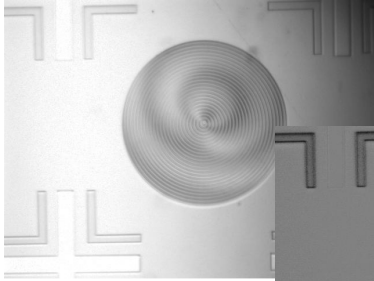
Resolution : 1nm
Stroke < 120um



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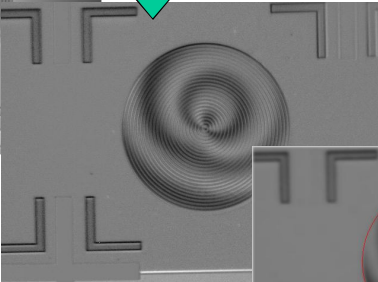

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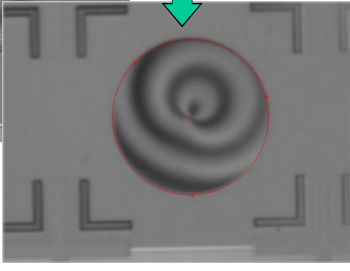
1st Alignment : Moire Fringe Analysis (1)



❖ Raw Image





❖ Remove Background image (or Noise) to enhance the Contrast of Moire fringe




❖ Remove Concentric Circular Grating Image

❖ Subtraction Reference Image (Mask Image) from Raw one

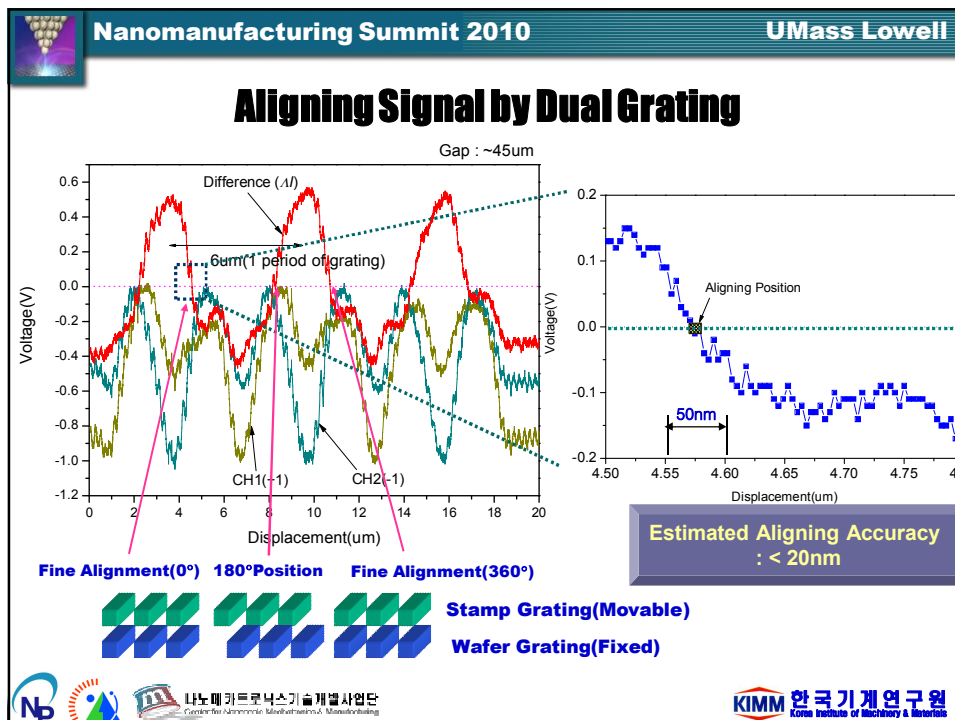
❖ Moire fringe extraction & Calculation of fringe center and boundary

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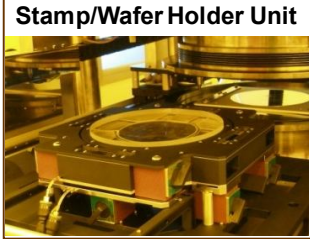


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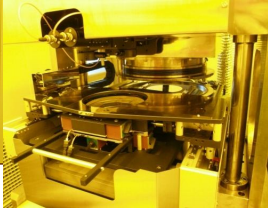
Multi-layer Nanoimprint System: ANT-6Ho





Stamp/Wafer Holder Unit




ANT-6Ho NIL



Imprint Unit

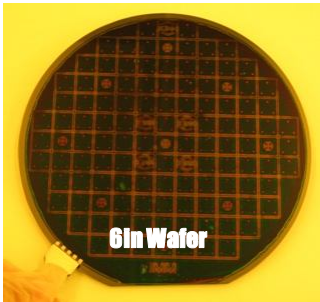
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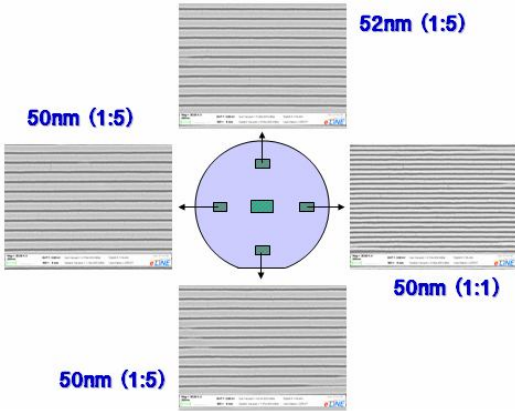
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Nanoimprinted Pattern Uniformity




6in Wafer




ANT-6H Imprinting Uniformity

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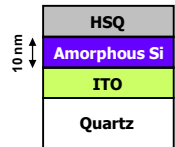


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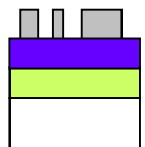
Quartz Stamp Fabrication for UV-NIL

Resolution & Chemical stability



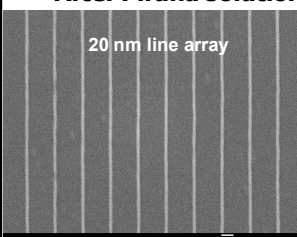
10 nm

→ E-beam litho. →

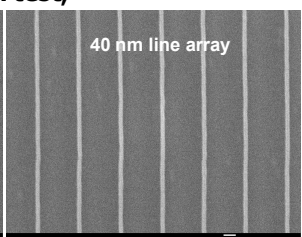


Pirana solution test
 : $\text{H}_2\text{SO}_4:\text{H}_2\text{O}_2$ 4:1
 : 10 min dipping

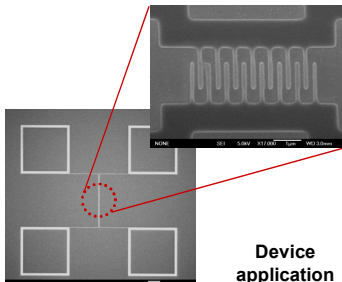
After Pirana solution test,





20 nm line array




40 nm line array




Device application

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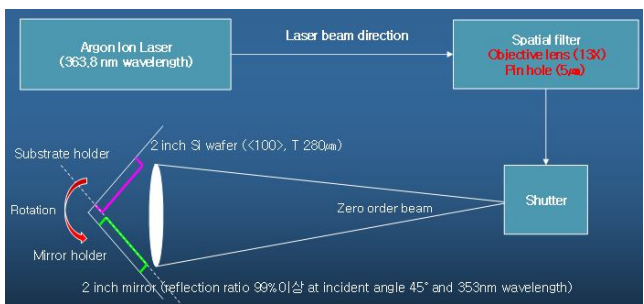
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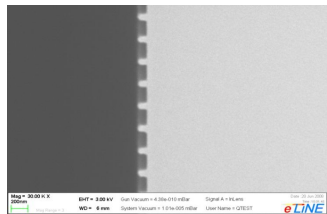


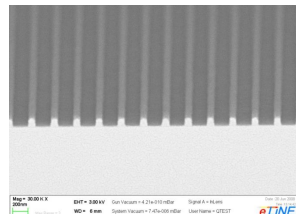
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Fabrication of Si Stamp using Interference Lithography









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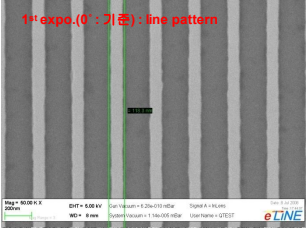


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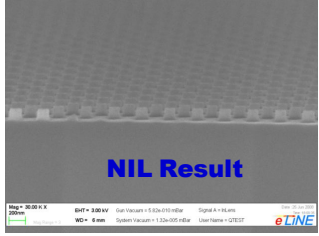
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Interference Lithography



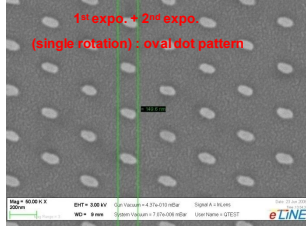
1st expo. (0° 기준) : line pattern

1st IL



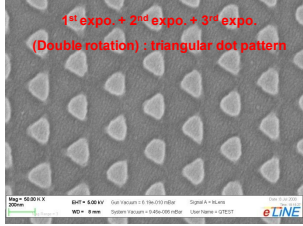
NIL Result

↓



1st expo. + 2nd expo.
(single rotation) : oval dot pattern



2nd IL




1st expo. + 2nd expo. + 3rd expo.
(Double rotation) : triangular dot pattern

3rd IL


→

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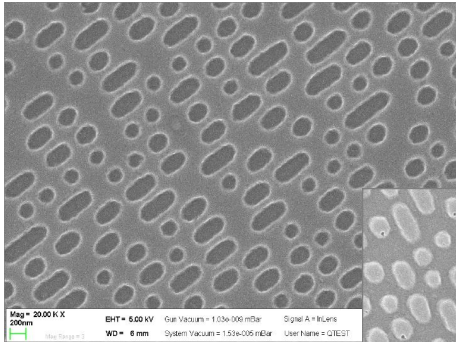


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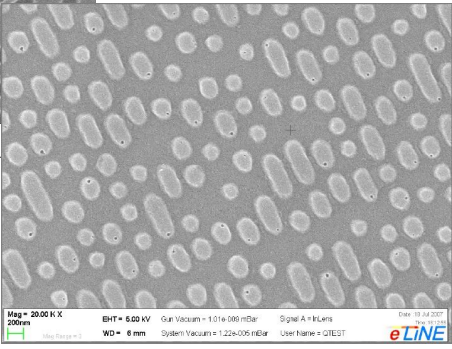
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Experimental Results using PC Replica





Polycarbonate replica

- Blue Ray Disc pattern
- CD = 100~300nm




Resist pattern

• T_{Resist} = 100nm

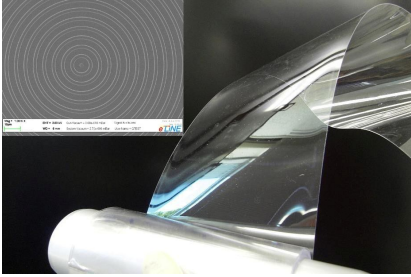
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RNIL system for Flexible Electronic Devices



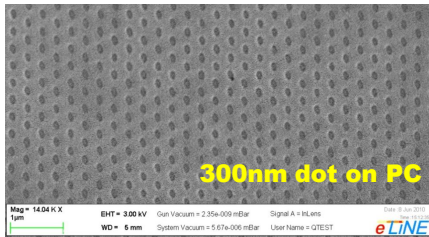
Micro patterned PC film by RNIL process and its SEM image.

RNIL conditions

- Stamp : 6" Si wafer (micro pattern)
2" Si wafer (nano pattern)
- Flexible substrate : PC film with 0.38mm(T) x 150mm(W)
- Temperature : 165 °C
- Moving speed of the press roller : 15 mm/min
- Maximum pressing force : 45 kgf

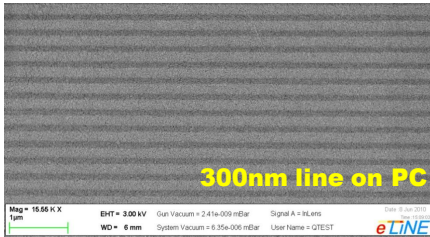
Key factors

- Heating and cooling conditions
- Pressing force and pressure conditions
- Tension of the flexible substrate
- Moving speed of the press roller



300nm dot on PC

Mag = 14.0K X
WD = 5 mm
EHT = 3.00 kV
Signal A = HLens
User Name = QTEST
Date: 8 Jun 2010
Time: 14:05:00
eLINE



300nm line on PC

Mag = 15.6K X
WD = 6 mm
EHT = 3.00 kV
Signal A = HLens
User Name = QTEST
Date: 8 Jun 2010
Time: 14:05:00
eLINE

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NanoImprint Lithography Applications

Tools : ANT-6H

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NIL Results: 40G Bragg Grating Device

250nm/50nm Grating

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Each line in the grating reflects back some of the light for the particular wavelength it is spaced for. It can take hundreds of lines to cause complete reflection and eventually all of the wavelength is reflected back. These are all conceptual illustrations.

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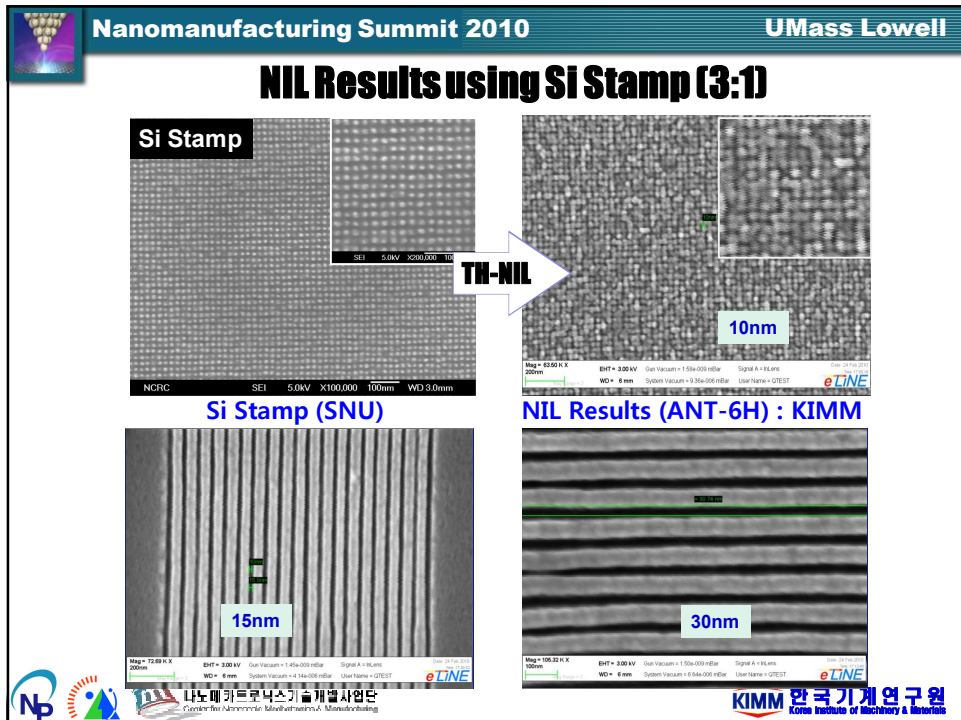
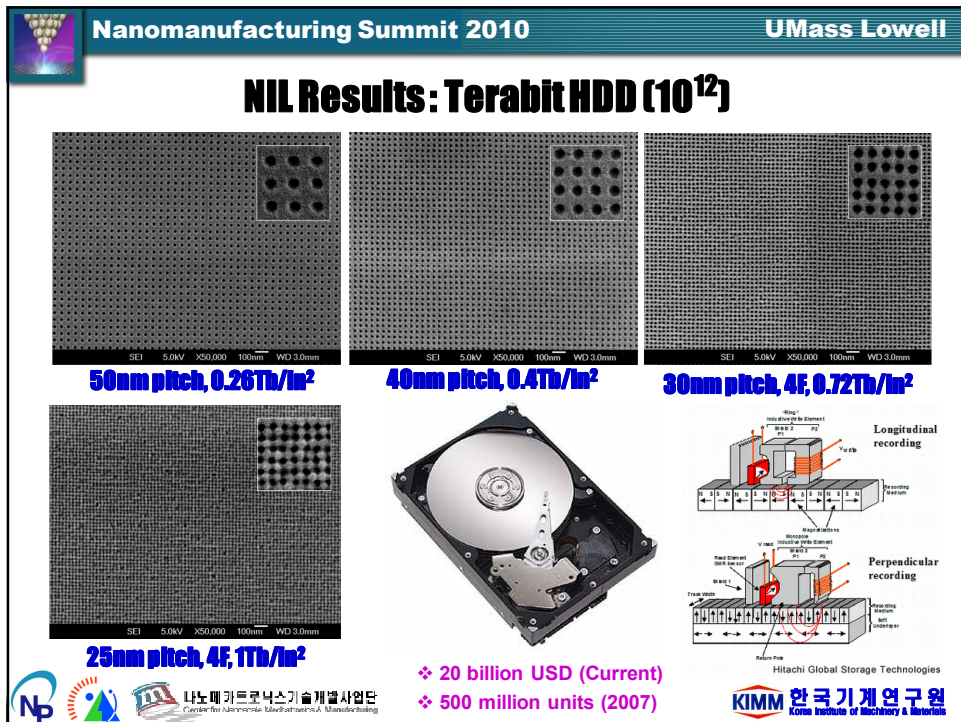
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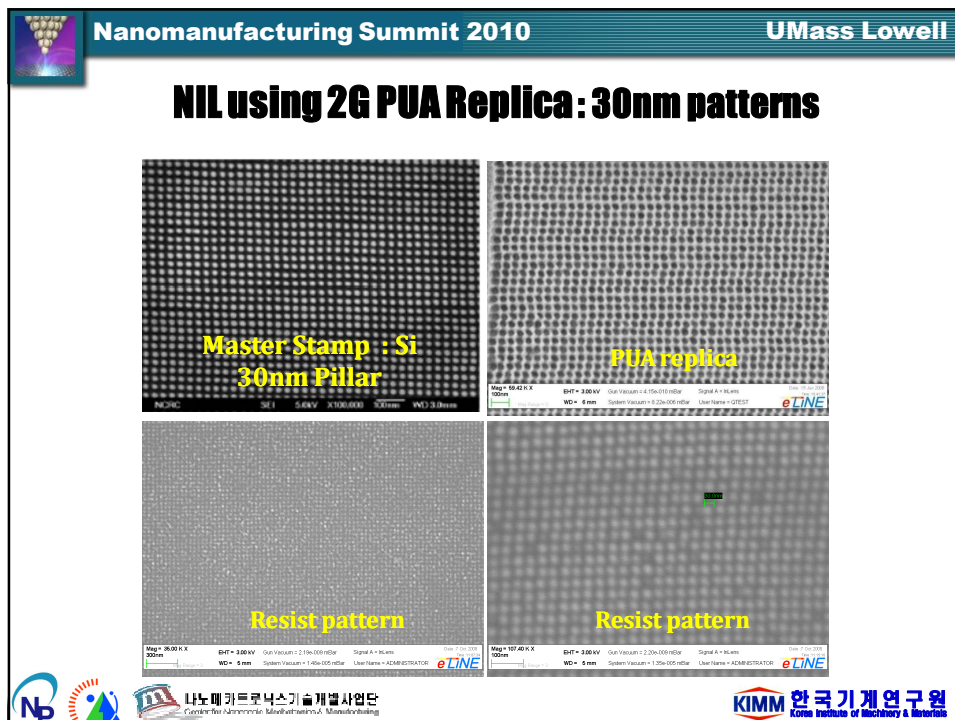
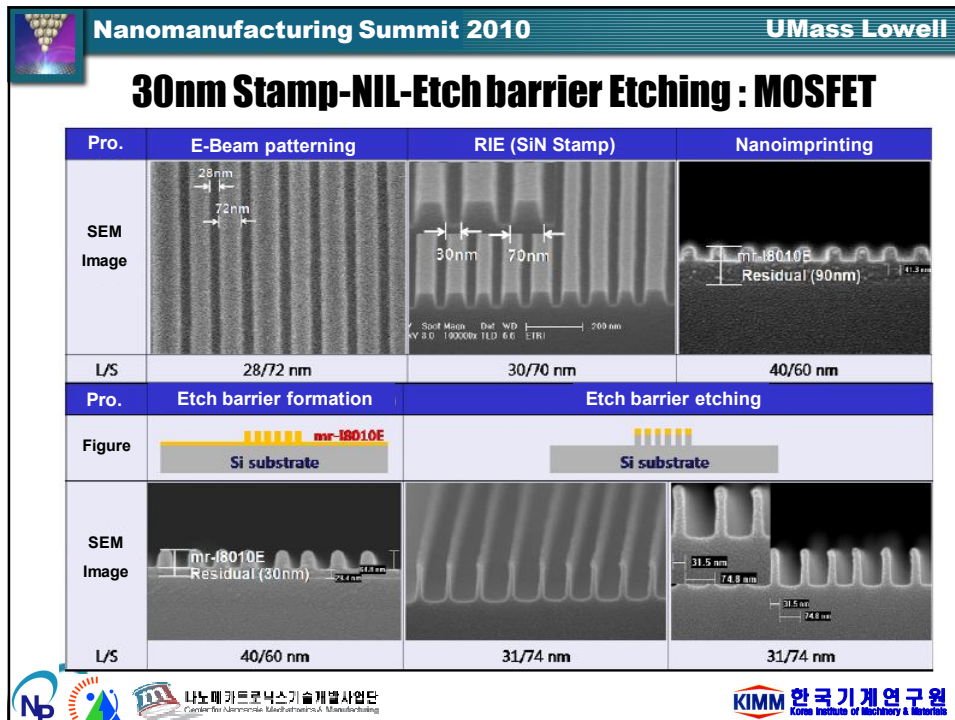
NIL Results: Blu-ray Disc

100~300nm BD Pattern

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