Nano-Imprint Lithography (NIL)

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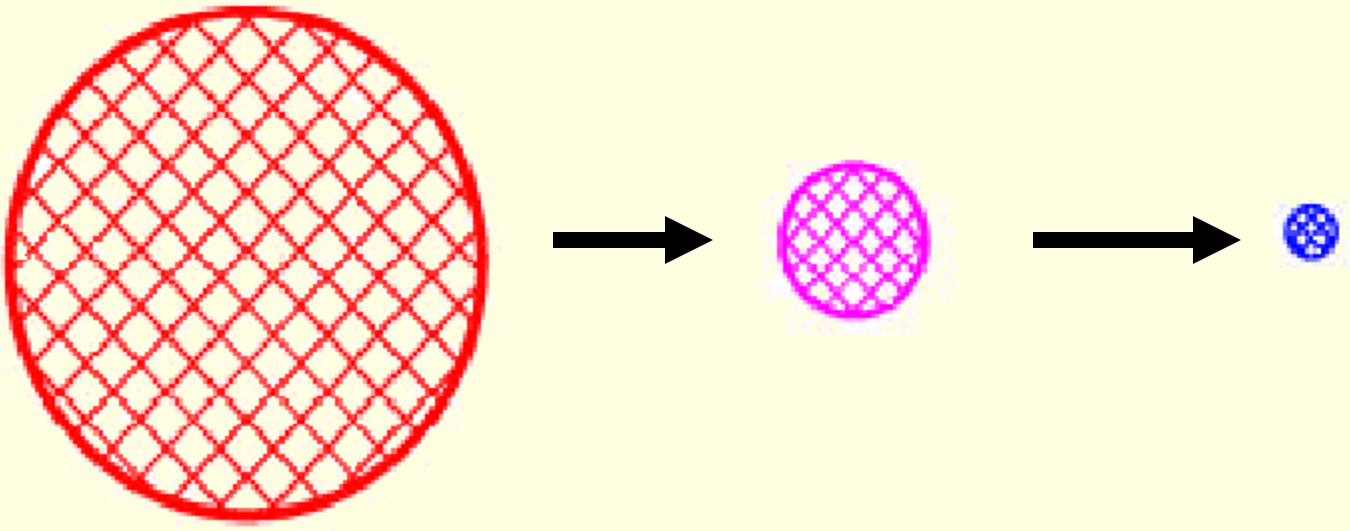
Outline

- Introduction
- Process
- Applications
- Advantages and Challenges
- Conclusions
- References

Introduction

Lithography: Producing desired pattern on a substrate
Nanolithography: lithography with feature-size less than 100nm



Conventional photolithography~ 500nm

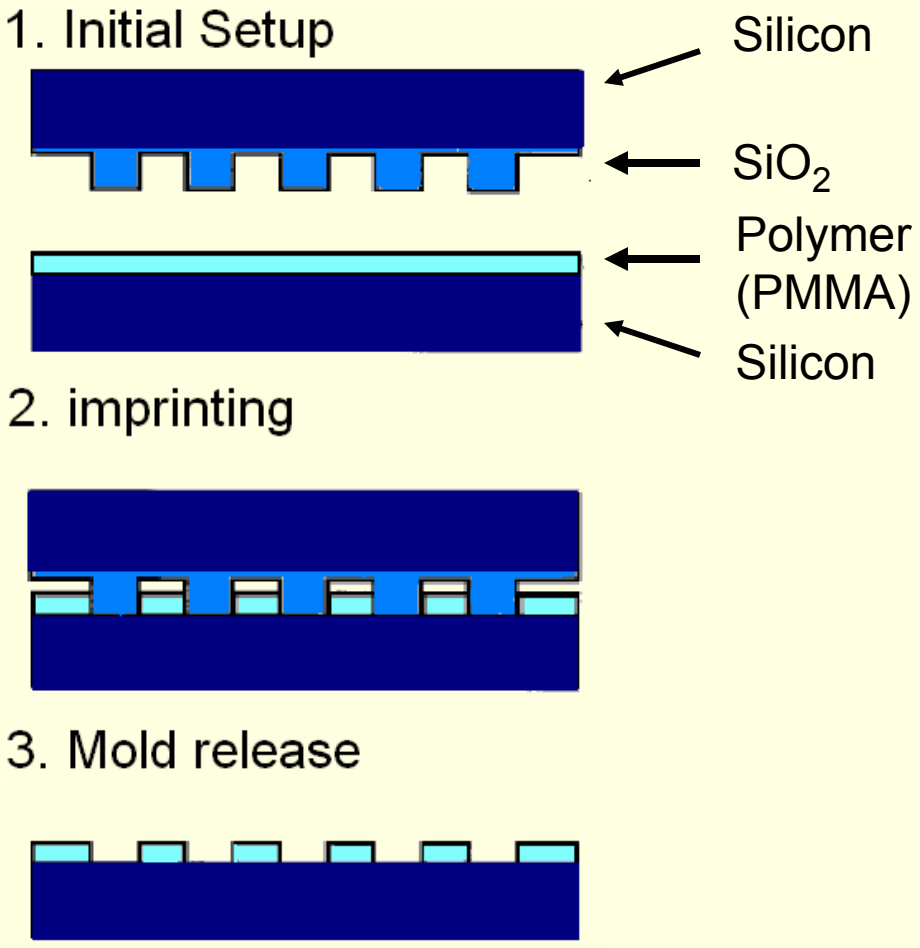
Deep UV photolithography~ 120nm

E-Beam/X-ray lithography~ <50nm

Introduction

- Photolithography is economically impractical for mass production of sub-50nm structures
- Imprint technology using compression molding of thermoplastic polymers is known as a low-cost mass manufacturing technology
- Is it possible to apply the imprint technology to lithography?

Process: Schematic View



Mold Contact

↓

Pressing

↓

Mold Release

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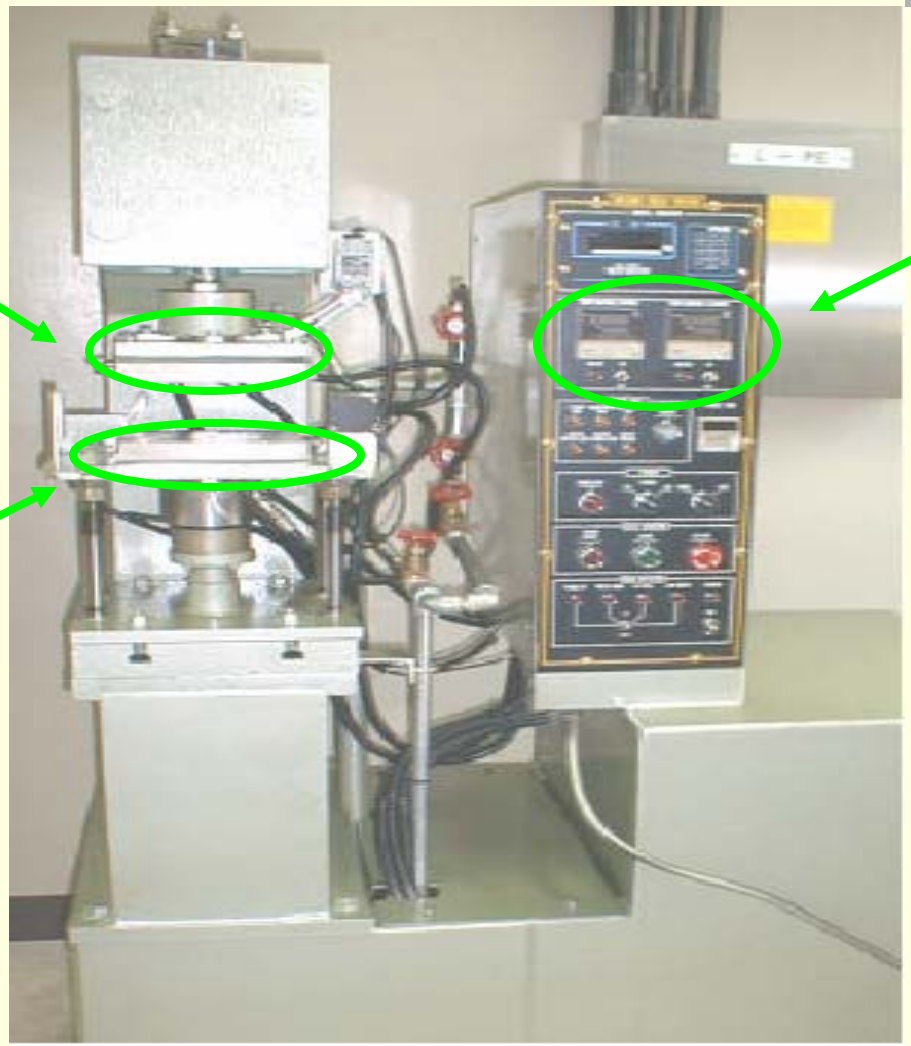
Residual polymer removal using RIE

Process: Practical View

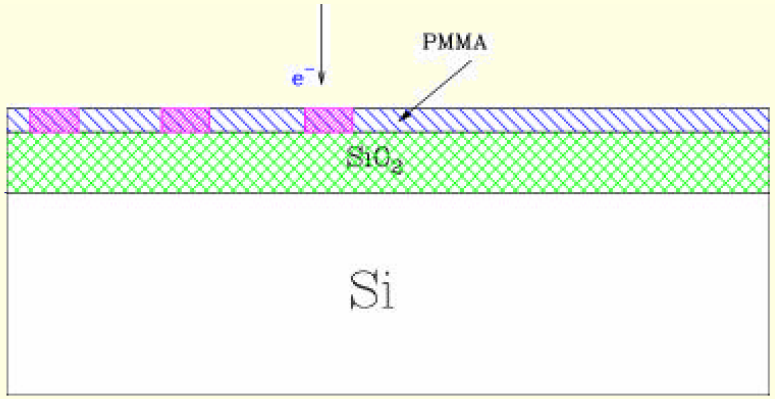
Upper Plate

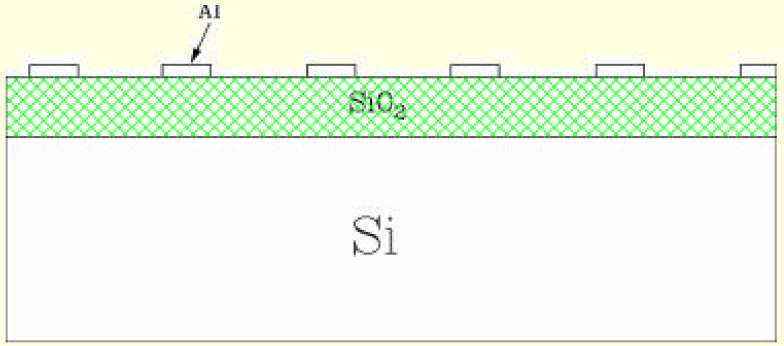
Lower Plate

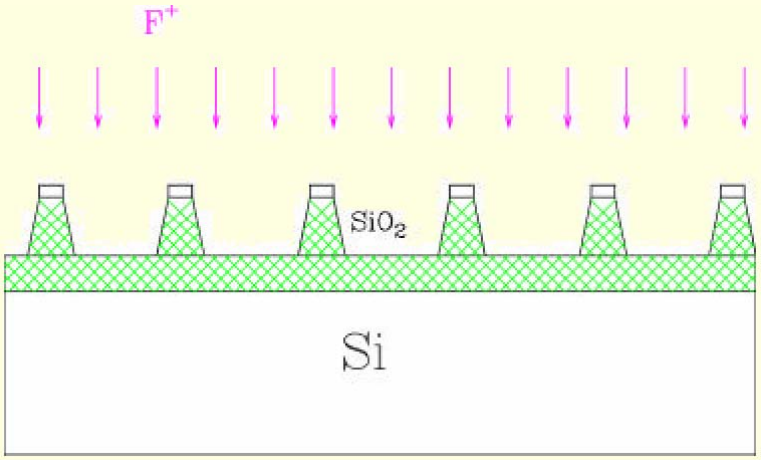


Heat Control Panel

Process: Mask Fabrication







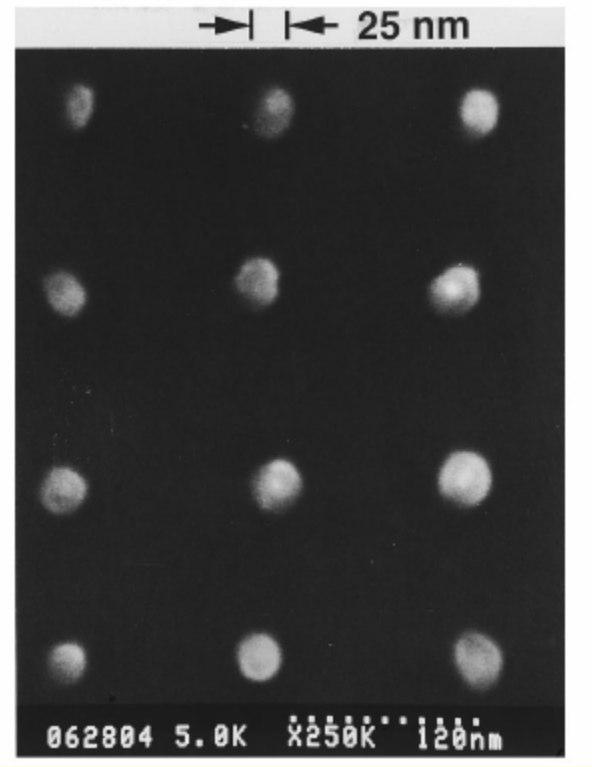
Process: Polymer Consideration

- Mold release property: not adhere to mold
- Shrinkage: small shrinkage due to temperature and pressure variance.

PMMA (Polymethylmethacrylate) :

- hydrophilic surface(not adhere to SiO_2)
- Less than 0.5% shrinkage at processing conditions.
- Glass-transition temperature Tg=105 ^{o}C

Process: Created Patterns

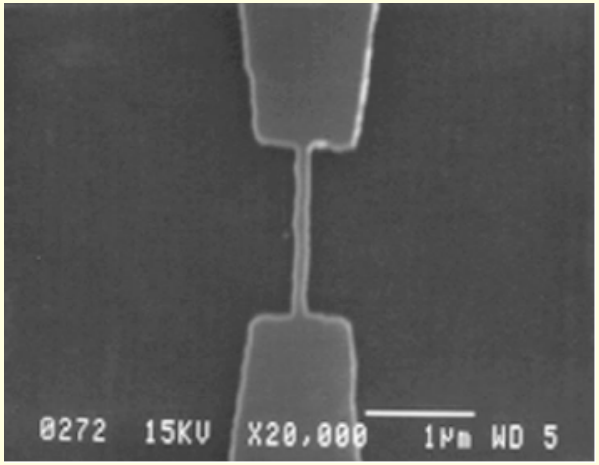


SEM micrograph of Ti/Au dot pattern on a silicon substrate fabricated by NIL [1]

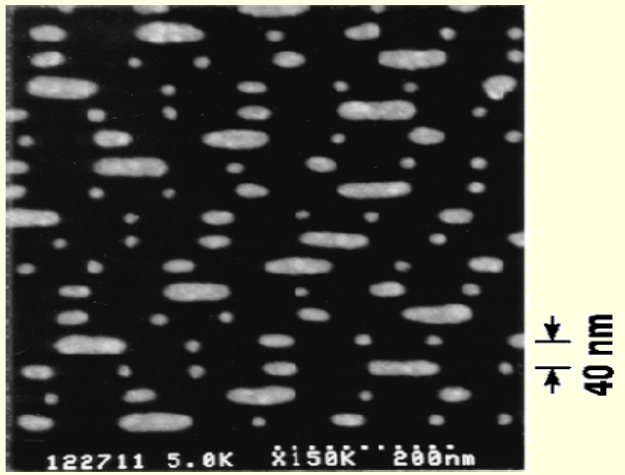
- RIE is used to cut down resist thickness until shallow regions are completely removed
- Ti/Au is deposited on resist
- Resist and metal coating is removed (by liftoff process) leaving metal dots with 25nm diameter and 120 nm period

Applications

- Quantum dot, Quantum wire
- Nanocompact disk

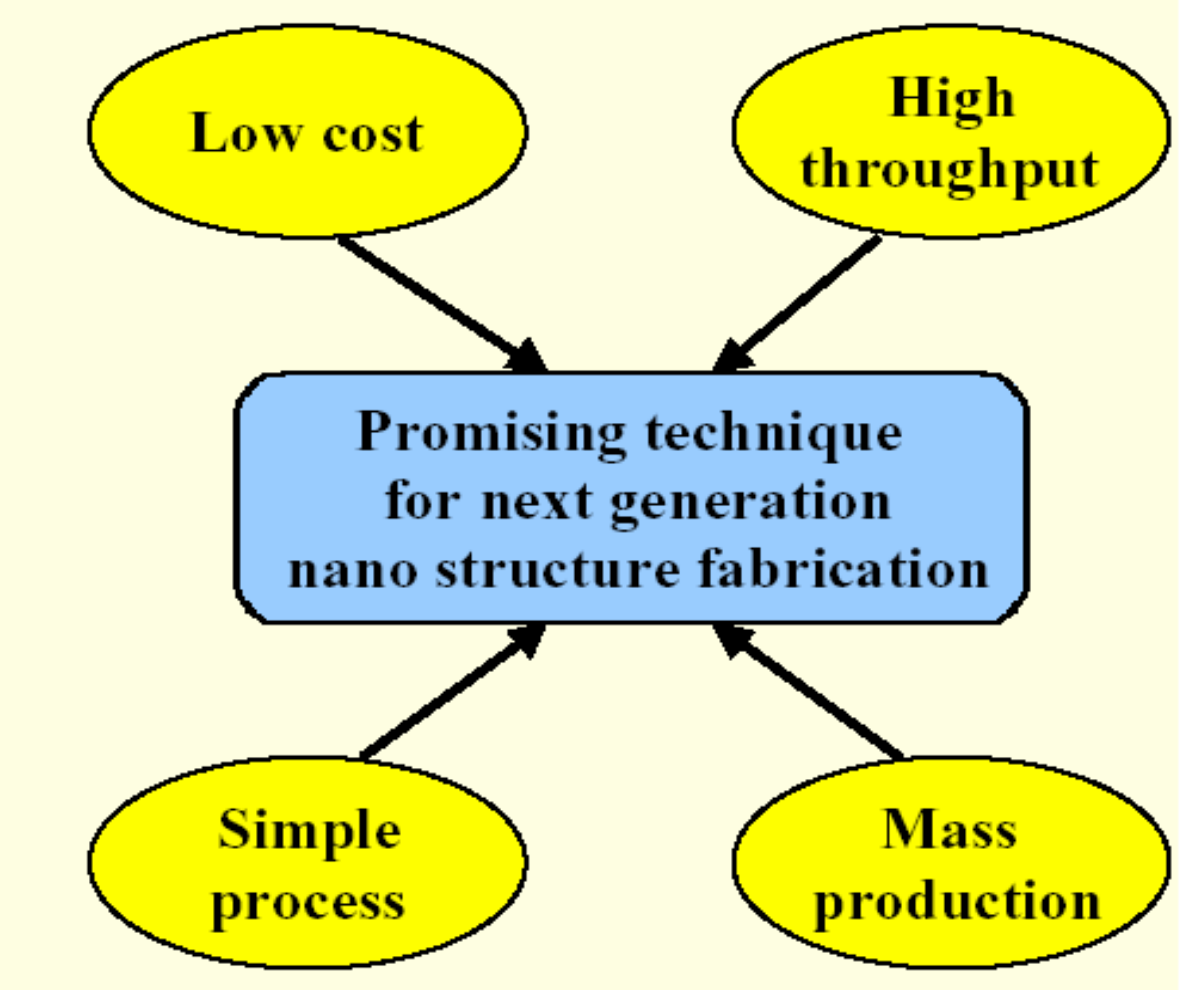


100nm wire channel MOSFET[2]



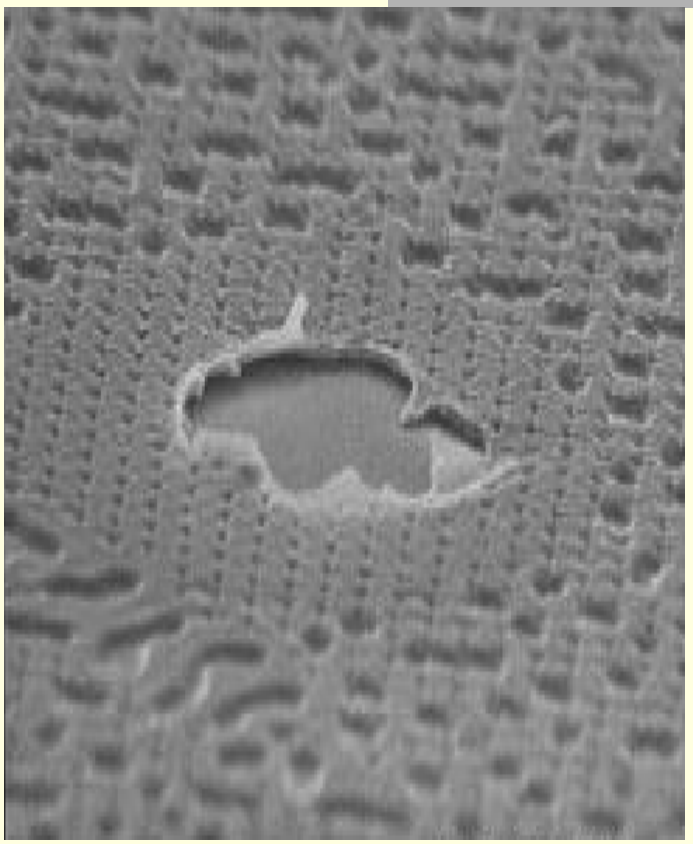
Nano-CD of 40nm track width [2]

Advantages


Low cost
High throughput
Promising technique for next generation nano structure fabrication
Simple process
Mass production

Limitations and Problems

- Global fidelity of patterns
- Multilevel alignment
- Large imprint areas
- Tearing of polymer



Conclusions

- NIL is a high throughput low-cost method to develop sub-100nm structures.
- Sticking and defect problems associated with the traditional contact printing exist.
- With a proper selection of the polymer and mold materials and an optimization of the pressing conditions, these problems may be solved.

References

[1] Stephen Chou & et al :Imprint of sub-25nm vias and trenches in polymers

[2] Stephen Chou & et al :Sub-10nm imprint lithography and applications