Application Specific Exposure System (ASS)

For Device Manufacturing

Ver1.4
Nov.2011

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1. Introduction of Mejiro Precision,Inc.
2. General Market Trend and Overview of Mejiro Stepper
3. Introduction of Application Specific Exposure System (ASS)
4. Strategy for Device Production
5. 3D Lithography by ASS

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4. Strategy for Device Production

Company overview

·Activities	**Design, research and development of optical system**
·Employees	**40**

Mejiro Precision aims at Fab-less Company.

The main business is research & development, and manufacturing has been consigned to the external cooperation company.

Business Composition

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Optical technology

Optics Reserch Institute

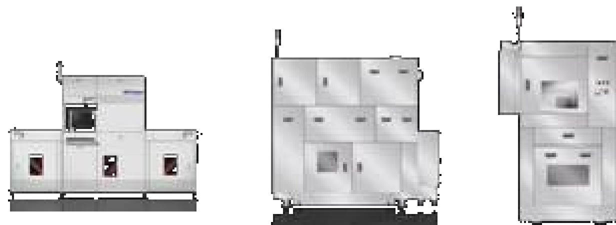
Light System Division

In three pole organization,
The synergy effect
is demonstrated.

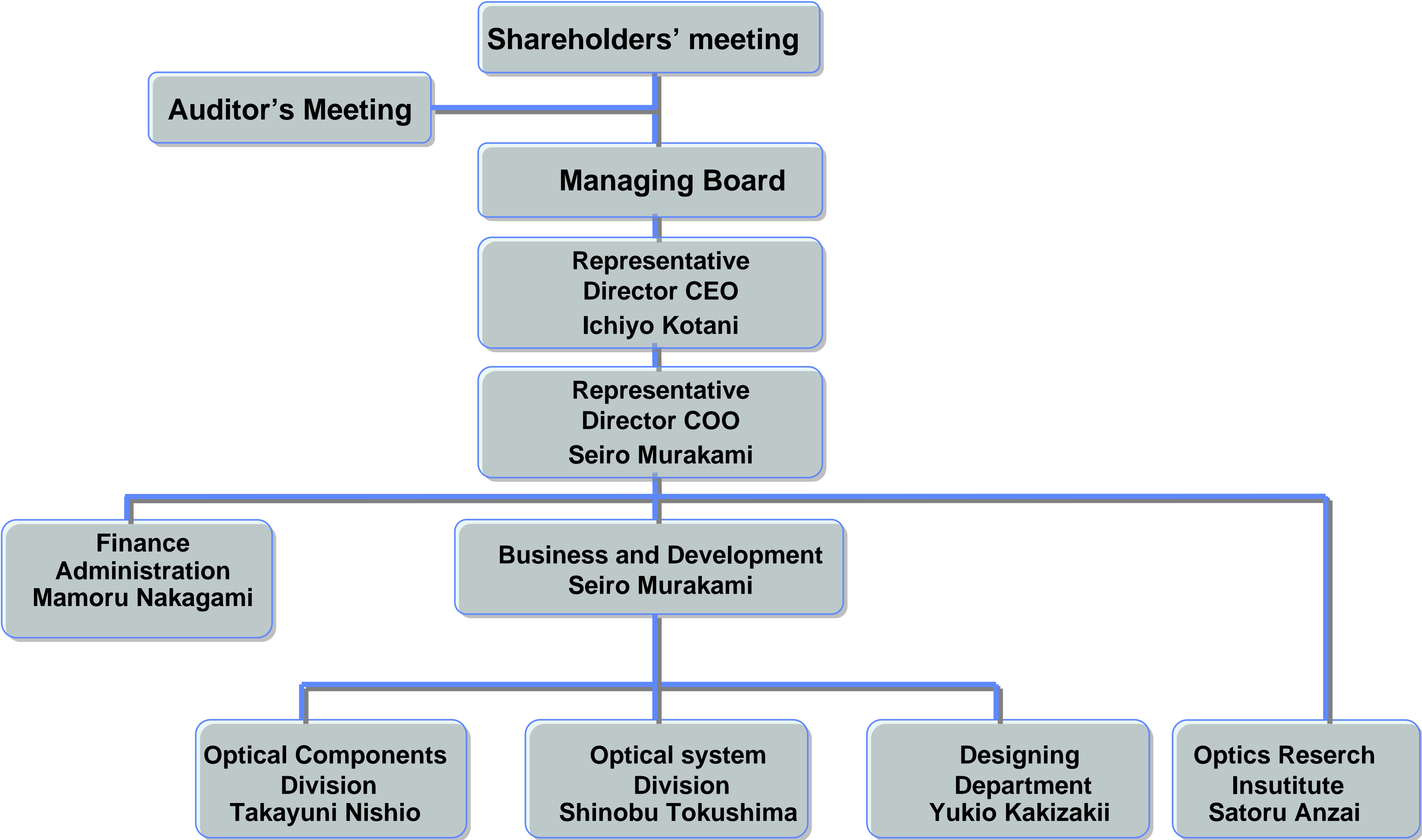
Light Components Division

Stepper(projection exposure machine)
Custom-designed optical system

Light source and optics irradiation unit
Objective lens



Organization



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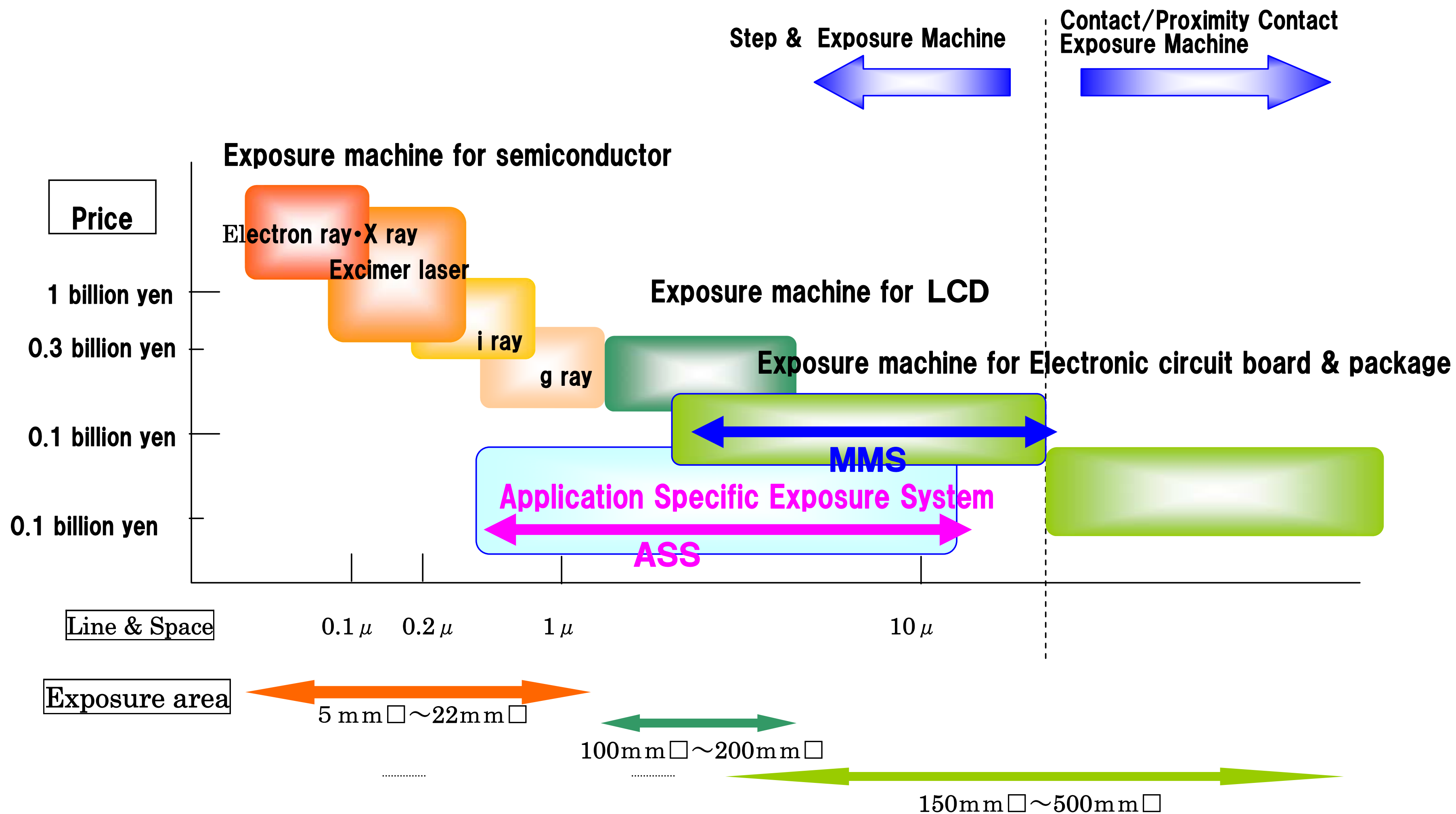
General Market Trend



Overview of Mejiro Precision Stepper

MEJIRO PRECISION

Stepper Series	Mode No.	Exposure Area (mmφ)	Resolution (μm)	Substrate Size	Application	Production beginning	Numbers of sales
MMS	P804	200	5	500mm x 600mm	PCB & package	2003	16
	P806	200	3.5	500mm x 600mm		2008/spring	
	P141	355	5	500mm x 600mm		2009/spring	
	P142	355	3.5	500mmx600mm		2012/spring	
ASS	A	10-20	0.5-1.0	300mm x 300mm 2″ - 12″Wafer	SAW, ASIC	2010/spring	9
	B	20-50	1-2.5	300mm x 300mm 2″ - 12″Wafer	LED, MEMS, LCD	2009/summer	
	C	50-110	2.5-∞	300mm x 300mm 2″ - 12″Wafer	advaced package, ceramic	2009/summer	
ASS Special	Ck	100	1	300mm x 300mm 2″ - 12″Wafer	LED, MEMS	2011/autumn	

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3．**Introduction of Application Specific Exposure System (ASS)**

4．Strategy for Device Production

MEJIRO PRECISION

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·Introduction of ASS (Application Specific Exposure System)

- Concept
- Achievement of Wide Exposure Specification
- Practicable Productivity
- Module Concept for High Cost Performance
- Back-Side Alignment
- Substrate Holder
- Edge Blind Mechanism
- Small and lightweight

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Demand for stepper from markets other than mass production field

Wide-ranging exposure specification

→One exposure machine

・can correspond to various applications.

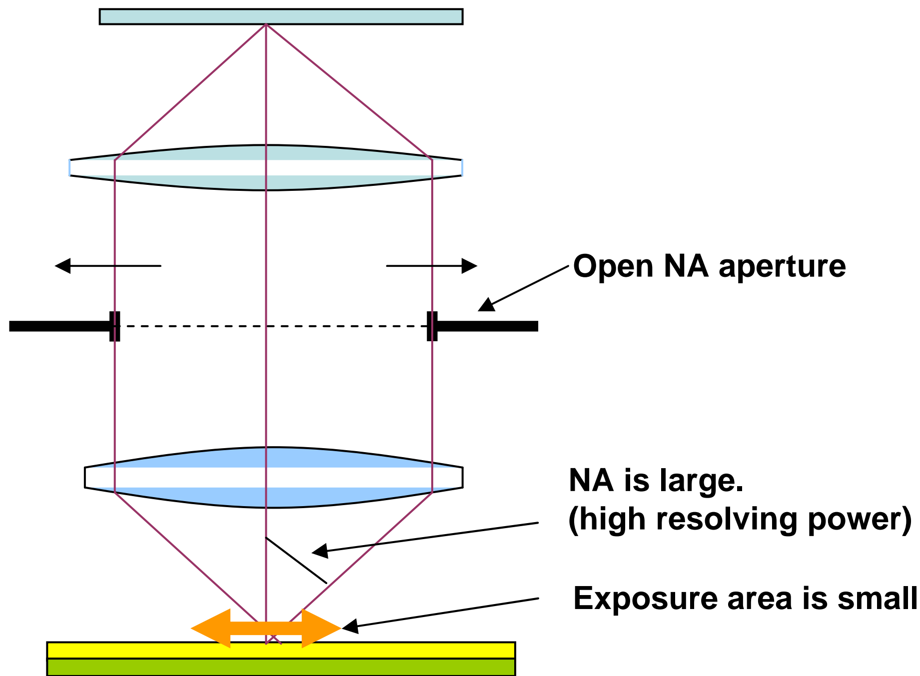
・has Multi generation character that can correspond to the future miniaturization

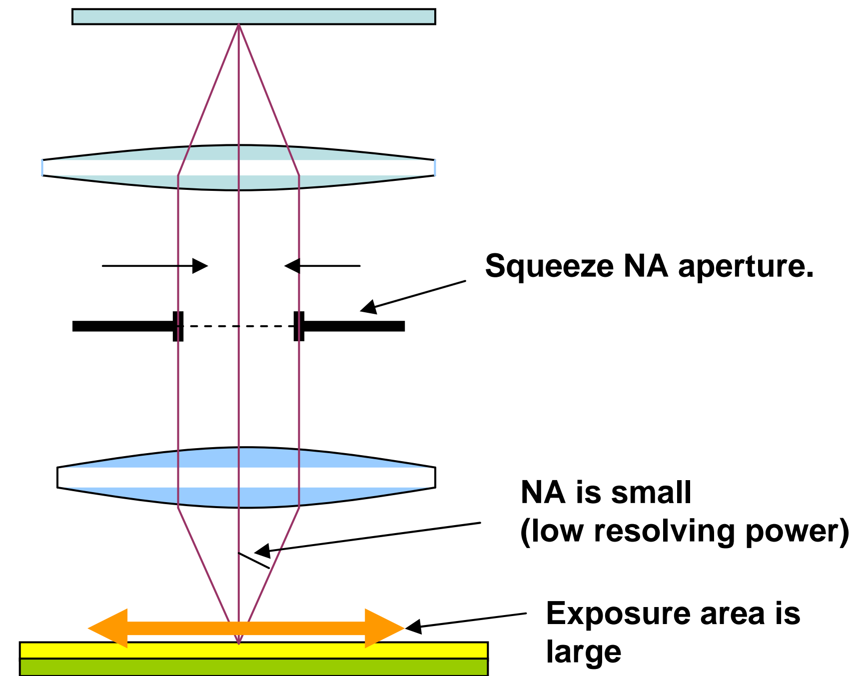
High Throughput

→It is not a mere experimental exposure machine.

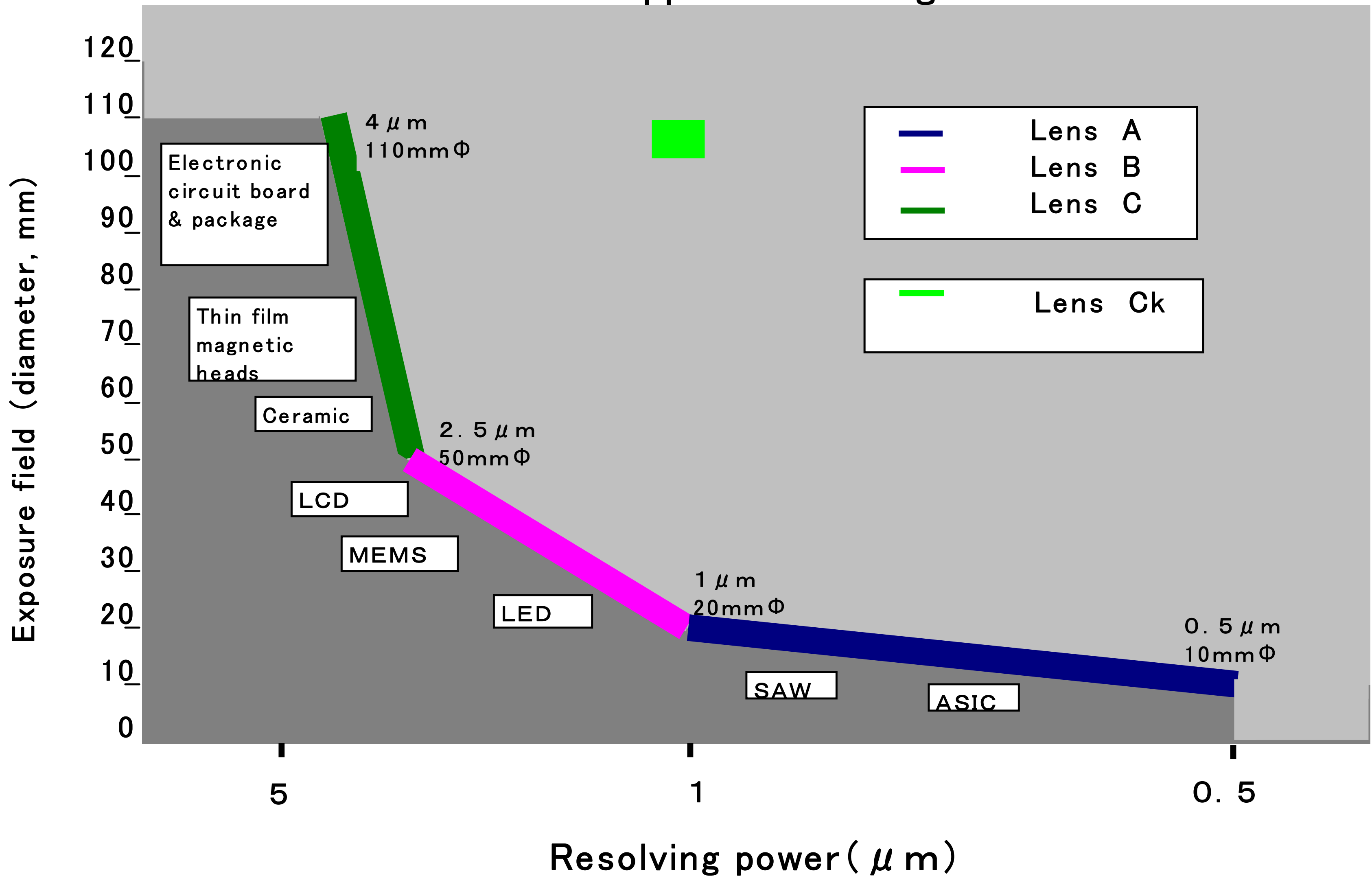
Low price

1-1 Introduction of NA changeable mechanism

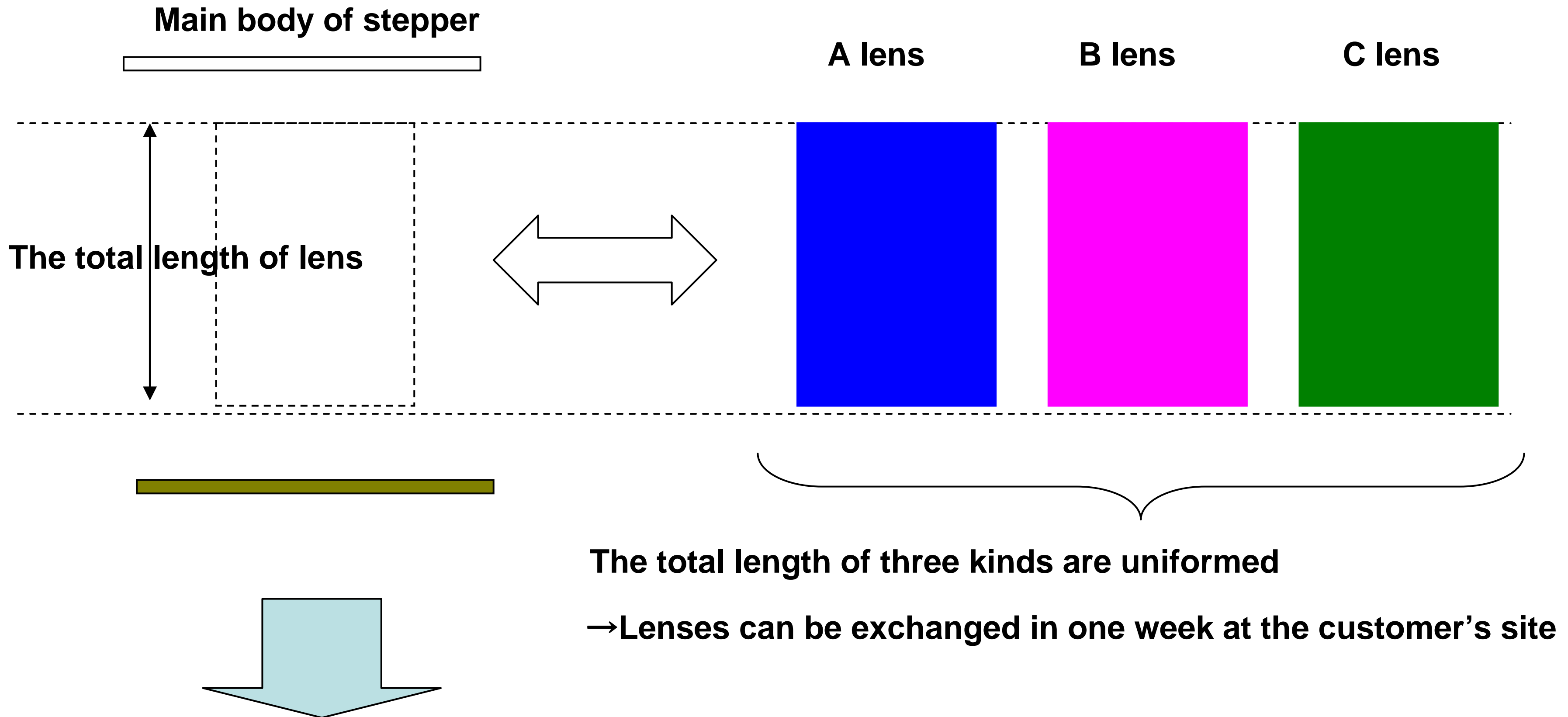




1-2 Continuously Covered with Three Kinds of Lenses

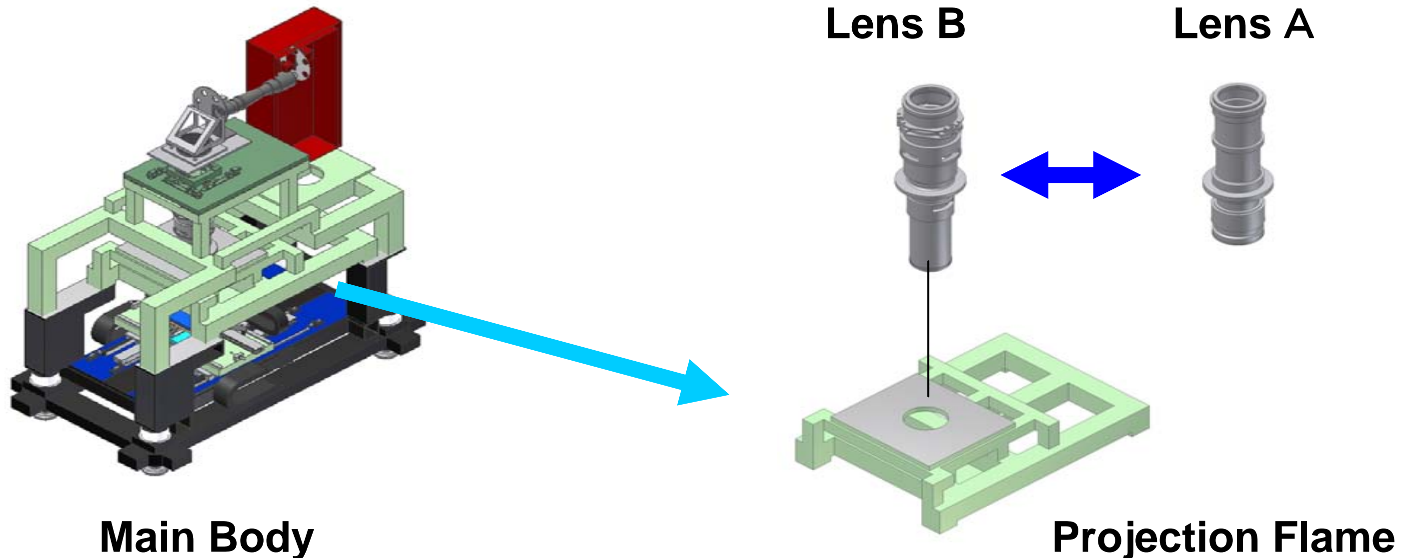


2-1 Lenses can be exchanged at the customer site.



A wide exposure specification and a multi generation are enabled with one exposure machine.

2-2 Lenses Exchange mechanism



- **Easy exchange on customer's site**
- **Mejiro's engineer can change the lens on customer's manufacturing area.**
- **Short period work schedule**

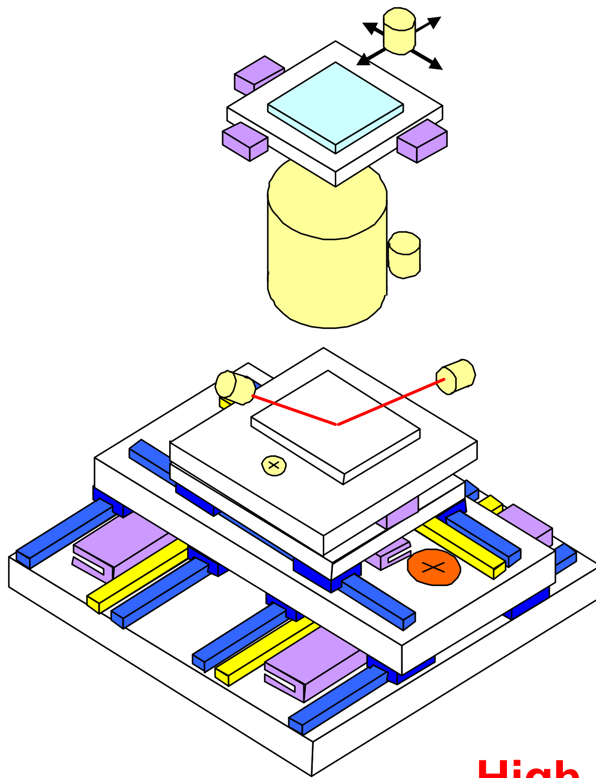
  → Changing lens and Readjust within 1 week ,
  and checking within 0.5 week.

Practicable Productivity

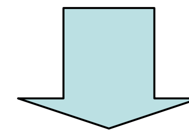
MEJIRO PRECISION

High Throughput

The technology of stepper (MMS) for electronic circuit board and the package mass production was applied as it was.



- **Small size and lightweight X/Y stage**
  (300mmx300mm 12” stroke capability)
- **Optical system of high illumination**
- **Real-time AF mechanism**
- **Global alignment function**

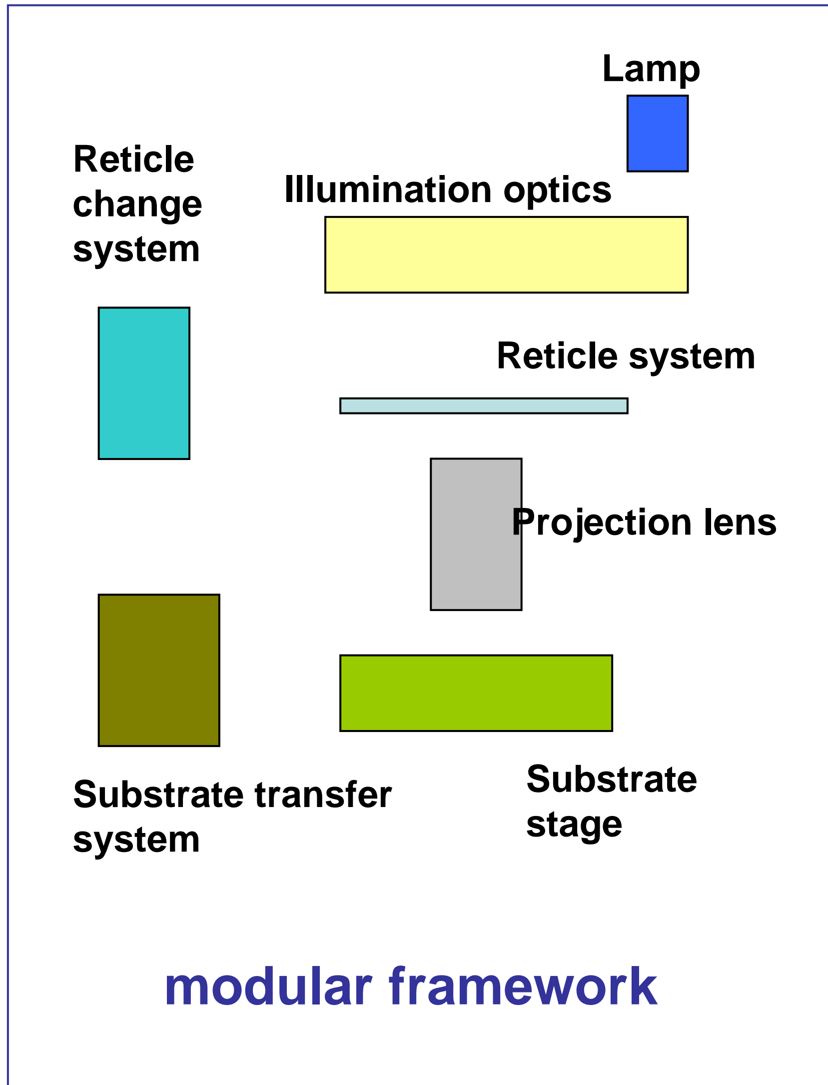


High throughput (30 second / 12 "Wafer substrate)

→A small-scale production line can be constructed.

Module Concept for High Cost Performance

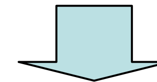
Module Concept



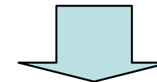
ASS stepper is composed of a lot of independent functional elements (more than 50 kinds of modules).

An individual module corresponds to all the possible function variations with the possibility that the customer uses it.

The module can be assumed that all are optional, and be selected.



The minimum requirement can be composed for the customer.



High Cost Performance

Back Side Alignment

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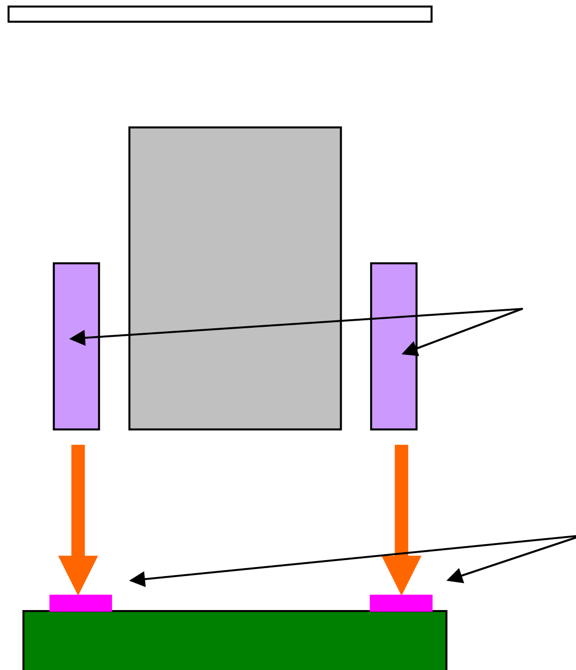

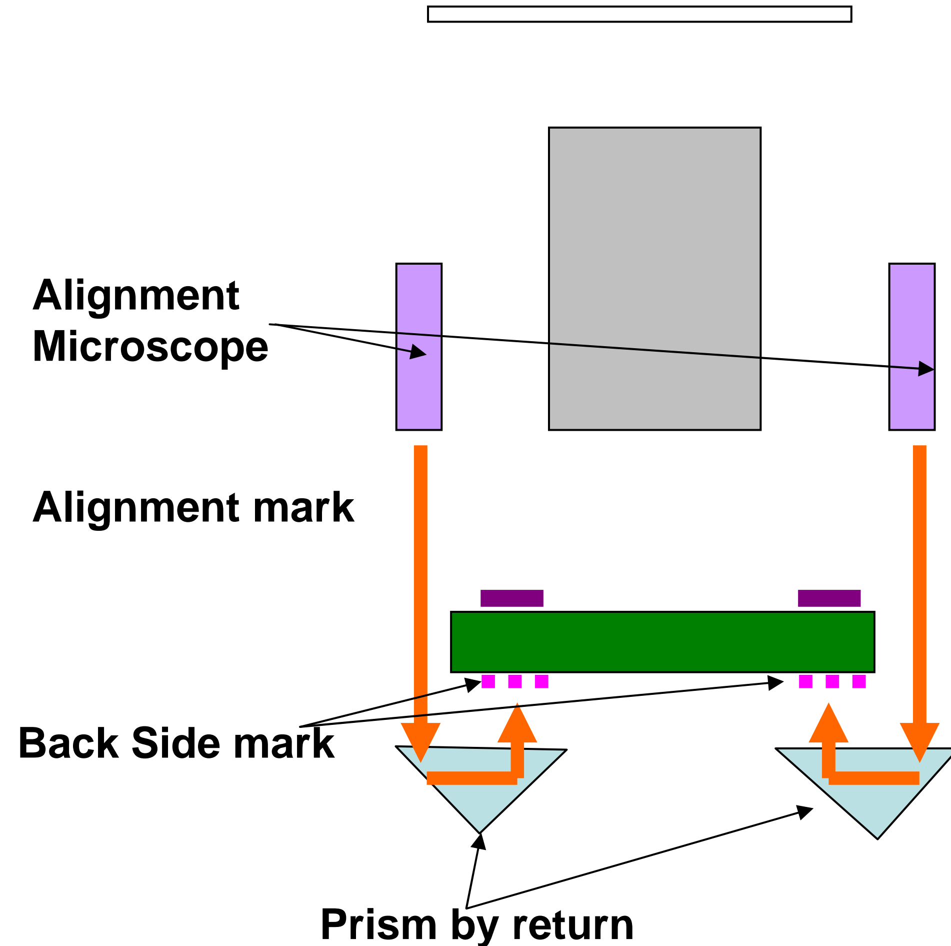

Substrate Holder

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Substrate

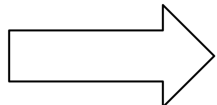
Peripheral Cramp Skirt

Stage Holder for substrate

Vacuum by

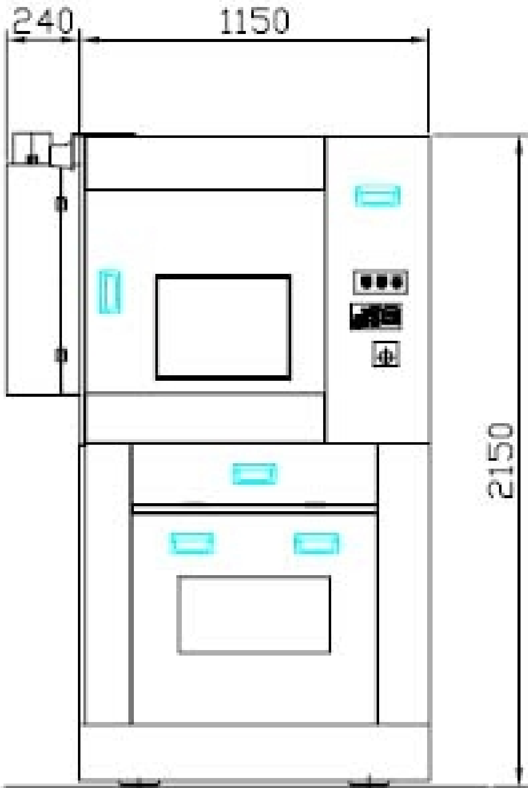
Sponge type material(多孔質）

→ Soft vacuum contact by innumerable air hole

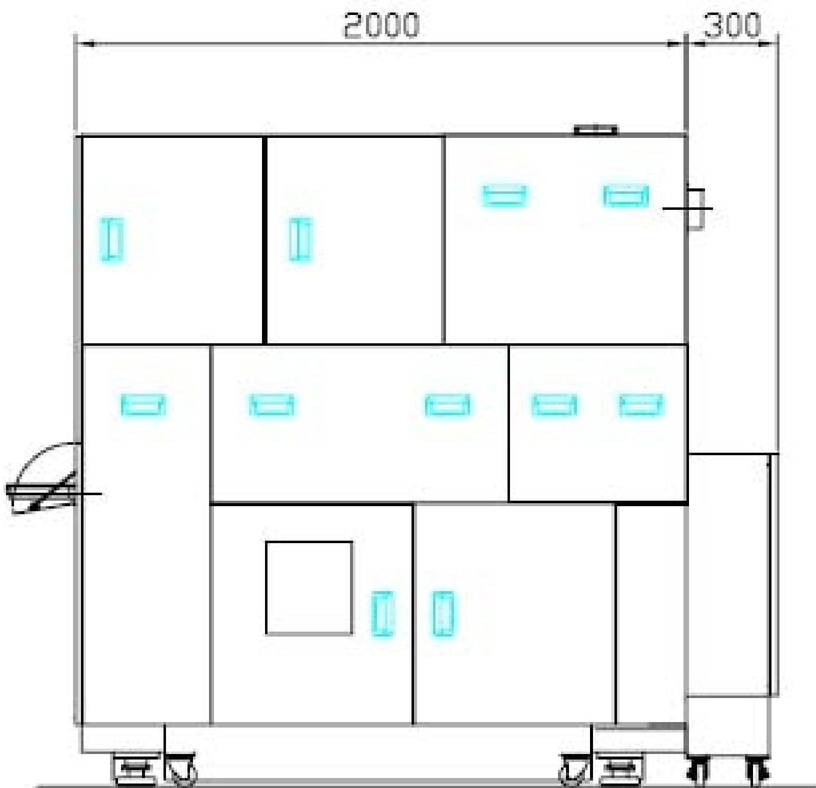


Flatness is secured without damaging the substrate.

Small and Lightweight



ASS front face



ASS side face

Total Weight 1.5 ton

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Strategy for Device Production

1. **Advanced Technology for Enhanced Resolution**

2. **Lithography Roadmap & Mejiro Strategy**

MEJIRO PRECISION

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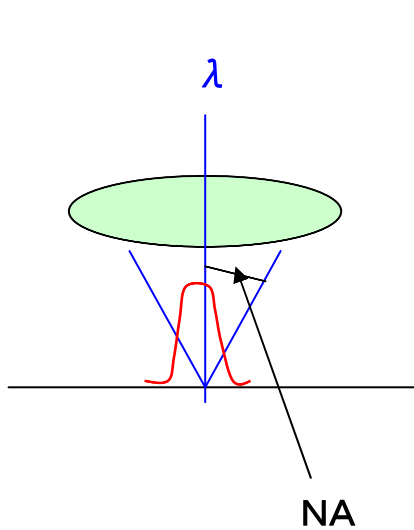
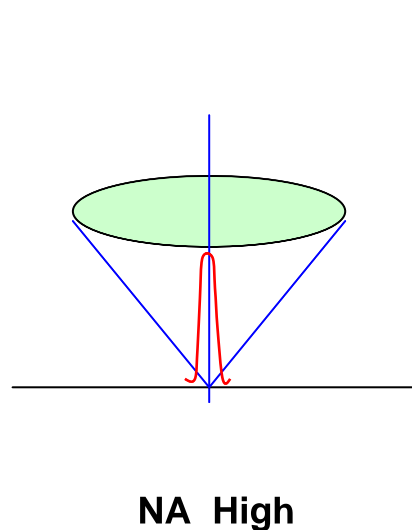
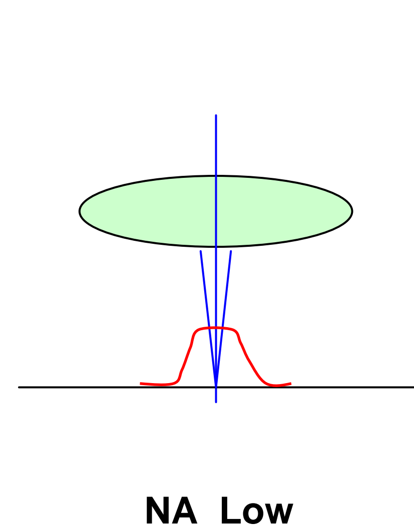
Advanced Technology for Enhanced Resolution

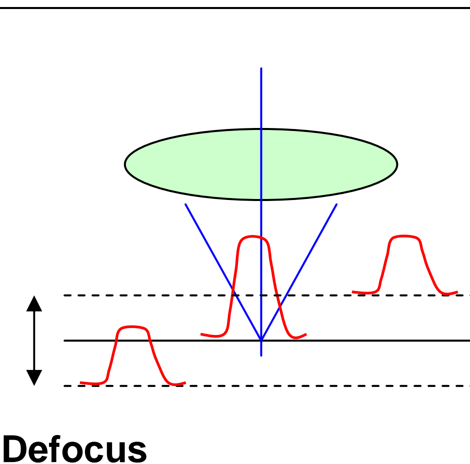


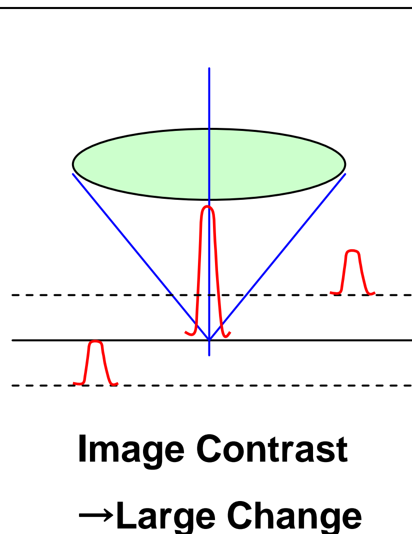


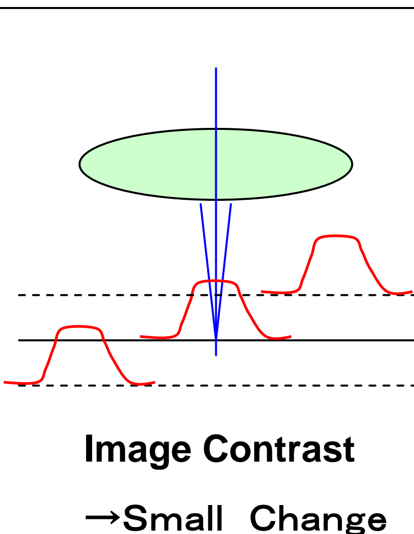


Resolution

= k ＊ λ／NA







Depth of Focus

$= \pm \lambda / NA^2$

1-2 Advanced Technology

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Higher NA lens can resolve critical dimension pattern, but reduces focus depth rapidly.

When high NA is used for the rough pattern, the focus depth becomes shallow.

In the rough pattern, large DOF can be obtained by lower NA according to pattern size.

・Fine IC,LSI（DRAM, CPU Logic, etc)

Super Flat（≦1μm） → No DOF Requirement

→ Larger NA → Finer Pattern

・Package, Bump, LED, Ceramic, MEMS….

Large凸凹（10～100～500μm）

→ Large DOF Requirement

→ Optimum NA → Maximum DOF

1-3 Advanced Technology

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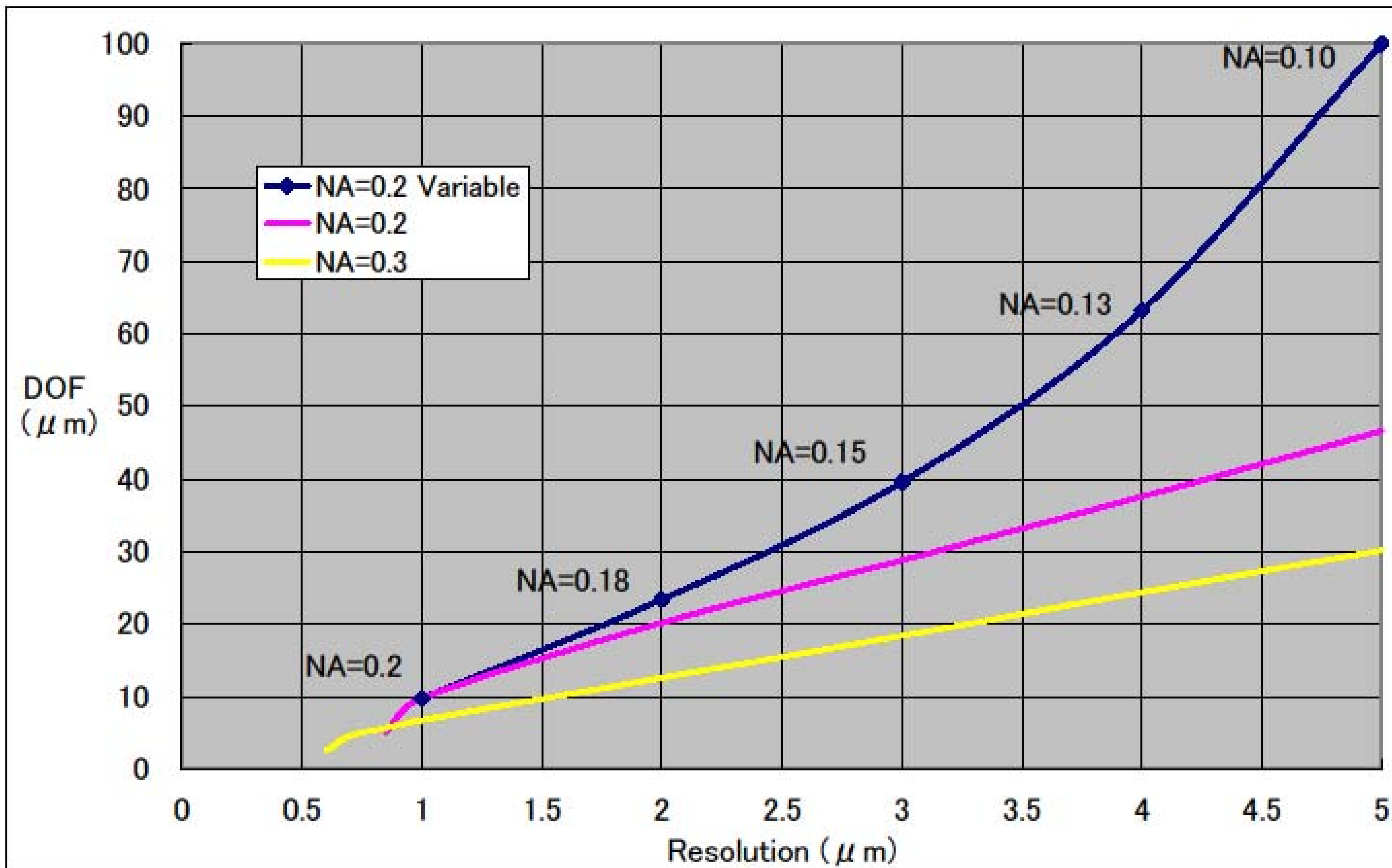
DOF Comparison in NA 0.3 Fixed NA

NA 0.2 Fixed NA

NA 0.2 with Variable NA



1-4 Advanced Technology

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・Introduction of Variable NA Optics enables to obtain best resolving power (maximum DOF) at various pattern size.

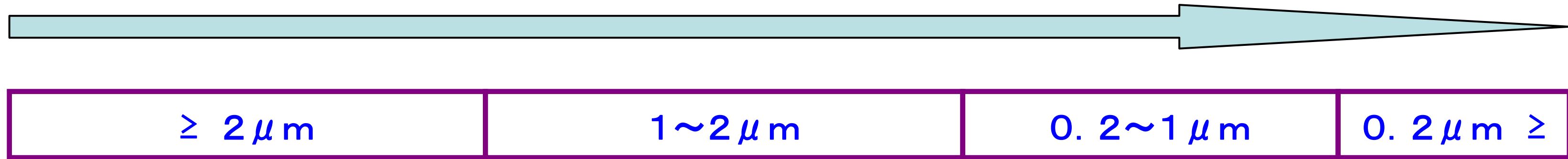
・Sub-micron pattern generation

1～0.8μm → Resolution Enhancement technology (RET) can enable much higher resolution and depth of focus.

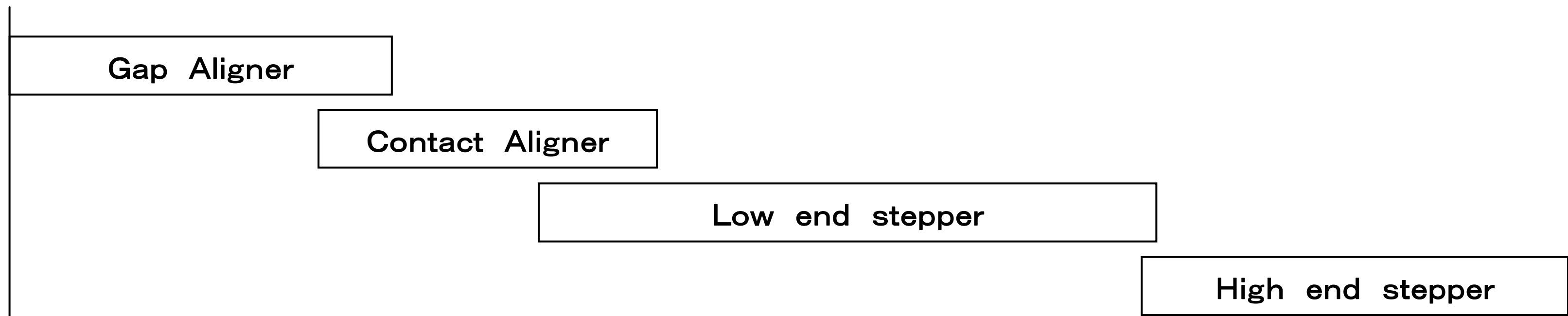
ASS stepper can introduce Annular Illumination as RET.
By Annular Illumination introduction、DOF increase is 20-30% compared to conventional illumination in optimum condition.

≦ 0.8μm → It is possible to correspond to 0.5μm pattern by exchanging for A lens.

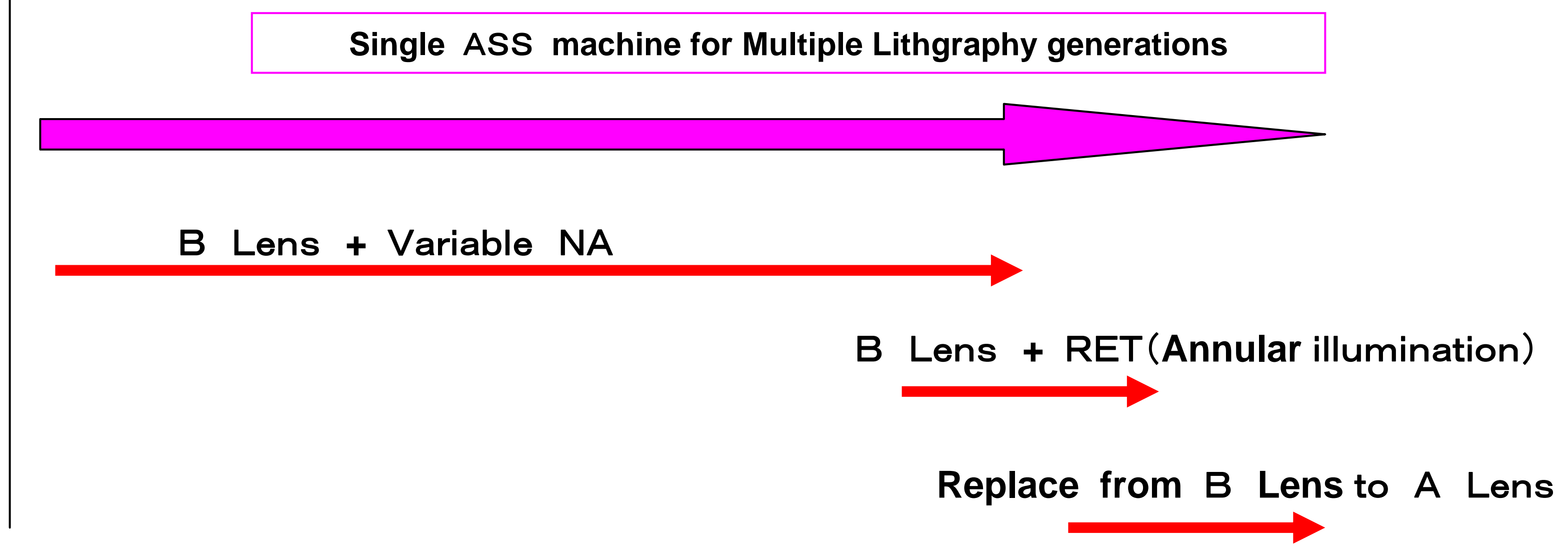
・As a result, deep focus depth can be secured in each generation of device manufacturing.



General Trend

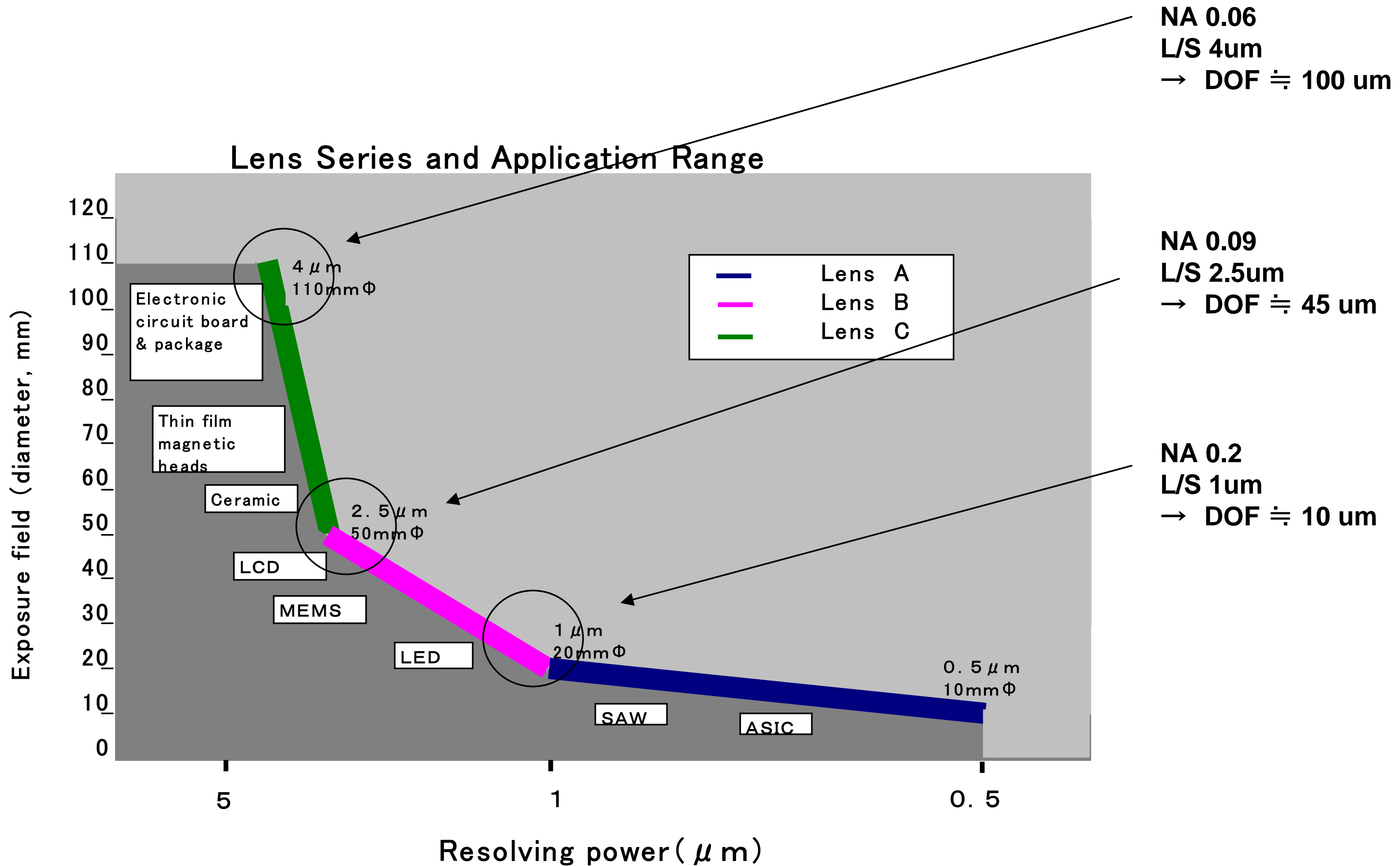


Mejiro Strategy



3D lithography by ASS stepper

ASS and Depth of Focus (DOF)



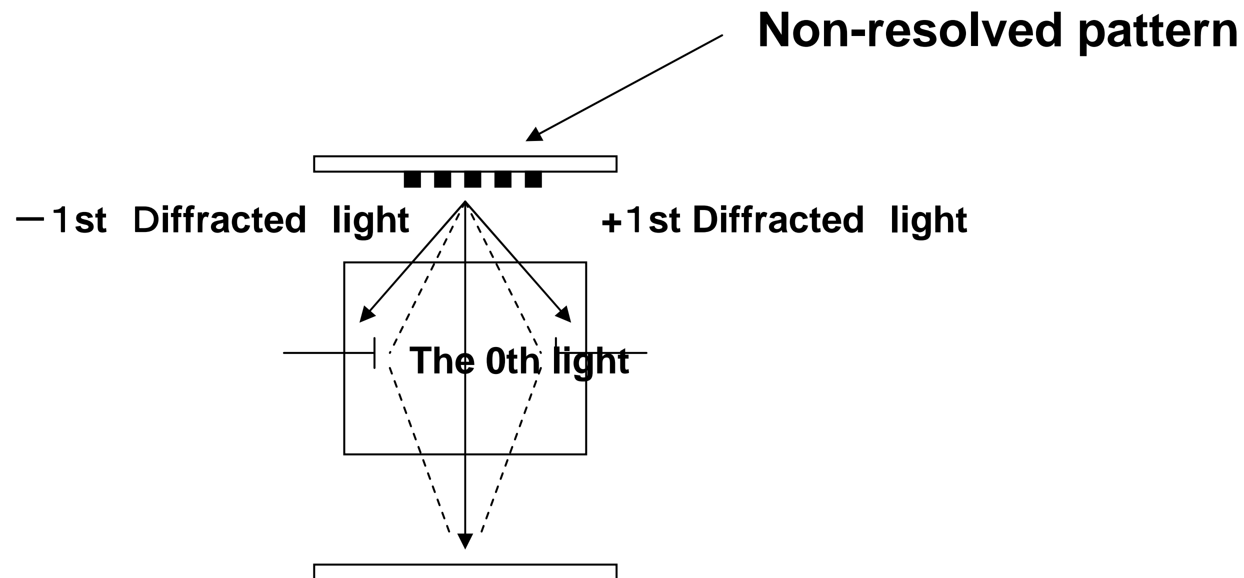
NA 0.06
L/S 4um
→ DOF ≒ 100 um

NA 0.09
L/S 2.5um
→ DOF ≒ 45 um

NA 0.2
L/S 1um
→ DOF ≒ 10 um

Basic concept

Resolution Limit



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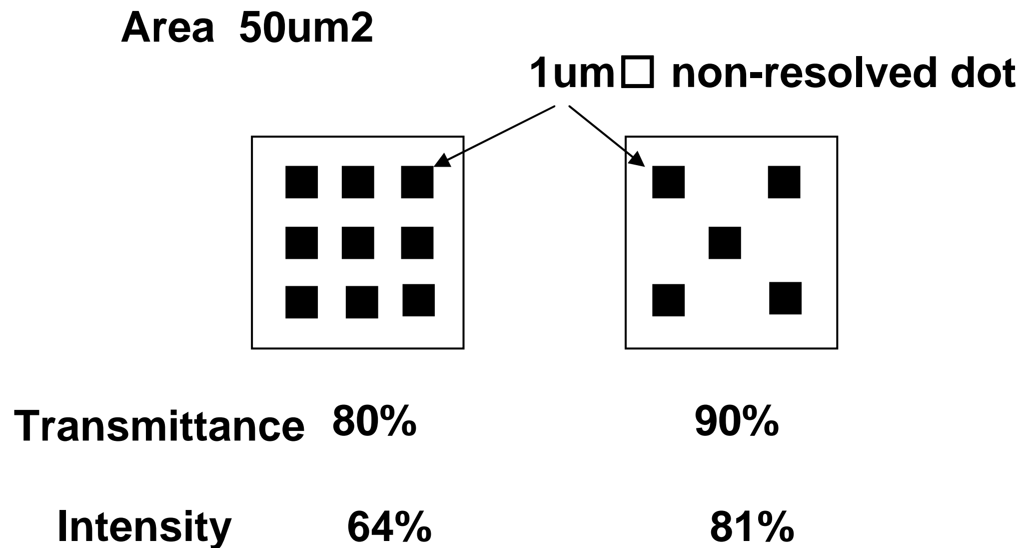
Control of reticle transmittance ratio by non-resolved dot pattern



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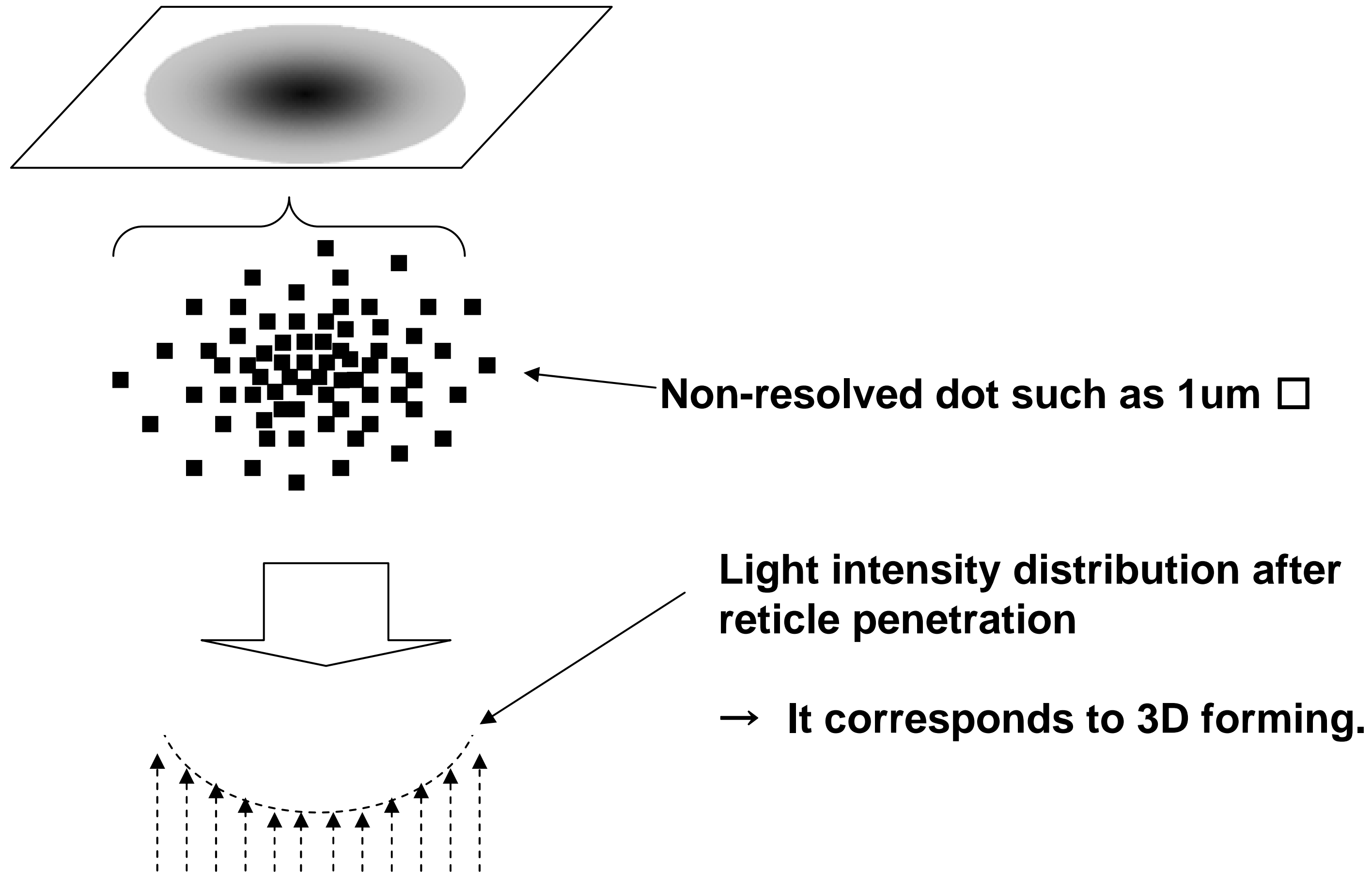
Reticle making for 3D exposure

The reticle with continuous density distribution is made corresponding to three dimension forming.
The density is decided by the number of patterns of the non-resolved dot for each area.



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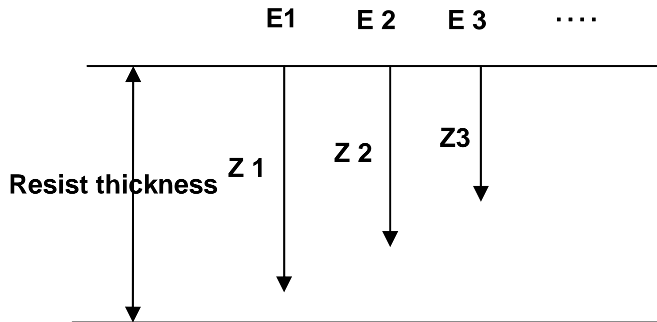
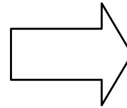
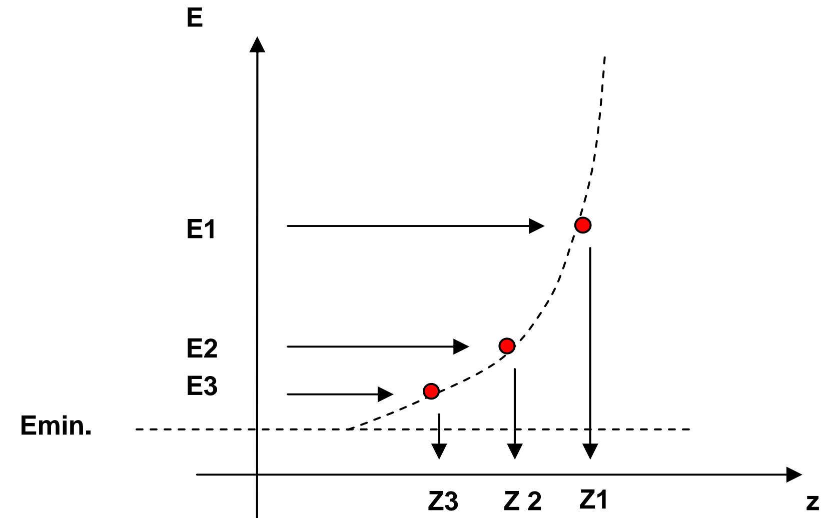
Absorption energy and resist dissolution depth

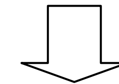
The relation between absorption energy (E) by the exposure and resist dissolution depth (Z) are experimentally decided.



Plot







Dissolution depth function Z = D (E) is decided.

→E(Z) corresponding to dissolution depth Z is calculated.

$$E(Z) = D^{-1}(Z)$$

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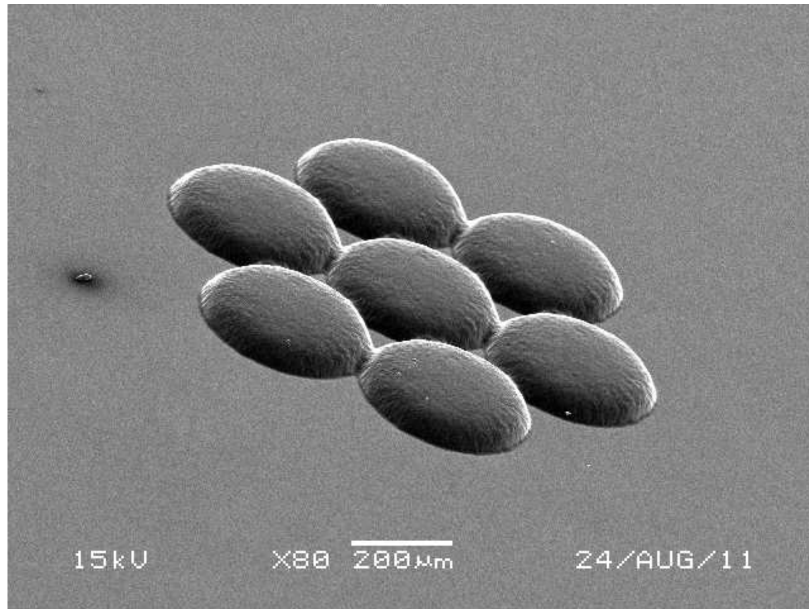
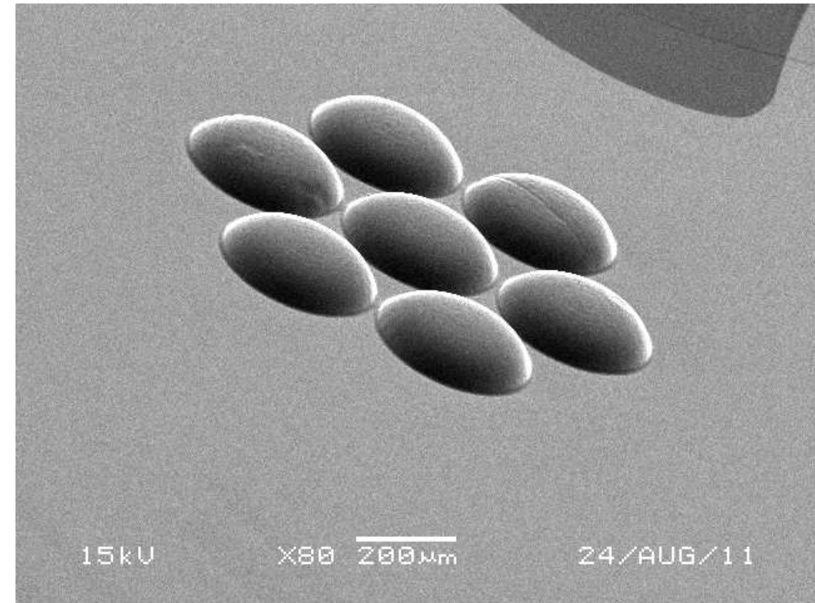
Actual Result for Micro Lens Array





Without thickness correction

With thickness correction
by dissolution depth function Z = D (E)

Presentation is ended above.
Thank you for listening.

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