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(22) 2004 04 22

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(71) 가 가 3 30 2

(72) 3 30 2 가 가

3 30 2 가 가

(74)

:

(54)

3 3 4 가 . .

1

- 1 1
- 2 2
- 3 3
- 4

5 (IC LSI), LCD, CCD

6 5 4

< >

M1: 1 M2: 2

M3: 3 M4: 4

M5: 5 M6: 6

MS: () W: ()

AX: MI:

200: 210:

214: 214a:

214b: 220:

230: 240:

250: 260:

, (LCD) (EUV: extreme ultraviolet) , 가 ,

가 0.1μm (Lamp;S) 80nm 가 가 (Lamp;S) , 가 가

) (가 ((R) , () (NA) . (

$$R = k_1 \times \lambda / NA \dots\dots\dots (1)$$

가 NA , (, 가). , , NA , KrF (excimer laser)(248nm) ArF (19 3nm) F2 (157nm) , , EUV(extreme ultraviolet) .

가 가 . , , , E
UV 가 가 (1) () 가

, NA EUV () 가 ()
, 13.5nm NA 0.2), 3, 4 가 6 (,)
'6 ')

6 , 6,033,097
6033079 2 EUV 6 가

4 , 5 , 1 4 가
, NA 6 6
(eclipse) , 4 가 5 6 6

6 가 09-211232 (585310)
2002-196242

, 6,033,079 , 3 가 가
, 3 , 3 가 , 4
700mm 가 , 4

, 5 가 5 5 가
0.4 ° 가 0.25, 16.7 ° 1mm 가 5 6,033,079 1 ,
가 가 가 가 (throughput) , 5

, EUV , 가 1500m
m , ,

, 3 3 / 4 ,

< >

가

1 3 , 1 , 2 3 (MS)()

, EUV ((W)(10 ~ 15nm,) 13.4 ~ 13.5nm) 가 .

1 (MI)() 2 (M2)() 3 (M3)() 4 (M4)()

(MS) 5 (M5)() 6 (M6)() 6 (MI) 가 . 가

(MS) 5 6 (W)

(MS) 1 (M1) (non-telecentric) , (MS)

(W)가 ,

가 , , 6 가 가

가 , ,

NA , (back focus) , 5 (M5)

, 6 (M6)

가, 가 가 (MS) (W) 가

of Petzval terms) $r_1 \sim r_6$, 가 (2) (3) (sum

$1/r_1 - 1/r_2 + 1/r_3 - 1/r_4 + 1/r_5 - 1/r_6 = 0 \dots\dots(2)$

$1/r_1 - 1/r_2 + 1/r_3 - 1/r_4 + 1/r_5 - 1/r_6 \approx 0 \dots\dots(3)$

3 (M3)가 가 3 (M3) 4 (M4)

3 가 가 3 가 5

70° 가 12° 가 19° 가

가 45° 가 25° ,가

, 4 (M4) 가 5 (M5) (eclipse) 3 6

(4) , 6 , 1

가 가 . 6 가 .

$$Z = \frac{ch^2}{1 + \sqrt{1 - (1+k)c^2 h^2}} + Ah^4 + Bh^6 + Ch^8 + Dh^{10} + Eh^{12} + Fh^{14} + Gh^{16} + Hh^{18} + Jh^{20} + \dots (4)$$

(4) , Z , c (r), h , k , A, B, C, D, E, F, G, H, J, . . . , 4 , 6 , 8 , 10 , 12 , 14 , 16 , 18 , 20

가

1, 2 3 (M3) 6 (M6) 3 (M3) 4 (M4)

가 3 (M3) 가 3 (M3)

가 가

3 (M3) 가 3 (M3) 3

(eclipse) 3 (M3) 6 (M6) 4 (M4) 가 5 (M5)

가 가 가 1, 2 3

3 (M3) 5 (M5) 가 5 (M5)

3 (M3) 4 (M4) 가 3 (M3) 가

0.01μm ~ 8μm, 0.01μm ~ 5μm 가 3 (M3)가

6,033,079 3 (M3) 4 (M4) 3 (M3) 5 (M5)

가 가 3 (M3)

가 EUV 가 (Mo) (Si)

20nm Mo/Si EUV (Mo) (Be) Mo/Be 가

가

5 (M5) 6 가 EUV 5 (M5)

(M4) , 5 (M5) 4 (M4) 4

가 8° 15° 5 (M5)

가 10° 14° 가

1 3 1 3

< 1 >

1 1 1 (100)

S) 1 (100) 6 (M1)() 2 (M2)(), 3 (M3) 4 (M4)(), 5 (M5)() 6 (M6)() (M3)
 . 3 (M3) 4 (M4) 5 (MI) 6 (MI)

(MS) , (W) ()

1 , 1 (100) NA 0.26 , 1:4, 138 ~ 146m
 m (2mm) . RMS 15m , 3nm

3 (M3) , 3 (M3) 4 (M4) 1 (M1), 2 (M2) 3 (M3)
 32.7 ° , 가 4 (M4) 5 (M5)

3 (M3) , 가 0.25, 가 1mm 1.31μm

, 3 (M3) 4 (M4) , 가
 1 (100) 가 1,236mm

5 (M5) , 0.25, 1mm 7.7
 °, 21 ° . 13.3 ° , 가

[1]

- No.
- M() 339.4777
- MI -2000 -391.3436
- M2 872.6187 439.2202
- M3 375.1731 -320.8985
- M4 580.6132 737.9442
- M5 305.1026 -292.1313
- M6 375.1247 322.1313
- W()

- MI K :-116.931826
- A :-.670181E-10 B :0.144096E-13 C :- .435492E-18
- D :0.145193E-22 E :- .622756E-27 F :0.231827E-31
- G :- .421307E-36
- M2 K :2.007473

A : -.373122E-09 B : -.136205E-15 C : 0.157375E-18

D : -.744742E-22 E : 0.236381E-25 F : -.408634E-29

G : 0.292633E-33

M3 K : 3.471994

A : -.901676E-08 B : 0.289184E-12 C : -.657974E-16

D : 0.287681E-20 E : 0.255935E-24 F : -.390393E-28

G : 0.137163E-32

M4 K : -0.044686

A : 0.956942E-10 B : 0.736613E-17 C : -.101759E-19

D : 0.207511E-24 E : -.658861E-30 F : -.108501E-34

G : 0.738458E-40

M5 K : 2.120289

A : -.610258E-08 B : 0.542562E-12 C : 0.338684E-16

D : -.158906E-19 E : 0.800719E-23 F : -.217410E-26

G : 0.251994E-30

M6 K : 0.041759

A : 0.106631E-09 B : 0.104596E-14 C : 0.986450E-20

D : -.873016E-25 E : 0.929688E-29 F : -.246930E-33

G : 0.265927E-38

< 2 >

2 2 2 (100A) .

2 , 2 (100A) NA 0.26 , 1:4, 140 ~ 144
 mm (2mm) . RMS 13.5m , 1.4nm .

3 (M3) , 3 (M3) 4 (M4)
 3) , 26.3° , 1 (M1), 2 (M2) 3 (M)
 , 가 4 (M4) 5 (M5)

3 (M3) 3 (M3) 6 (M6) .

3 (M3) , 0.25, 1mm 1.94μm
 , 가 가 .

, 3 (M3) 4 (M4) , 가 ,
 1 (100A) 가 1,343mm .

5 (M5) , 0.25, 1mm 9.3

°, 21° . 11.7° . 가 ,

[2]

No.

M () 782.9024

MI -3000 -434.2191

M2 986.3720 605.0807

M3 557.8812 -433.0176

M4 718.6422 783.6680

M5 274.00041 -270.6504

M6 356.0210 313.7101

W()

MI K :-177.180694

A :0.793933E-09 B :-.393306E-14 C :-.139116E-19

D :0.130527E-23 E :-.311665E-28 F :0.443632E-34

G :0.267089E-37

M2 K :0.449622

A :0.229919E-10 B :0.156132E-14 C :-.182568E-18

D :0.963975E-22 E :-.256166E-25 F :0.351754E-29

G :-.194839E-33

M3 K :0.045120

A :0.659822E-09 B :-.557183E-13 C :0.410361E-16

D :-.317182E-20 E :-.237235E-24 F :0.425191E-28

G :-.160620E-32

M4 K :0.002787

A :0.708916E-10 B :-.639861E-15 C :0.839509E-20

D :-.241587E-25 E :-.369797E-30 F :0.384196E-35

G :-.109928E-40

M5 K :0.315310

A :0.138224E-08 B :0.105862E-11 C :0.197184E-16

D :0.895863E-20 E :-.304525E-23 F :0.775932E-27

G :-.877582E-31

M6 K :0.039889

A :0.147010E-09 B :0.153805E-14 C :0.543962E-20

D :0.129313E-23 E :-.101970E-27 F :0.464801E-32

G :-.850841E-37

< 3 >

3 3 2 (100A) .
 NA 0.26 , 1:4, 122 ~ 130mm (2mm) .
 RMS 13.5m , 2.3nm .
 , 3 (M3) , 3 (M3) 4 (M4)
 , 36° . , 1 (M1), 2 (M2) 3 (M3)
 , 가 , 4 (M4) 5 (M5)
 3 (M3) 6 (M6) . , 1 (M1) 2 (M2)
 가 .
 3 (M3) , 가 0.25, 1mm 0.44μm
 , 가 .
 , 3 (M3) 4 (M4) , 가 ,
 1 (100A) 가 1,361mm .
 5 (M5) , 0.25, 1mm 5.65
 °, 19.1° . 13.4° . 가 ,

[3]

No.

M () 768.3742

MI -1396.8231 -314.9793

-291.8614

M2 1368.8180 557.6862

M3 441.4054 -229.5154

M4 582.6684 828.6221

M5 322.1290 -366.0451

M6 452.2826 408.6979

W()

M1 K :0.260716

A :0.146445E-08 B :-.164758E-13 C :0.317627E-18

D :-.207116E-22 E :0.179601E-26 F :-.908835E-31

G :0.191325E-35 H :0.000000E+00

M2 K : -14.574333

A :0.741726E-09 B :-.275694E-14 C :0.992898E-19

D :-.174216E-22 E :0.200285E-26 F :-.121819E-30

G :0.304220E-35 H :0.000000E+00

M3 K :0.276803

A :-.131078E-08 B :0.659659E-13 C :-.277262E-17

D :0.256152E-22 E :-.171689E-28 F :0.100339E-30

G :-.342734E-35 H :0.000000E+00

M4 K : -0.008783

A :0.106495E-08 B :-.233547E-13 C :0.308297E-18

D :-.194328E-2 E :0.153263E-29 F :0.431370E-34

G :-.146560E-39 H :0.000000E+00

M5 K : -0.233173

A :0.184221E-08 B :0.780441E-12 C :-.272684E-16

D :0.210085E-19 E :-.103583E-22 F :0.269109E-26

G :-.282927E-30 H :0.000000E+00

M6 K : -0.026937

A :0.129873E-09 B :0.749528E-15 C :0.434370E-20

D :-.363118E-25 E :0.260695E-29 F :-.471061E-34

G :0.992951E-40 H :0.000000E+00

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, 4

(200)

1

3

. 4 ,

(100, 100A, 100B)
(200)

) , 가 .

(245) , XYZ 240 (245a) (245) , (240) , (225) (240) (245) (220) , (240) ,

(250) , (220) (230) (240) (240) (230) (220) (240) (240) (230) (225) (245) , (240) (240)

(260) , (240) (240) (230) (245)

(240) (210) EUV (220) , (220) (220) (240) () , () (220) (220) (240)

() , , 가 가 , , 가

< >

5 6 (200)

5 , (IC LSI), LCD CCD 1 3 4 5 , () 4 6 5 () 7

6 , 4 11 13 15 () 14 16 (200) 18 17 19

(200)

ArF 가 (excimer laser) F2 가 EUV 200nm 가

, 3 / ,

(57)

1.

1 , 2 , 3 , 4 , 5 , 6 ,
3 가 , 3 4

2.

1 ,
1 6
12° 70° 3 , 3

3.

1 2 ,
3 6

4.

1 3 ,
5 가 , 6 가

5.

1 4 ,
3 0.01μm 8μm 가

6.

1 5 ,
1 6 , 3 , 6 5 2 , 4 ,

7.

1 5 ,
3 6 , 1 , 6 5 2 , 4 ,

8.

1 7 ,
5 8° 15°

9.

1 8 ,
1 2 가 .

10.

1 , 2 , 3 , 4 , 5 , 6 ,
1 3 4
, 1 6 70° 3 , 3 .

11.

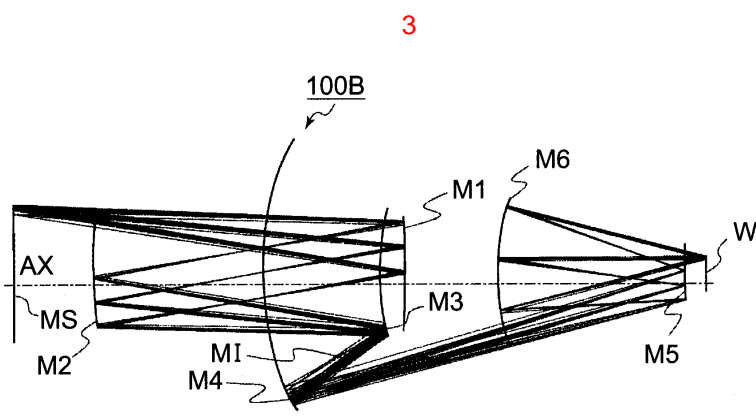
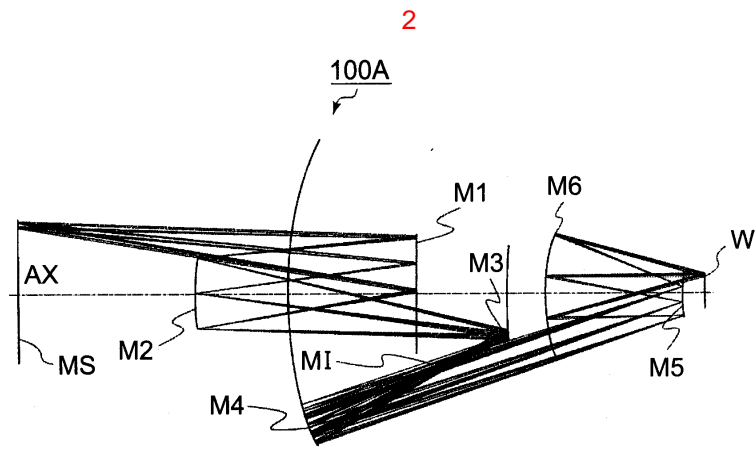
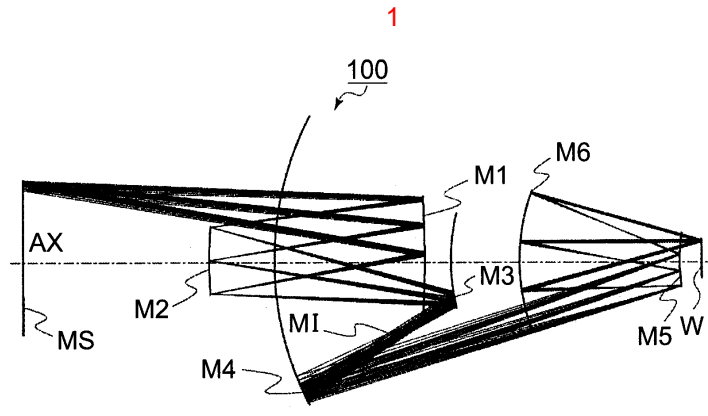
1 , 2 , 3 , 4 , 5 , 6 ,
1 3 4
6 , 1 6 , 3 .

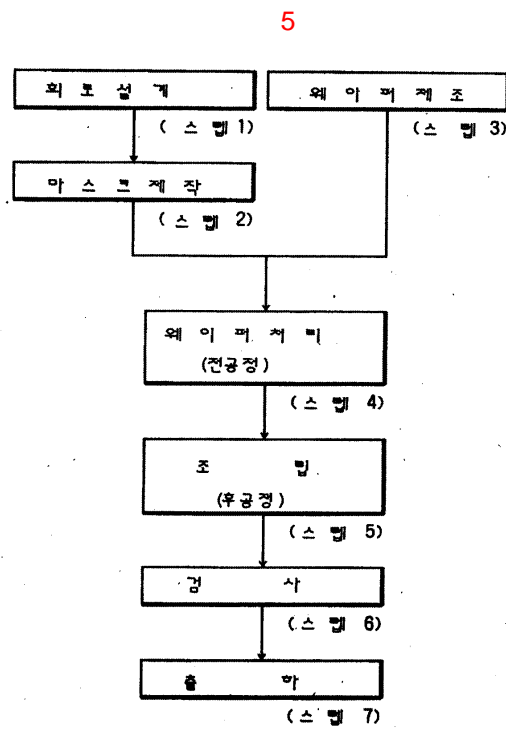
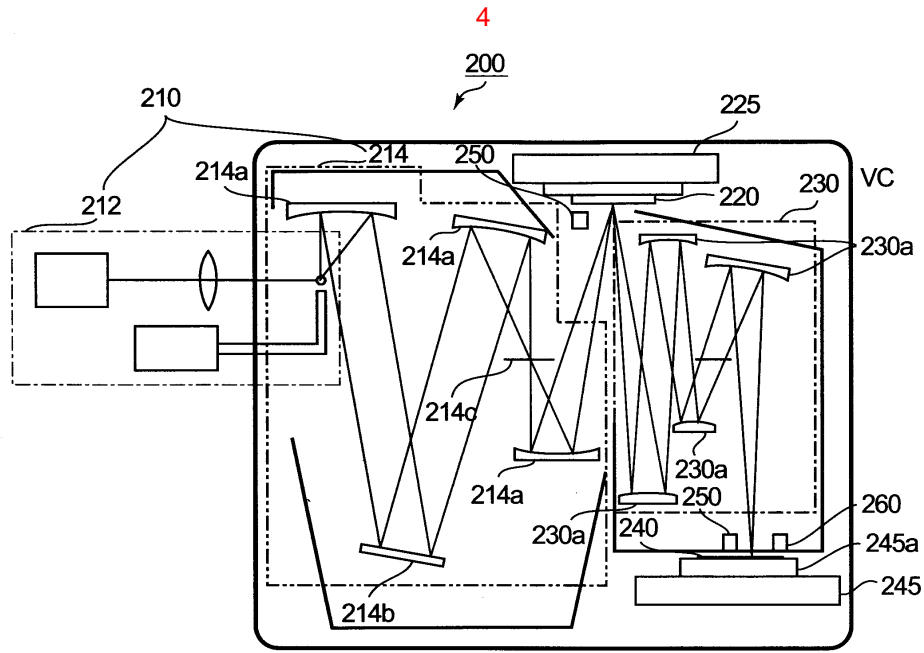
12.

가 ;
1 11 ;
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13.

12 ;
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6

