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(71) 73447 - - 22

(72) 13086 - 56

73434 44

(74)

:

(54)

3 , 가 4 가 , 1 , 가 5 가 2 , 가 4
 5 , 가 4 , 가 5 . 가 4
 NA>1 , . 100n
 m 200nm

가
 가 100nm (image-side) (NA) 가
 248nm, 193nm, 157nm / (oblique) 가 NA=0.8 260nm 가
 가 1

$$\lambda_{eff} = \lambda_0 / n$$

0 n (DOF; Depth of Focus) 2 3

$$R = k_1 (\lambda_{eff} / NA_0)$$

$$DOF = \pm k_2 (\lambda_{eff} / NA_0^2)$$

NA₀ = sin θ₀ , 0 k₁ k₂

, NA=1

가

'157nm (M. Switkes M. Rothschild, J. Vac. Sci. Technol. Vol. 19(6), Nov./Dec. 2
 001, 1) 157nm (PFPE; perfluoropolyeth
 er)

0.86 157nm n=1.37 가 (lens-free) NA=
 60nm
 5,610,683 (0 605 103)
 가 ,
 5,900,354 , 가

가 (image field) ,

1 가 가

- 가 1 ;
- 1 가 2 ;
- 2 가 3 ;
- 3 가 4 ;
- 4 가 5 ;
- 4 5 ;

(belly)

90% 95%가 가 (transilluminate) 가

NA 0.9 , n>1.3 가 NA=1.1 가
 30% 가
 100 μm , 10 20% 가 200 μm , 1
 20 μm 가

cated) (trun
 (sine) 90% 85% NA=0.9 1
 (quartz glass)가, 157nm 193nm (calcium fluoride)가
 F, MgF₂ 가 . BaF₂, NaF, Sr

- 1 193nm 1
- 2 193nm 2
- 3 157nm 3
- 4 193nm 4

가 ()
 가

(1) 가 1 5:1
 (2) (3) 가
 (4) (6), (8) (7) 가
 (LG1) (LG4) 166mm (LG3)
 2 (2) 121mm 가 4 (LG4) 166mm 3 (LG5)
 가 -33mm 가 1 4 (LG4) 5 (LG5) 2
 170mm 가 4 1 (LG1)
 (5) 4 (LG4) 5 (LG5)
 (8)
 (2) 가 1 (LG1) 1 (6) 1 (11) 2 (12) 1
 3 (13) (11, 12, 13) (2) 1 (3)
 2 3 , 1

2 (LG2) (2) (14, 15, 16, 17) ,
 (18) , (3) (19, 20) .
 가 (18) (18)
 (7) (19) (balancing-out) .

3 (LG3) , 가 (21),
 (22),
 가 (24) . (22) (23) (9) ,
 ()
 2 (19, 20) 4 (LG4) (25, 26) , (9)
 (19, 20) (21)가 , (22, 23)
 가 . (9) (24) (25, 26)
 , 4 (tension)

3 (22) (24)

4 (LG4) (27, 28) (29, 30) (25,
 26) (27, 29) 가
 (28, 30)
 (28)(f'=-728mm) (30)(f'=-981mm) (5)

5 (LG5) 2
 (8) (28, 30), (28) 5 (LG5) ,
 (5) 5 (LG5) 가 (5) 가 (32),
 (31), 가 가 (23), 가 (35) ()
 가 가 가
 (24) , 가 (35) ,
 31, 32, 33 34) (5) 4 (LG4) ,

4 (LG4) 5 (LG5)
 1 (27)
 (5) (31) ,
 5 (LG5) , (35)

n=1.47) 8.4mm 가 , (10) ()
 193nm

(1) 가 RMS 4m
 (field point) 1nm . 193nm , 100nm

(35) 가 (10)
 (evanescent field) 100nm

1
(d)(mm) 2 (r) 3 1
4 (free radii) 5 1/2(mm) 6
(4, 6, 15, 29, 34 44) 2
:

$$p(h) = [((1/r)h^2)/(1 + \sqrt{1 - (1+K)(1/r)^2 h^2})] + C1 * h^4 + C2 * h^6 + \dots$$

(1/r) h p(h)
(sagitta), z
K, C1, C2...)

(1) 193nm
n=1.56029 가
(10) n=1.56 (10)
1162mm () 가 24.1mm
가 22mm

1 가 2
(1') n=1.37
(PFPE) 157nm

4 5 1 LG4 1 1
(28) 가 (28')
가 (28') (30)
29, 30) 5 (LG5) 1
5) (31, 32) (32')
(5) (3) (5)

3 3 가 5 6 가 (1') 157nm
가 가 가 1 2
(28') 1 (11) 2
4 (LG4) (28) 가 1
(31, 32) (28') 2 (32')
(8) 2 (5) 2

n=1.37 , 157nm PFPE
50 μm
90% 가
(resolve) . 70nm

7 8 3 ()

(17)가

5 6 가 가

193nm 4:1 9 10 가 (1") 4 가 4

3 가 NA=0.9 가 25 2

(14, 15, 16) (LG2) (17)

4 (LG4) (27, 28)

3 (LG3) 2 (19, 20) 4

(25, 26) 가 가

4.5m 7 8 6.5m RMS 1 2

1nm , 4 5.2m

가

가 가 , 193nm (compaction) 가

가 (catadioptric)

가 2

가 가 1% 1.5% 2%

가 () 1% 가

가 가 가 2 2

가 2 2 3 1.8

3 2 3

가 가

; 가

26%, 30% 35%

가

가 가 2

가 3 가 2

[2]

비구면 상수

표면 번호 4

K 0.0000
 C1 2.13647921e-007
 C2 -3.57933301e-011
 C3 2.93263063e-015
 C4 -4.61461071e-019
 C5 2.76861570e-023
 C6 1.62740830e-027
 C7 -3.43732853e-031
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 44

K 0.0000
 C1 -5.18910040e-009
 C2 3.51025484e-013
 C3 -5.47716488e-018
 C4 4.43561455e-023
 C5 3.42844064e-028
 C6 -1.97724021e-032
 C7 2.22456117e-037
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 6

K 0.0000
 C1 -1.14265623e-007
 C2 2.02166625e-011
 C3 -1.76403105e-015
 C4 2.36305340e-019
 C5 -2.55314839e-023
 C6 1.35459868e-027
 C7 -2.70730236e-032
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 25

K 0.0000
 C1 -9.78914413e-008
 C2 -4.33166283e-012
 C3 -8.01001563e-017
 C4 -1.31611936e-019
 C5 6.54375176e-023
 C6 -1.37293557e-026
 C7 1.58764578e-030
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 29

K 0.0000
 C1 2.99497807e-008
 C2 -3.16131943e-012
 C3 -9.61008384e-017
 C4 2.05647555e-020
 C5 -2.56167018e-024
 C6 1.74321022e-028
 C7 -7.59802684e-033
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 34

K 0.0000
 C1 -5.83592306e-009
 C2 -4.08253893e-015
 C3 -3.40928951e-018
 C4 1.36466433e-022
 C5 -1.03090955e-026
 C6 4.02018916e-031
 C7 -9.89542799e-036
 C8 0.00000000e+000
 C9 0.00000000e+000

[3]

표면	반지름	두께	렌즈	굴절률 ??? nm	자유지름의 1/2
0	0.000000000	21.900160000	L710	0.99958200	55.000
1	0.000000000	6.228362492	L710	0.99998200	59.974
2	-603.070624671	9.513063455	SIO2HL	1.56028900	60.690
3	280.916333783	13.300217883	HE193	0.99971200	64.385
4	-461.660931347AS	8.066000000	SIO2HL	1.56028900	65.790
5	681.261406487	25.166533824	HE193	0.99971200	70.487
6	421.796712825AS	13.410528957	SIO2HL	1.56028900	89.920
7	306.236502978	23.641854301	HE193	0.99971200	95.293
8	-881.743075988	64.144962259	SIO2HL	1.56028900	97.777
9	-397.616228767	1.022715830	HE193	0.99971200	123.195
10	-1049.995266570	39.473283137	SIO2HL	1.56028900	130.947
11	-266.549348161	2.251083976	HE193	0.99971200	136.447
12	-659.273684770	52.089256568	SIO2HL	1.56028900	143.894
13	-209.207390137	1.008491553	HE193	0.99971200	146.415
14	-565.795559961	15.829681399	SIO2HL	1.56028900	145.408
15	-410.848668817	1.000000613	HE193	0.99971200	146.045
16	809.207497255	37.599045382	SIO2HL	1.56028900	142.424
17	-599.260287529AS	1.006000015	HE193	0.99971200	141.453
18	136.304287826	42.528385200	SIO2HL	1.56028900	113.454
19	157.516637917	1.000000000	HE193	0.99971200	101.084
20	126.013978931	34.051407776	SIO2HL	1.56028900	96.007
21	157.519818688	23.554259229	HE193	0.99971200	84.914
22	795.455608357	9.035828932	SIO2HL	1.56028900	82.369
23	78.918295718	38.239343318	HE193	0.99971200	63.551
24	-647.136797738	6.066000184	SIO2HL	1.56028900	63.056
25	148.158813477AS	32.440106724	HE193	0.99971200	61.484
26	-197.858636028	9.960377452	SIO2HL	1.56028900	62.472
27	1367.448704100	41.007582498	HE193	0.99971200	66.716
28	-87.255013445	0.475217865	SIO2HL	1.56028900	68.713
29	-396.760639119AS	6.473661900	HE193	0.99971200	88.202
30	-317.095597644	34.300021646	SIO2HL	1.56028900	90.935
31	-136.816156215	1.956487291	HE193	0.99971200	56.054
32	-384.621022314	18.250891268	SIO2HL	1.56028900	107.862
33	-158.063116797	1.000000006	HE193	0.99971200	111.057
34	807.690134076AS	41.496271568	SIO2HL	1.56028900	117.589
35	-280.885163902	25.354810908	HE193	0.99971200	117.901
36	-166.502630134	5.238823967	SIO2HL	1.56028900	117.263
37	988.468038668	6.681211723	HE193	0.99971200	131.802
38	1106.583200370	44.085872378	SIO2HL	1.56028900	134.587
39	-353.437766566	1.600000005	HE193	0.99971200	136.483
40	445.824457242	52.624318854	SIO2HL	1.56028900	142.739
41	-460.556866224AS	26.188809880	HE193	0.99971200	142.372
42	-248.318425801	36.706472180	SIO2HL	1.56028900	141.622
43	-340.049722714AS	16.312593082	HE193	0.99971200	146.673
44	0.000000000	12.926710616	HE193	0.99971200	142.237
45	1026.963905660	42.907366082	SIO2HL	1.56028900	142.523
46	-417.465602619	1.875432853	HE193	0.99971200	142.184
47	189.031074062	41.889210814	SIO2HL	1.56028900	121.251
48	698.095904580AS	1.076370948	HE193	0.99971200	117.434
49	109.988479121	34.05123871	SIO2HL	1.56028900	91.356
50	167.147263939	1.034746212	HE193	0.99971200	84.177
51	123.915863411	79.999373259	SIO2HL	1.56028900	77.713
52	0.000000000	10.366030727	IMMERS	1.37000000	25.089
53	0.000000000	0.000000000		1.00000000	11.000

[4]

비구면 상수

표면 번호 4

K 0.0000
 C1 2.26522214e-007
 C2 -3.59236651e-011
 C3 2.92133725e-015
 C4 -3.77696224e-019
 C5 7.96388858e-024
 C6 3.91986385e-027
 C7 -4.54711324e-031
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 6

K 0.0000
 C1 -1.19063117e-007
 C2 1.94138266e-011
 C3 -1.81962009e-015
 C4 2.25193097e-019
 C5 -2.25566558e-023
 C6 1.19237134e-027
 C7 -2.51584924e-032
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 17

K 0.0000
 C1 1.74375723e-011
 C2 -2.04139734e-014
 C3 7.67666306e-019
 C4 -1.93715606e-023
 C5 1.92834024e-027
 C6 -7.02565837e-032
 C7 1.14576119e-036
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 25

K 0.0000
 C1 -6.99705361e-008
 C2 -3.25537639e-012
 C3 -2.93013408e-016
 C4 -9.17751598e-020
 C5 4.34261555e-023
 C6 -1.01901896e-026
 C7 1.42841266e-030
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 29

K 0.0000
 C1 3.01669174e-008
 C2 -4.16186211e-012
 C3 -2.10017649e-017
 C4 1.39690646e-020
 C5 -1.51163159e-024
 C6 6.56520689e-029
 C7 -3.15414270e-033
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 31

K 0.0000
 C1 -4.23637017e-009
 C2 -3.29710303e-014
 C3 -3.52756803e-018
 C4 -4.13266120e-023
 C5 -2.18653880e-027
 C6 2.27691141e-031
 C7 -8.70596013e-036
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 41

K 0.0000
 C1 3.45855942e-009
 C2 5.47566277e-014
 C3 -3.85610770e-018
 C4 2.74041138e-023
 C5 1.86632362e-027
 C6 -3.44742394e-032
 C7 3.29571792e-038
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 43

K 0.0000
 C1 -3.55873802e-010
 C2 9.63322458e-014
 C3 -7.64415866e-018
 C4 2.00153471e-023
 C5 -1.98329358e-027
 C6 5.52524526e-032
 C7 -4.80876507e-037
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 48

K 0.0000
 C1 -2.25289484e-009
 C2 2.62711822e-013
 C3 3.12883195e-018
 C4 -2.96009757e-022
 C5 1.93969203e-026
 C6 -7.02702044e-031
 C7 1.40339412e-035
 C8 0.00000000e+000
 C9 0.00000000e+000

[5]

표면	반지름	두께	렌즈	굴절률 ??? . ?? -mm	자유지름의 1/2
0	0.000000000	21.580160000	L710	1.000000000	55.000
1	0.000000000	5.521159992	L710	1.000000000	59.973
2	-653.380153342	10.709637537	CAF2HL	1.558487200	60.652
3	234.066819378	14.792447066	HE193	1.000000000	64.672
4	-541.443785623AS	8.069018137	CAF2HL	1.558487200	66.216
5	809.687192810	22.060952617	HE193	1.000000000	70.663
6	437.017712375AS	16.925408940	CAF2HL	1.558487200	88.269
7	315.047933823	22.322216303	HE193	1.000000000	94.661
8	-105E.166104070	68.241607282	CAF2HL	1.558487200	97.341
9	-440.417777767	1.550157109	HE193	1.000000000	124.495
10	-833.235756565	45.202998015	CAF2HL	1.558487200	130.520
11	-248.097167968	6.967867993	HE193	1.000000000	136.785
12	-667.629333865	58.527118374	CAF2HL	1.558487200	147.021
13	-230.265801432	1.000000000	HE193	1.000000000	152.069
14	-635.989091493	52.689533957	CAF2HL	1.558487200	151.782
15	-420.897980530	1.000000000	HE193	1.000000000	155.231
16	682.574050518	42.565469096	CAF2HL	1.558487200	150.819
17	-650.602325928AS	1.000000000	HE193	1.000000000	149.697
18	143.909393739	39.312156678	CAF2HL	1.558487200	117.562
19	170.361039751	1.000000000	HE193	1.000000000	106.663
20	127.366697165	33.064705940	CAF2HL	1.558487200	99.556
21	149.757517850	27.658696477	HE193	1.000000000	88.267
22	893.404652749	8.000000000	CAF2HL	1.558487200	85.687
23	85.474739309	42.082501866	HE193	1.000000000	67.021
24	-554.412638267	8.000000000	CAF2HL	1.558487200	65.854
25	113.887772525AS	36.097576773	HE193	1.000000000	63.605
26	-202.032636775	8.000000000	CAF2HL	1.558487200	64.919
27	136B.827225050	39.670298843	HE193	1.000000000	68.993
28	-87.722719327	8.150939605	CAF2HL	1.558487200	70.057
29	-341.867554503AS	7.243142706	HE193	1.000000000	89.680
30	-270.393973321	34.812062471	CAF2HL	1.558487200	92.272
31	-131.925970131	1.000000000	HE193	1.000000000	97.490
32	-356.379287279	37.218470508	CAF2HL	1.558487200	109.741
33	-160.486735217	1.000000000	HE193	1.000000000	113.010
34	72E.417353927AS	44.411516365	CAF2HL	1.558487200	121.086
35	-285.991760803	26.777077207	HE193	1.000000000	121.404
36	-169.413078216	8.000000000	CAF2HL	1.558487200	120.698
37	1233.439177430	5.704973599	HE193	1.000000000	135.519
38	196E.954811160	42.925033480	CAF2HL	1.558487200	136.862
39	-334.436426428	1.000000000	HE193	1.000000000	138.795
40	44B.482885926	53.515273929	CAF2HL	1.558487200	145.983
41	-481.778223591AS	38.864604302	HE193	1.000000000	145.641
42	-257.207339099	39.651511432	CAF2HL	1.558487200	141.395
43	-252.351244424AS	8.074724759	HE193	1.000000000	146.219
44	0.000000000	8.135112666	HE193	1.000000000	142.806
45	1571.538613070	41.393617207	CAF2HL	1.558487200	143.060
46	-395.530190539	4.955628551	HE193	1.000000000	142.883
47	189.584554041	44.893605417	CAF2HL	1.558487200	122.058
48	737.400220721AS	1.254530428	HE193	1.000000000	117.739
49	113.971025132	34.166140572	CAF2HL	1.558487200	91.975
50	186.560340242	1.000000000	HE193	1.000000000	85.029
51	124.915012572	92.227373544	CAF2HL	1.558487200	76.952
52	0.000000000	0.059000026	IMMERS	1.370000000	11.068
53	0.000000000	0.000600000		1.000000000	11.000

[6]

비구면 상수

표면 번호 4

K 7.3965
 C1 2.19490589e-007
 C2 -3.18478613e-011
 C3 2.65699241e-015
 C4 -2.54396719e-019
 C5 1.30925174e-023
 C6 2.26447806e-027
 C7 -2.54478129e-031
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 6

K 0.6253
 C1 -1.14294859e-007
 C2 1.87842360e-011
 C3 -1.79164086e-015
 C4 2.34304280e-019
 C5 -2.31194499e-023
 C6 1.12536497e-027
 C7 -2.03074756e-032
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 17

K 0.7878
 C1 -3.05439457e-010
 C2 -4.89773136e-014
 C3 1.06523190e-018
 C4 -1.49516954e-023
 C5 1.34357146e-027
 C6 -5.23906240e-032
 C7 8.17069597e-037
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 25

K 0.0013
 C1 -6.90163181e-008
 C2 -2.08603493e-012
 C3 -3.48958289e-016
 C4 -3.58451964e-020
 C5 2.16254654e-024
 C6 -3.58801026e-027
 C7 6.60002235e-031
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 29

K -0.0334
 C1 3.02609727e-003
 C2 -3.89225347e-012
 C3 -2.10302538e-017
 C4 1.38850354e-020
 C5 -1.75116022e-024
 C6 5.45164389e-029
 C7 -4.34831621e-033
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 34

K 1.5440
 C1 -3.43367330e-009
 C2 -1.34450662e-014
 C3 -2.29266384e-018
 C4 9.75729676e-023
 C5 -1.35202712e-026
 C6 8.80518329e-031
 C7 -2.65068179e-035
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 41

K 0.0872
 C1 3.26909809e-009
 C2 7.76009100e-014
 C3 -3.82550397e-018
 C4 2.28007850e-023
 C5 -2.34153651e-028
 C6 1.34376006e-032
 C7 -1.01621532e-036
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 43

K -0.0312
 C1 -4.99867832e-010
 C2 1.15316140e-013
 C3 -1.41640795e-018
 C4 7.05365641e-023
 C5 -2.43649494e-027
 C6 6.83361566e-032
 C7 -6.25588420e-037
 C8 0.0000000e+000
 C9 0.0000000e+000

표면 번호 45

K -1.8716
 C1 -4.01414746e-009
 C2 1.94301708e-013
 C3 4.07775004e-018
 C4 -4.70574709e-022
 C5 2.42642656e-026
 C6 -8.38949812e-031
 C7 1.38189311e-035
 C8 0.0000000e+000
 C9 0.0000000e+000

[7]

표면	반지름	두께	렌즈	굴절률 157.6 nm	자유자극의 1/2
0	0.00000000	21.980160000			55.000
1	0.00000000	5.694926000			59.974
2	-683.677082960	0.000016965	CAF2HL	1.55848720	60.653
3	241.864516194	43.492175419			64.060
4	-561.32737491EAS	8.000000000	CAF2HL	1.55848720	65.556
5	699.454774317	23.282413511			69.867
6	400.792577467AS	11.762291230	CAF2HL	1.55848720	88.232
7	293.254619517	22.305108600			92.839
8	-1055.962319550	71.454692862	CAF2HL	1.55848720	95.242
9	-483.111726442	2.387528569			124.181
10	-967.495111648	48.847817148	CAF2HL	1.55848720	130.362
11	-235.898512938	5.659224997			136.444
12	-579.940954244	54.879651202	CAF2HL	1.55848720	145.324
13	-221.637621898	1.000000000			149.602
14	-775.372223325	15.081823940	CAF2HL	1.55848720	147.807
15	-525.919669017	1.000000000			148.157
16	660.302511324	38.720317303	CAF2HL	1.55848720	144.440
17	-732.467947129AS	1.000000000			142.303
18	147.955956945	38.541140120	CAF2HL	1.55848720	116.315
19	174.954421407	1.000000000			105.360
20	118.333525649	33.404122786	CAF2HL	1.55848720	96.491
21	140.216192798	28.013456674			85.972
22	788.027919344	8.457239650	CAF2HL	1.55848720	83.494
23	83.038352631	41.178404325			65.374
24	-597.396381251	8.000000000	CAF2HL	1.55848720	64.284
25	136.956016017AS	31.536496068			62.327
26	-200.199292002	8.000000000	CAF2HL	1.55848720	63.210
27	1650.730497600	43.442178500			66.958
28	-86.362069271	8.210360232	CAF2HL	1.55848720	69.385
29	-360.179454579AS	2.567422592			89.255
30	-280.681605332	34.872981631	CAF2HL	1.55848720	92.027
31	-132.71394399E	1.004709559			97.215
32	-361.662148157	37.722697596	CAF2HL	1.55848720	109.325
33	-159.165877620	1.000000000			112.571
34	750.946018427AS	43.541363913	CAF2HL	1.55848720	120.144
35	-265.800553705	25.930047100			120.440
36	-169.581349559	8.030377840	CAF2HL	1.55848720	119.789
37	1077.110465570	5.662989489			134.185
38	1605.653205960	43.332820801	CAF2HL	1.55848720	135.539
39	-333.794563037	1.000000000			137.425
40	448.584289713	52.027765048	CAF2HL	1.55848720	144.043
41	-487.266144069AS	37.362834300			143.681
42	-256.080121302	40.279714930	CAF2HL	1.55848720	139.838
43	-353.759022671AS	7.564240001			144.656
44	0.000000000	10.832272687			141.334
45	1499.148980820	42.690870531	CAF2HL	1.55848720	141.660
46	-394.545474104	2.590581943			141.445
47	188.588735298	43.117430646	CAF2HL	1.55848720	121.630
48	731.593986095AS	1.000000000			117.999
49	114.385951039	38.926813476	CAF2HL	1.55848720	92.421
50	184.018635075	1.000000000			85.485
51	123.357012260	93.333950149	CAF2HL	1.55848720	77.332
52	0.000000000	0.050000000	Immersion	1.370000000	11.068
53	0.000000000	0.050000000			11.000

[8]

비구면 상수

표면 번호 4

K 2.4315
 C1 2.24623591e-007
 C2 -3.32117029e-011
 C3 2.75211747e-015
 C4 -3.79240993e-019
 C5 1.61861324e-023
 C6 2.15578277e-027
 C7 -2.81211737e-031
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 6

K 1.5259
 C1 -1.13176954e-007
 C2 1.85234618e-011
 C3 -1.79284980e-015
 C4 2.32876675e-019
 C5 -2.32868876e-023
 C6 1.17478944e-027
 C7 -2.27644098e-032
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 17

K 1.6238
 C1 -4.04184504e-010
 C2 -5.52222230e-014
 C3 1.07782813e-018
 C4 -9.66877933e-024
 C5 1.93184487e-027
 C6 -7.97223584e-032
 C7 1.33745628e-036
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 25

K 0.0096
 C1 -6.72874580e-002
 C2 -2.6601173e-012
 C3 -4.28260635e-016
 C4 -8.53656144e-020
 C5 3.61027613e-023
 C6 -7.30828628e-027
 C7 1.01538199e-030
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 29

K -0.2785
 C1 3.11515963e-008
 C2 -4.08777758e-012
 C3 -6.25352384e-016
 C4 1.47781039e-020
 C5 -1.67736576e-024
 C6 7.45170419e-029
 C7 -2.04782511e-033
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 34

K 1.5943
 C1 -3.41875063e-009
 C2 -1.06207572e-014
 C3 -2.75870187e-018
 C4 1.25443795e-022
 C5 -1.53842992e-026
 C6 9.81335165e-031
 C7 -2.88557010e-035
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 41

K 0.1099
 C1 3.24105758e-009
 C2 7.37348572e-014
 C3 -3.58460435e-018
 C4 2.55537441e-023
 C5 -1.78486202e-028
 C6 1.62622698e-032
 C7 -1.16103266e-036
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 43

K 0.0331
 C1 -4.94661761e-010
 C2 1.09503739e-013
 C3 -1.45124835e-018
 C4 6.84609756e-023
 C5 -2.60450711e-027
 C6 7.57276741e-032
 C7 -7.11474674e-037
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 48

K -1.8262
 C1 -4.00081230e-009
 C2 1.92491101e-013
 C3 3.74976393e-018
 C4 -4.50566284e-022
 C5 2.41249474e-026
 C6 -8.61661412e-031
 C7 1.44171993e-035
 C8 0.00000000e+000
 C9 0.00000000e+000

[9]

표면	반지름	두께	렌즈	굴절률	자유지름의 $\frac{1}{2}$
				1.933368 nm	
0	0.00000000	21.980160000		1.00000000	56.080
1	0.00000000	2.246886384	L710	0.9998200	61.197
2	-7758.072975441	8.000000000	SiO2HL	1.56028900	61.896
3	355.789181967	7.529172915	HE193	0.99971200	63.992
4	1890.36984232AS	8.000000000	SiO2HL	1.56028900	65.078
5	268.213281606	15.157771412	HE193	0.99971200	68.460
6	3183.17465849AS	8.000000000	SiO2HL	1.56028900	72.301
7	542.737827921	25.228019508	HE193	0.99971200	76.281
8	-190.186655474	54.303344531	SiO2HL	1.56028900	78.244
9	-200.972554549	1.000000000	HE193	0.99971200	102.934
10	-1181.739114120	41.618091168	SiO2HL	1.56028900	116.315
11	-200.899751189	1.000000000	HE193	0.99971200	119.335
12	-345.801617038	34.756009233	SiO2HL	1.56028900	122.895
13	-183.035943027	1.000000000	HE193	0.99971200	125.001
14	468.598304219	28.888366130	SiO2HL	1.56028900	119.583
15	-1579.330378454AS	1.000000000	HE193	0.99971200	118.410
16	130.622577421	25.607493426	SiO2HL	1.56028900	101.535
17	167.663753684	1.000000000	HE193	0.99971200	96.903
18	109.815011627	32.485629573	SiO2HL	1.56028900	88.871
19	139.897752059	27.284753341	HE193	0.99971200	79.284
20	8434.054206242	8.000000000	SiO2HL	1.56028900	76.872
21	75.280373304	30.508120723	HE193	0.99971200	60.167
22	712.917049547	8.000000000	SiO2HL	1.56028900	59.980
23	137.047950149AS	41.376149228	HE193	0.99971200	58.756
24	-120.168111858	8.000000000	SiO2HL	1.56028900	60.070
25	-335.689995101	26.955101014	HE193	0.99971200	64.725
26	-86.294324443	6.405631441	SiO2HL	1.56028900	65.622
27	-401.221976575AS	6.791819241	HE193	0.99971200	82.386
28	-295.528316334	33.017957091	SiO2HL	1.56028900	84.761
29	-156.311920634	1.000000000	HE193	0.99971200	53.276
30	-268.579127216	33.049041389	SiO2HL	1.56028900	99.716
31	-143.116318461	1.000000000	HE193	0.99971200	103.445
32	472.893981029AS	41.687451272	SiO2HL	1.56028900	115.709
33	-346.217431641	22.889302349	HE193	0.99971200	116.094
34	-187.601096847	12.645469238	SiO2HL	1.56028900	115.710
35	-359.852656461	1.000000000	HE193	0.99971200	121.777
36	722.017664882	60.459509481	SiO2HL	1.56028900	125.218
37	-1816.432711561AS	24.260458335	HE193	0.99971200	125.322
38	2199.280274610	24.178147653	SiO2HL	1.56028900	124.815
39	-1512.556712635	8.000000000	HE193	0.99971200	124.440
40	0.000000000	14.309578556	HE193	0.99971200	123.088
41	1738.196396601	35.559449287	SiO2HL	1.56028900	124.310
42	-429.627570104AS	1.000000000	HE193	0.99971200	124.575
43	179.589162742	55.687793359	SiO2HL	1.56028900	115.507
44	589.02798743AS	10.530033379	HE193	0.99971200	105.186
45	136.621158961	53.097791469	SiO2HL	1.56028900	89.320
46	137.713831620	1.000000000	HE193	0.99971200	67.001
47	93.326477153	90.505495277	SiO2HL	1.56028900	62.339
48	0.000000000	1.000000545	IMMERS	1.56000000	14.735
49	0.000000000	0.000000000		1.00000000	14.020

[10]

비구면 상수

표면 번호 4

K 0.0000
 C1 2.81531001e-007
 C2 -3.99703415e-011
 C3 2.76850090e-015
 C4 -4.54887122e-019
 C5 -5.66904777e-024
 C6 5.03662466e-027
 C7 -4.520E0360e-031
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 32

K 0.0000
 C1 -2.59168418e-009
 C2 -8.93760219e-014
 C3 -4.25486946e-018
 C4 3.13091668e-022
 C5 -1.87333640e-026
 C6 1.28572875e-030
 C7 -3.94471730e-035
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 6

K 0.0000
 C1 -1.16706261e-007
 C2 2.00348321e-011
 C3 -1.51130378e-015
 C4 3.09660955e-019
 C5 -1.76658953e-023
 C6 3.15835636e-027
 C7 -4.23595936e-031
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 37

K 0.0000
 C1 3.92265908e-009
 C2 5.90432031e-014
 C3 -4.61273256e-018
 C4 5.09437288e-023

표면 번호 15

K 0.0000
 C1 -9.37524970e-010
 C2 -2.58161066e-013
 C3 -5.12506559e-018
 C4 1.80598481e-022
 C5 3.60535800e-027
 C6 3.85878819e-031
 C7 -3.50550744e-037
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 23

K 0.0000
 C1 -9.05676602e-008
 C2 -7.64727914e-013
 C3 -9.31867049e-016
 C4 9.20035750e-020
 C5 -9.15433014e-023
 C6 1.32736186e-026
 C7 -9.23872382e-031
 C8 0.00000000e+000
 C9 0.00000000e+000

표면 번호 27

K 0.0000
 C1 2.51819254e-006
 C2 -4.37829106e-012
 C3 2.68987386e-017
 C4 1.45024261e-020
 C5 -1.31152094e-024
 C6 1.04657156e-030
 C7 -9.71174549e-034
 C8 0.00000000e+000
 C9 0.00000000e+000

가

(57)

1.

가 1 (LG1);

1 가 2 (LG2);

2 가 3 (LG3);

3 가 4 (LG4);

4 가 5 (LG5);

4 5 (5);

2.

1 , (5) (3)

3.

1 2 , NA 0.9 가 , NA=1.0

4.

n>1.3 가 (10)

5.

10 μm 200 μm, 20 μm 100 μm 가

6.

4 (LG4) 5 (LG5) 0.9 1.1

7.

1 (LG1) 5 (LG5) 0.7 1.3 , 0.9
1.1

8.

5 (LG5) 5 , 6 , 8

9.

1 (LG1) , 1

10.

3 (LG3) ,

11.

,
1 / ,

12.

,
1 (LG1) 가 (13)가 (2)

13.

14 2 가 , 가 (20)

14.

2 (LG2) (14, 15, 16, 17) (2) 가 , / 2 가 , (19)
, 20) 가 가

15.

2 (LG2) 가 가
(14, 15, 16, 17), (18) ,
(19, 20) 가

16.

3 (LG3) 가 (21, 22, 23, 24)

17.

3 (LG3) (9) , 3 /
3 (LG3)

18.

3 (LG3) 3 2 (LG2) 3 4 (LG4)
(9)

19.

4 (LG4) (27, 29) 가 (27, 28, 29, 30)
가 (28, 30) 가 ,

20.

(25, 26) 가 , 4 (LG4) 가 (2)
가

21.

90% , 85%

22.

5 (LG5) 가

23.

5 (31 35)

24.

3, 34) 5 (LG5) 가 가 (3)
가

25.

- (35) 5 (LG5) 가 가

26.

25 , (35)

27.

/ 157nm , 193nm

28.

(6), (8) (7) 가 -

29.

1.5% 10nm , 20nm / 1.0% ,

30.

1% , 2%

31.

(5)

32.

가 (5)

33.

26% , 30%

34.

가 가 가

35.

(1, 1', 1')

36.

가 ;

;

1 34

;

가







