FIG. 1

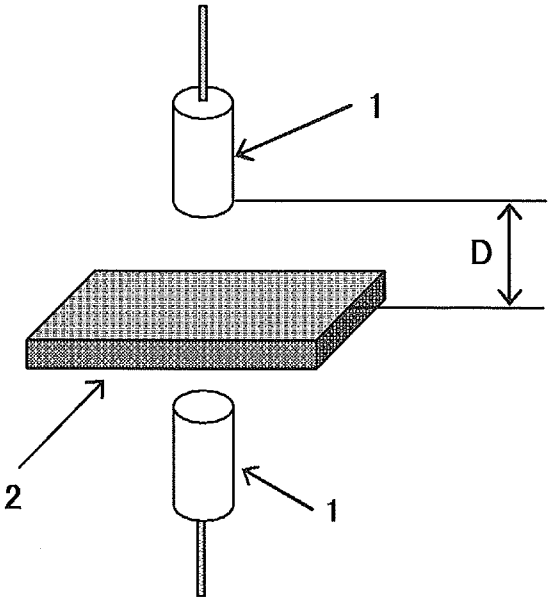


FIG. 2

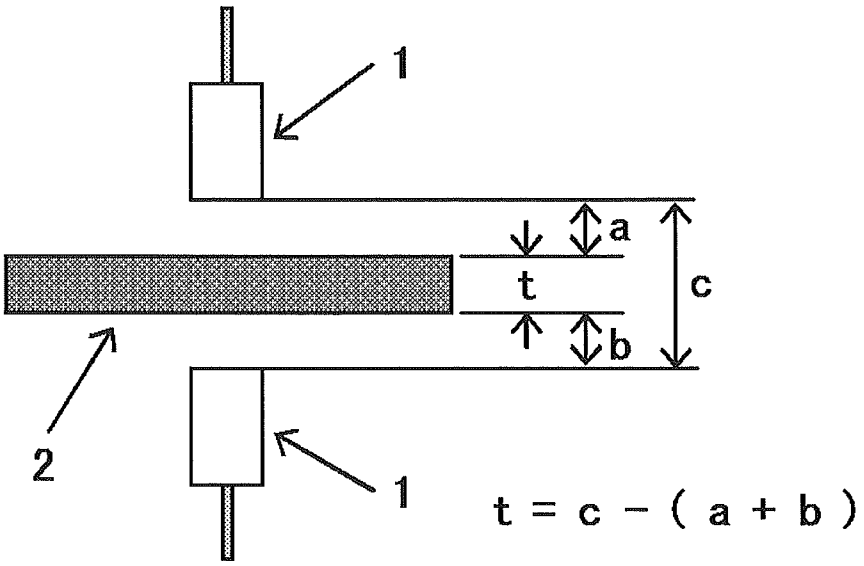


FIG. 3

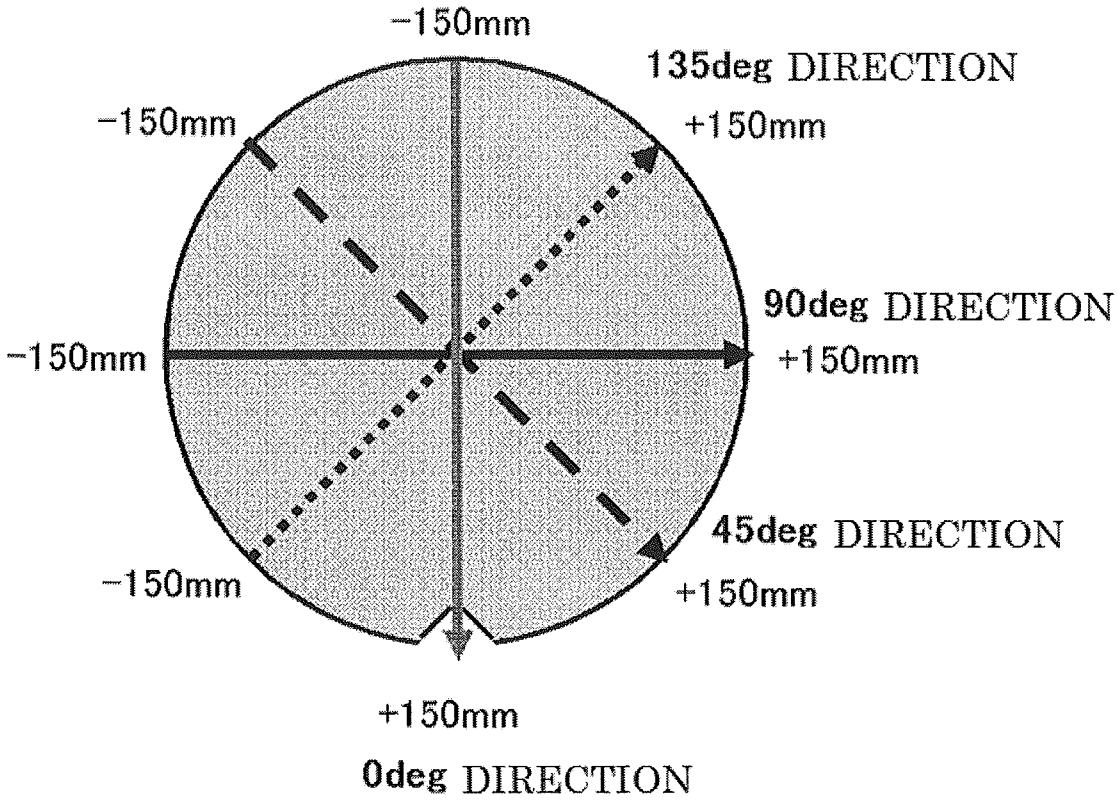

−150mm
135deg DIRECTION
−150mm
+150mm
90deg DIRECTION
−150mm
+150mm
45deg DIRECTION
−150mm
+150mm
+150mm
0deg DIRECTION

FIG. 4

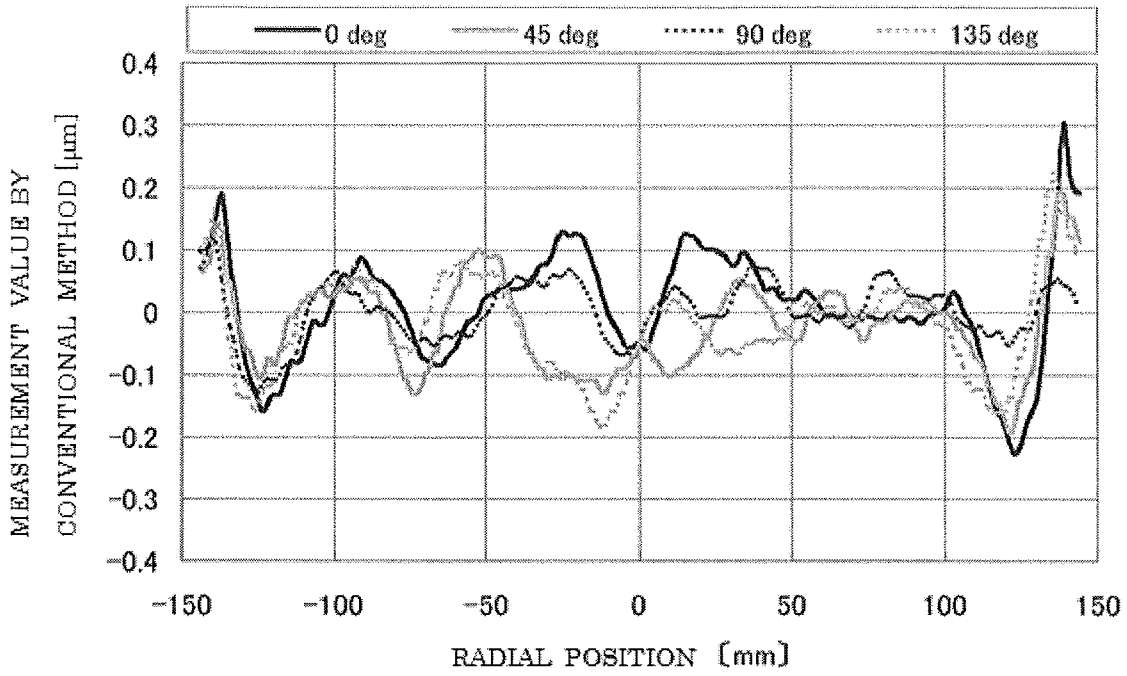

0 deg
45 deg
90 deg
135 deg
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-150
-100
-50
0
50
100
150
MEASUREMENT VALUE BY CONVENTIONAL METHOD [μm]
RADIAL POSITION [mm]

FIG. 5

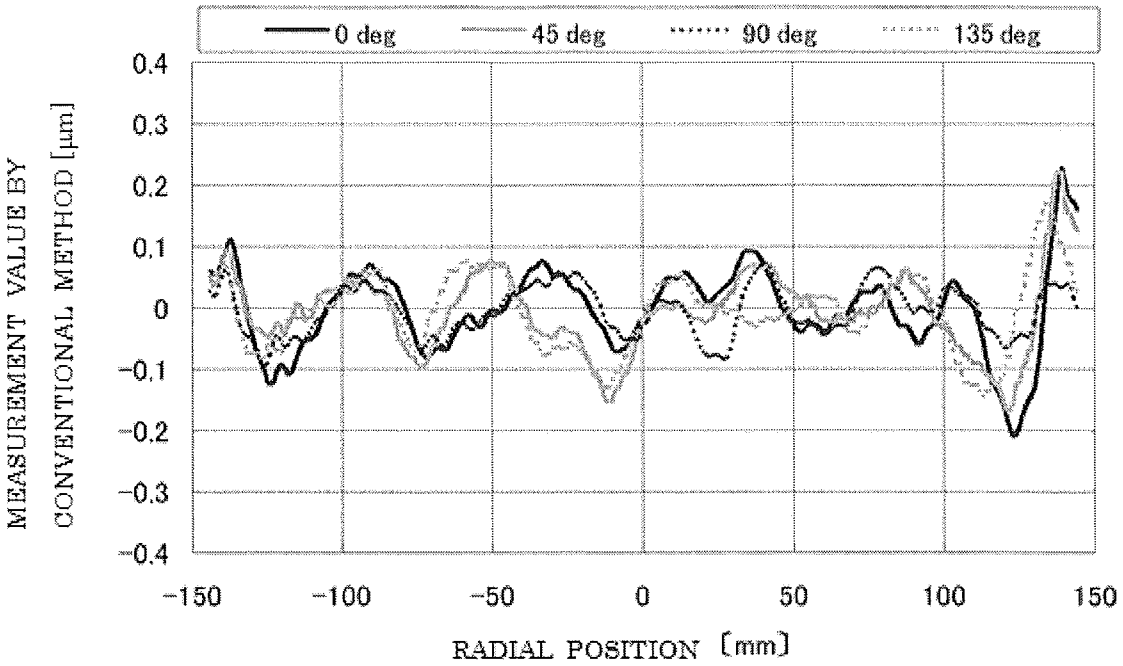

0 deg
45 deg
90 deg
135 deg
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−150
−100
−50
0
50
100
150
MEASUREMENT VALUE BY CONVENTIONAL METHOD [μm]
RADIAL POSITION [mm]

FIG. 6

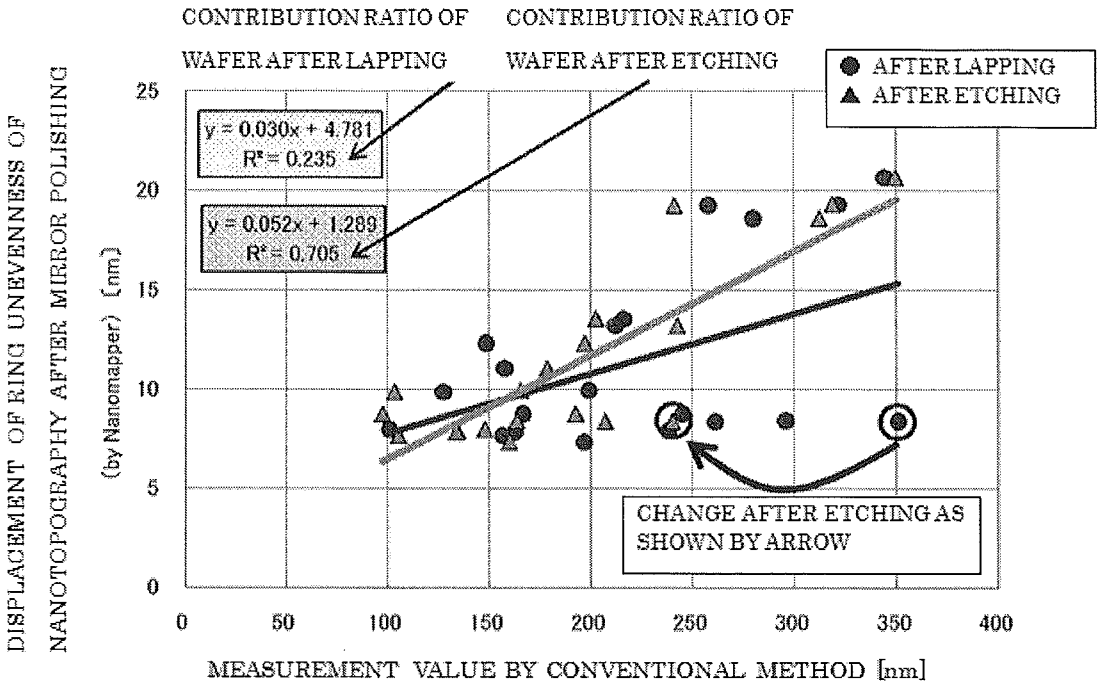

CONTRIBUTION RATIO OF WAFER AFTER LAPPING
CONTRIBUTION RATIO OF WAFER AFTER ETCHING
AFTER LAPPING
AFTER ETCHING
y = 0.030x + 4.781
R² = 0.235
y = 0.052x + 1.289
R² = 0.705
CHANGE AFTER ETCHING AS SHOWN BY ARROW
DISPLACEMENT OF RING UNEVENNESS OF NANOTOPOGRAPHY AFTER MIRROR POLISHING (by Nanomapper) [nm]
MEASUREMENT VALUE BY CONVENTIONAL METHOD [nm]
0
5
10
15
20
25
0
50
100
150
200
250
300
350
400

FIG. 7

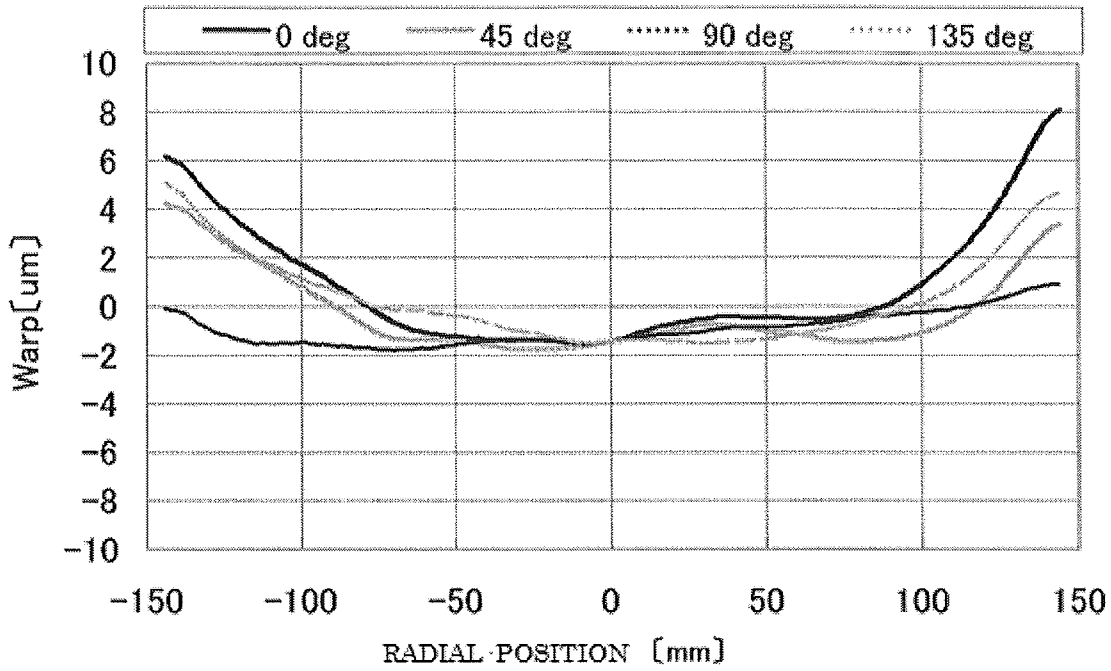

0 deg
45 deg
90 deg
135 deg
10
8
6
4
2
0
-2
-4
-6
-8
-10
Warp[um]
-150
-100
-50
0
50
100
150
RADIAL POSITION [mm]

FIG. 8

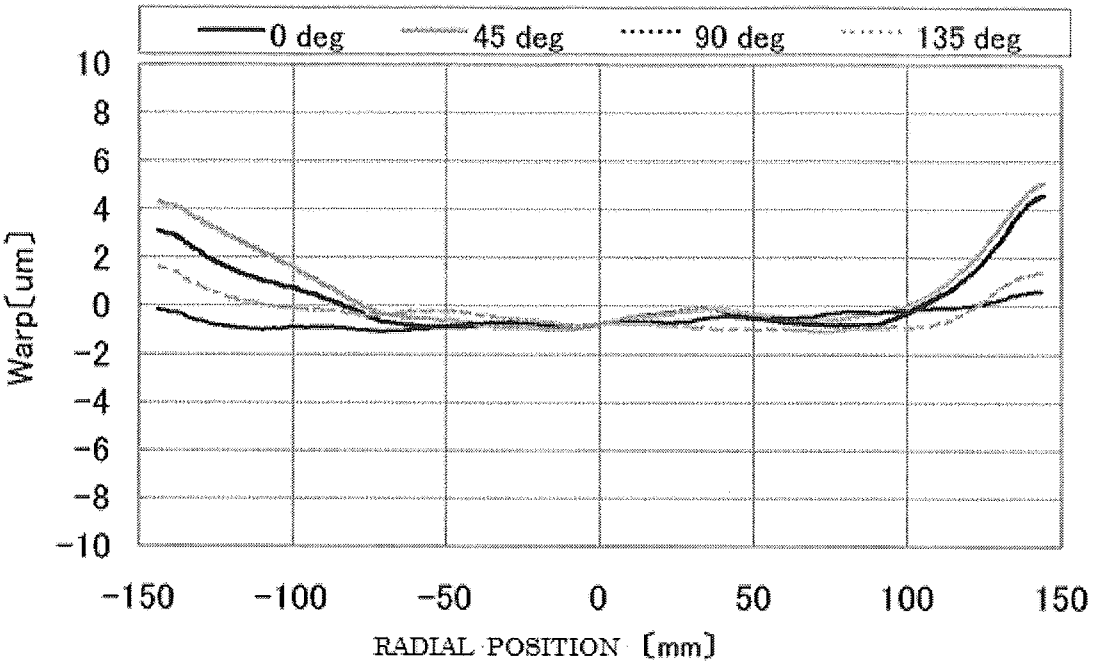

0 deg
45 deg
90 deg
135 deg
10
8
6
4
2
0
-2
-4
-6
-8
-10
Warp[um]
-150
-100
-50
0
50
100
150
RADIAL POSITION [mm]

FIG. 9

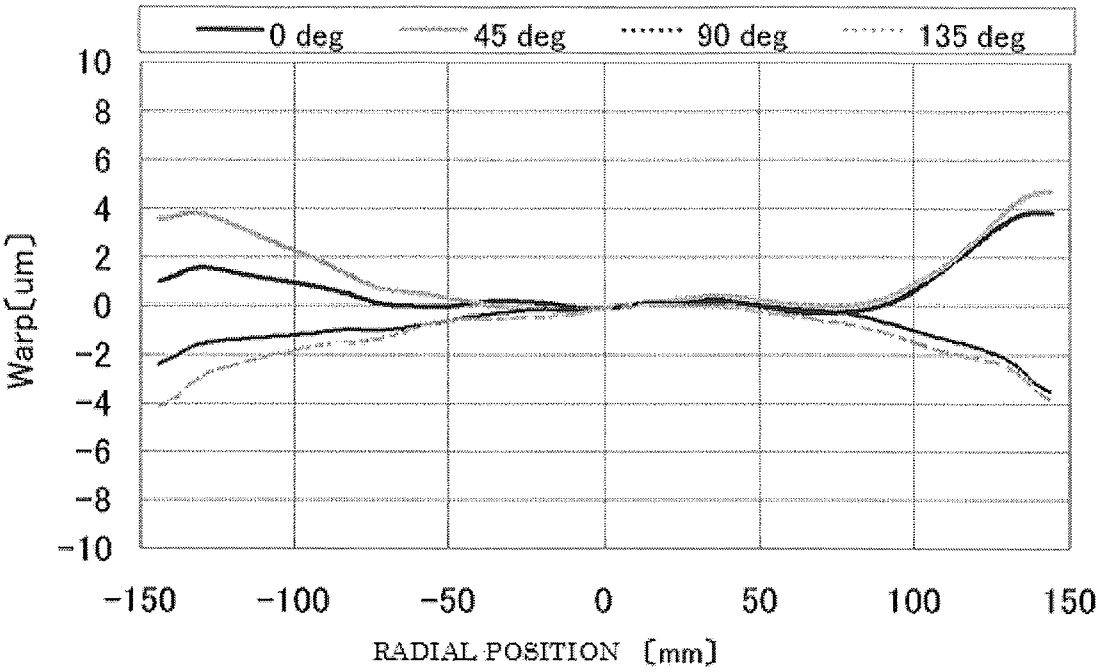

0 deg
45 deg
90 deg
135 deg
10
8
6
4
2
0
-2
-4
-6
-8
-10
Warp[um]
-150
-100
-50
0
50
100
150
RADIAL POSITION [mm]

FIG. 10

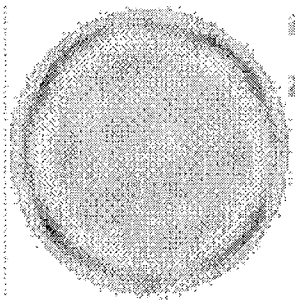
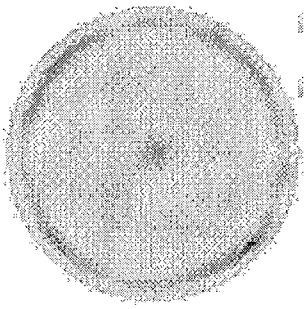
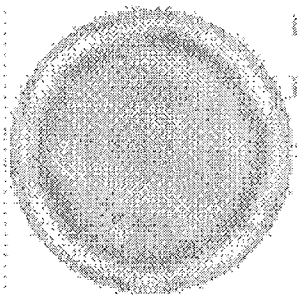
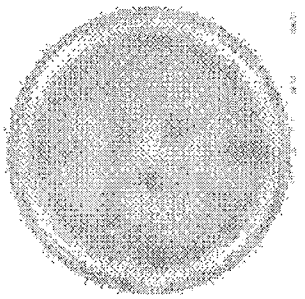
	LAPPED WAFER	DOUBLE-DISC GROUND WAFER
CONCAVE RING (BLACK RING)		
CONVEX RING (BLACK RING)		

FIG. 11

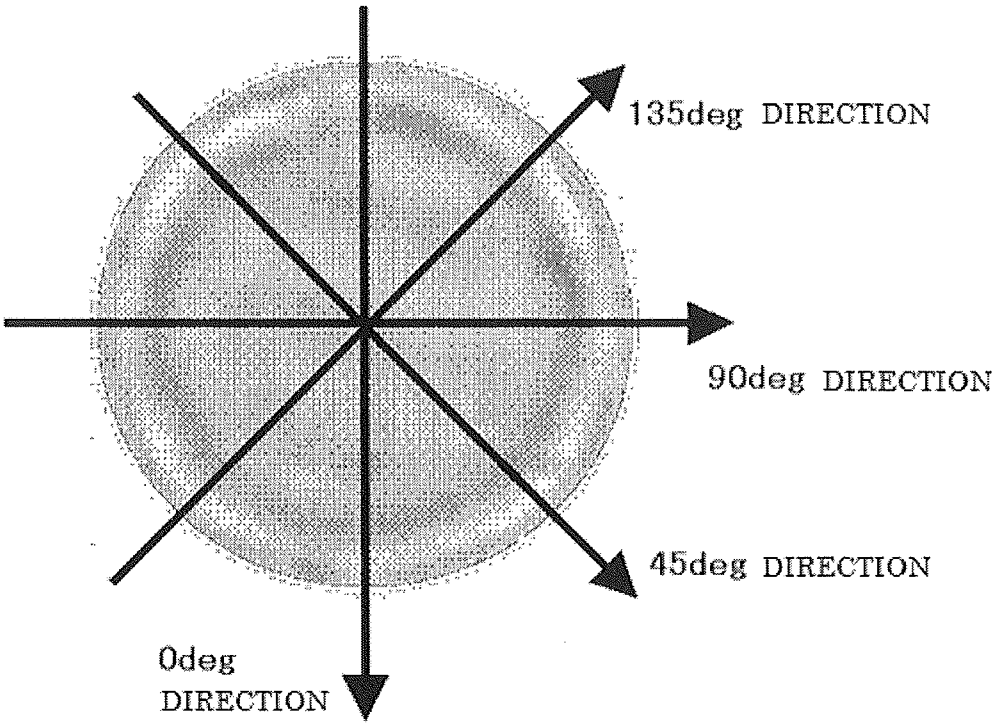

135deg DIRECTION
90deg DIRECTION
45deg DIRECTION
0deg
DIRECTION

FIG. 12

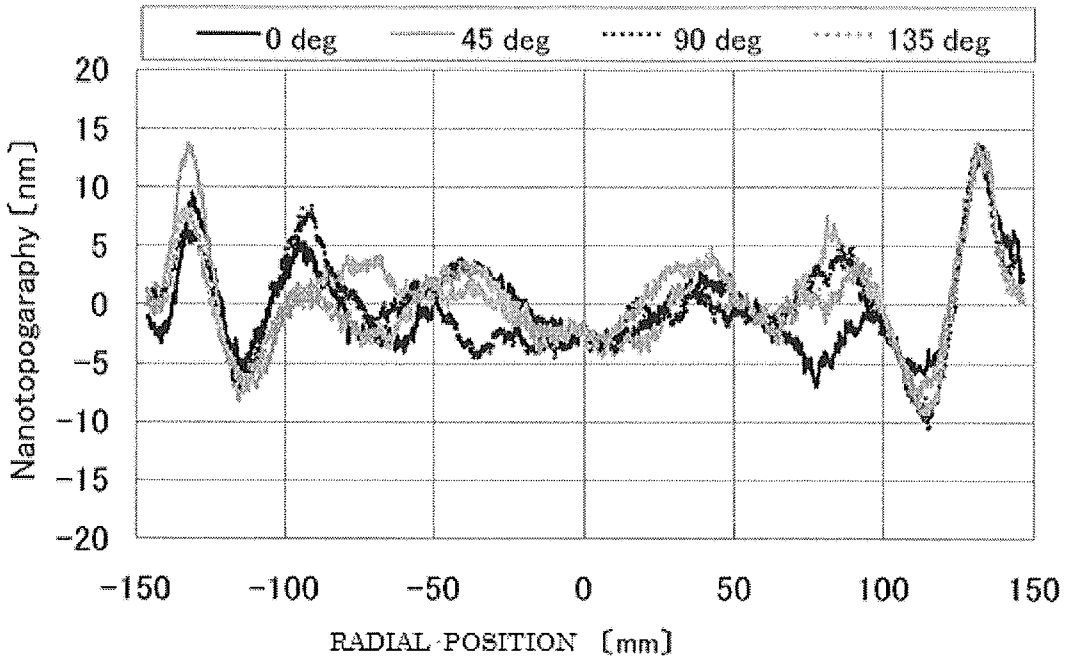

0 deg
45 deg
90 deg
135 deg
Nanotopogaraphy [nm]
20
15
10
5
0
-5
-10
-15
-20
-150
-100
-50
0
50
100
150
RADIAL POSITION [mm]

FIG. 13

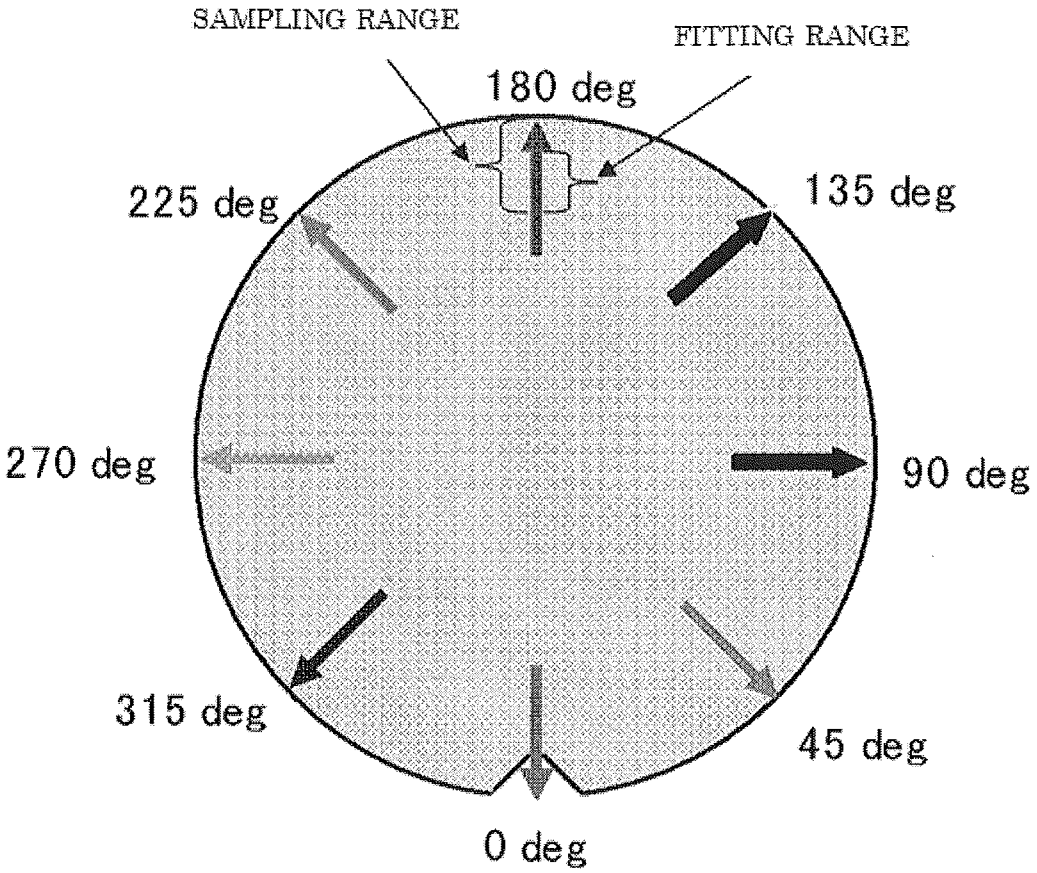

SAMPLING RANGE
FITTING RANGE
180 deg
135 deg
90 deg
45 deg
0 deg
315 deg
270 deg
225 deg

FIG. 14

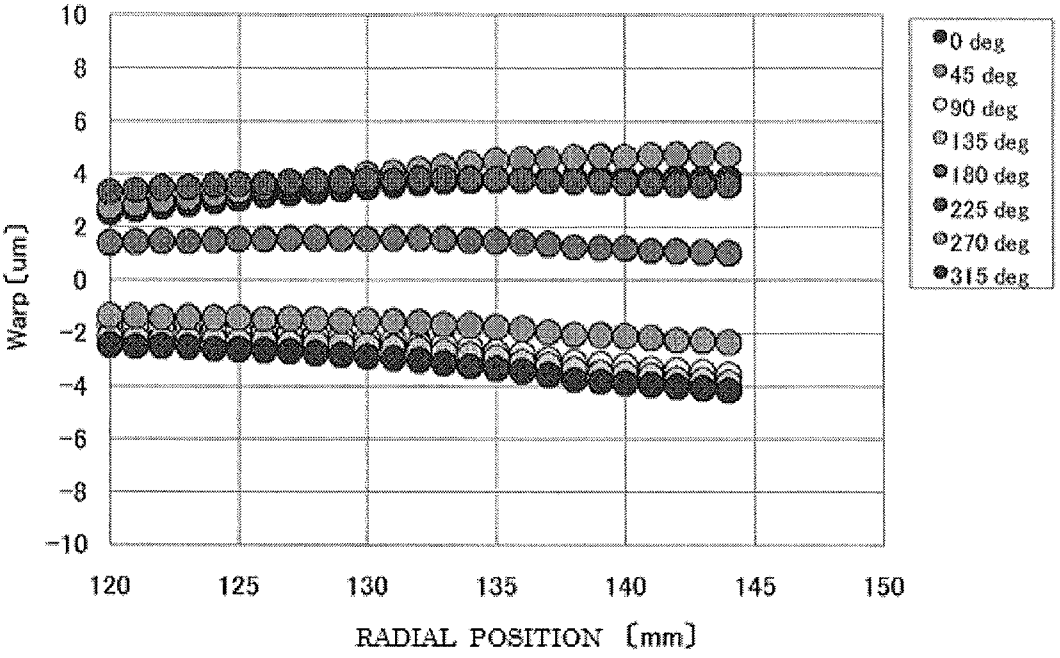

10
8
6
4
2
0
-2
-4
-6
-8
-10
Warp [um]
120
125
130
135
140
145
150
RADIAL POSITION [mm]
0 deg
45 deg
90 deg
135 deg
180 deg
225 deg
270 deg
315 deg

FIG. 15

(a)

FITTING RANGE

$((ax+b)-f(x))^2$ IN EACH CELL

Fitting in the range of 120 mm to 130 mm
[Liner approximation by the least squares method $((ax+b)^2-f(x)^2)$]

r	0 deg	45 deg	90 deg	135 deg	180 deg	225 deg	270 deg	315 deg
120	0.000171	5.56E-05	0.000468	0.000199	0.000292	0.000783	8.38E-05	0.001461
121	9.6E-05	1.22E-05	0.000288	0.000128	8.31E-06	4.48E-05	1.41E-07	0.000126
122	3.92E-05	0.000102	6.06E-05	7.85E-05	1.92E-05	2.5E-05	1.07E-05	6.56E-05
123	2.09E-05	8.64E-05	3.96E-06	9.99E-06	1.25E-05	8.02E-05	1.34E-06	0.000193
124	1.71E-05	2.72E-05	0.000225	8.37E-05	2.12E-06	9.08E-05	4.46E-07	0.00016
125	0.000353	3.18E-05	0.000778	0.000471	3.68E-05	5.01E-05	8.11E-07	0.000169
126	0.000854	0.000236	0.001184	0.000769	9.15E-05	0.000203	5.06E-05	0.000477
127	0.000573	0.000165	0.00046	0.000453	0.000211	0.000464	8.18E-05	0.00066
128	1.03E-05	2.29E-05	2.22E-06	1.83E-05	0.000101	0.000211	1.28E-05	0.000203
129	0.000228	3.15E-05	0.00037	0.000157	2.79E-05	5.99E-05	1.59E-05	0.000216
130	0.000926	0.000151	0.001302	0.001109	0.000543	0.001415	9.73E-05	0.001985

	0 deg	45 deg	90 deg	135 deg	180 deg	225 deg	270 deg	315 deg
SUM	0.003288	0.000922	0.005141	0.003476	0.001346	0.003428	0.000356	0.005716
const a	0.095741	0.125224	-0.05266	-0.03285	0.018116	0.04337	-0.01812	-0.04315
const b	-8.89001	-12.268	-4.677759	-1.809313	-0.2365	-1.80732	0.839074	2.777059

This is $\Sigma\,[((ax+b)-f(x))^2]$ at a radial position from 120mm to 130mm.

* use of least squares method

Constants a and b are automatically determined by Solver such that total of cells becomes minimum.

(b)

```
Sub   DATA ANALYSIS()
'
'
'
.

    SolverOk SetCell:="$V$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$V$57:$V$58"
    SolverSolve Userfinish:=True
    SolverOk SetCell:="$W$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$W$57:$W$58"
    SolverSolve Userfinish:=True
    SolverOk SetCell:="$X$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$X$57:$X$58"
    SolverSolve Userfinish:=True
    SolverOk SetCell:="$Y$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$Y$57:$Y$58"
    SolverSolve Userfinish:=True
    SolverOk SetCell:="$Z$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$Z$57:$Z$58"
    SolverSolve Userfinish:=True
    SolverOk SetCell:="$AA$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$AA$57:$AA$58"
    SolverSolve Userfinish:=True
    SolverOk SetCell:="$AB$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$AB$57:$AB$58"
    SolverSolve Userfinish:=True
    SolverOk SetCell:="$AC$56", MaxMinVal:=2, ValueOf:="0", ByChange:="$AC$57:$AC$58"
    SolverSolve Uaerfinish:=True

    Range("C17").Select
    Selection.Copy

End Sub
```

FIG. 16

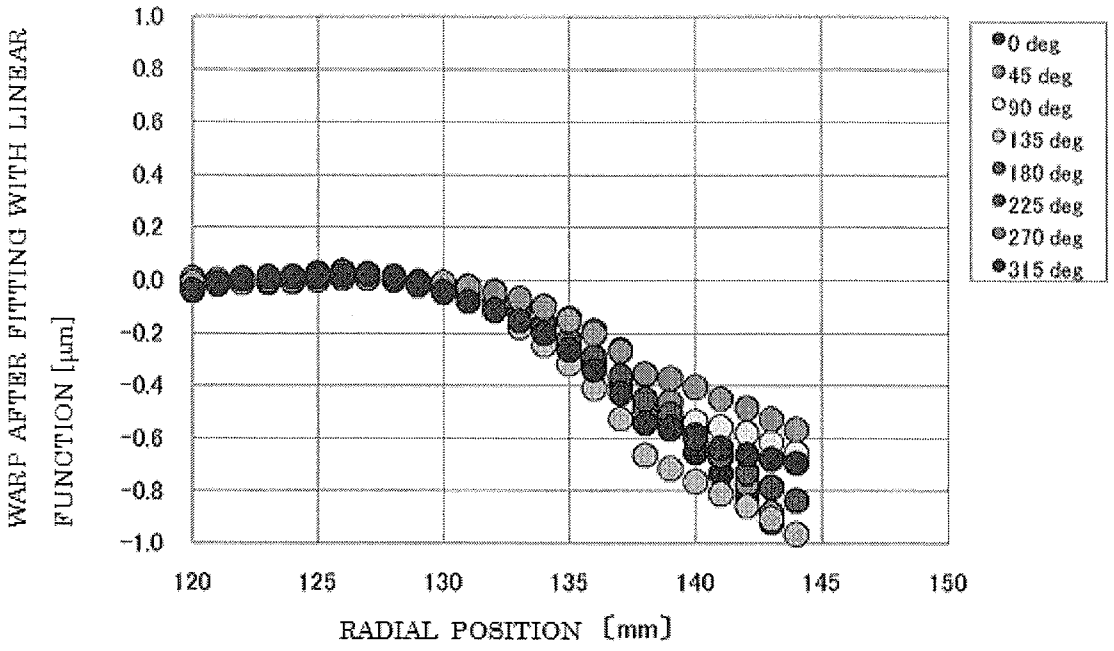

WARP AFTER FITTING WITH LINEAR FUNCTION [μm]
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
120
125
130
135
140
145
150
RADIAL POSITION [mm]
0 deg
45 deg
90 deg
135 deg
180 deg
225 deg
270 deg
315 deg

FIG. 17

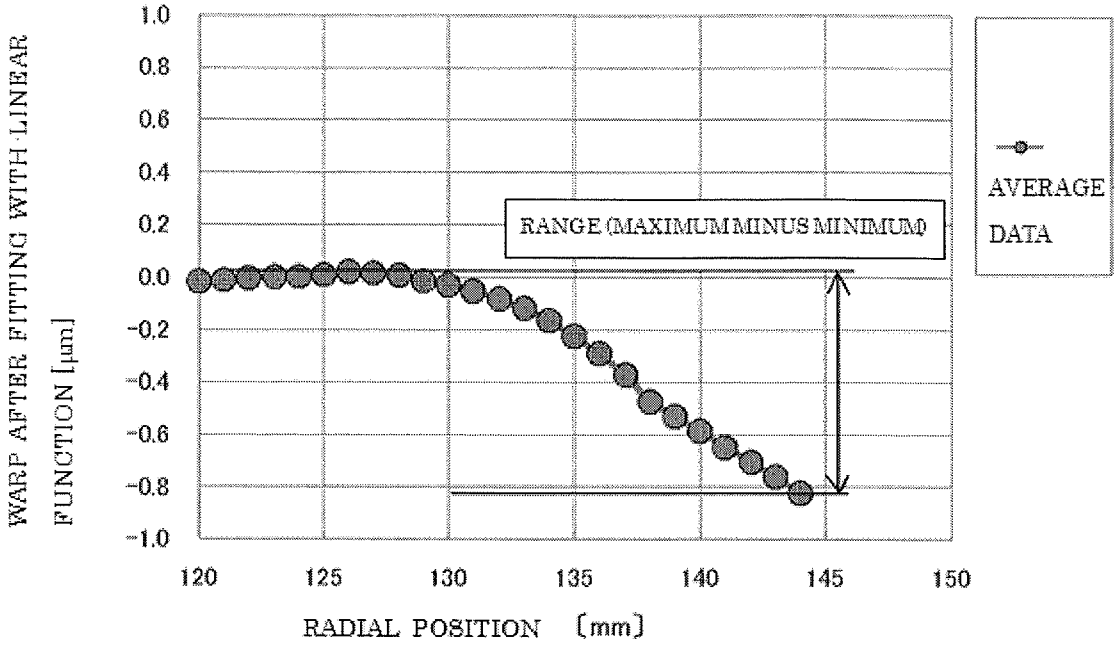

WARP AFTER FITTING WITH LINEAR FUNCTION [μm]
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
120
125
130
135
140
145
150
RADIAL POSITION (mm)
RANGE (MAXIMUM MINUS MINIMUM)
AVERAGE DATA

FIG. 18

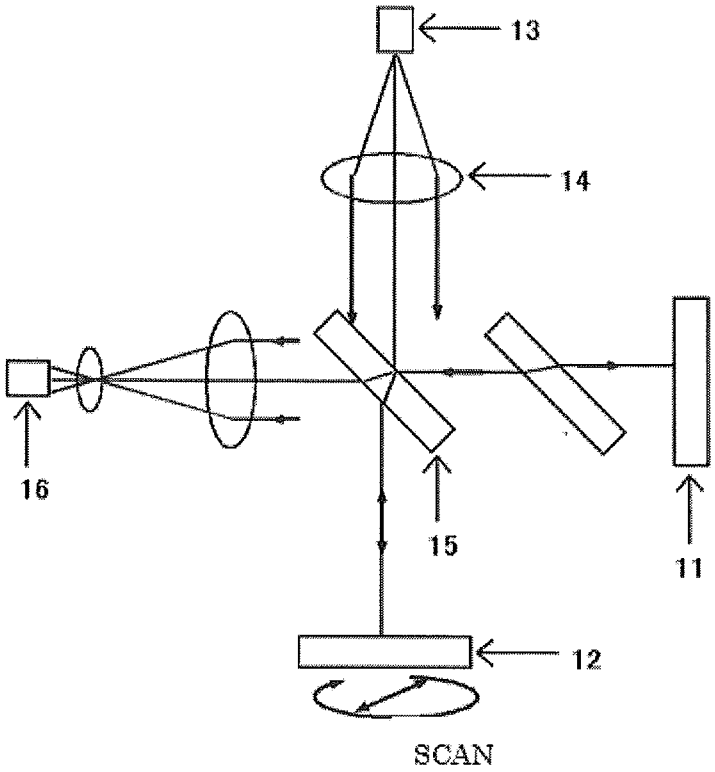


FIG. 19

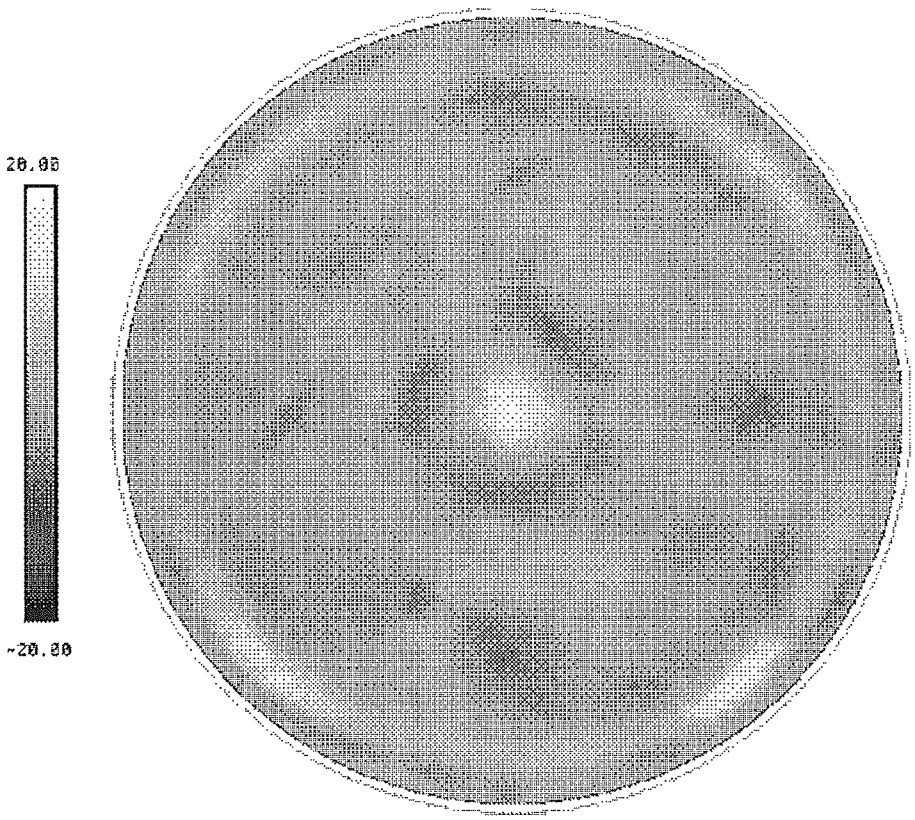


FIG. 20

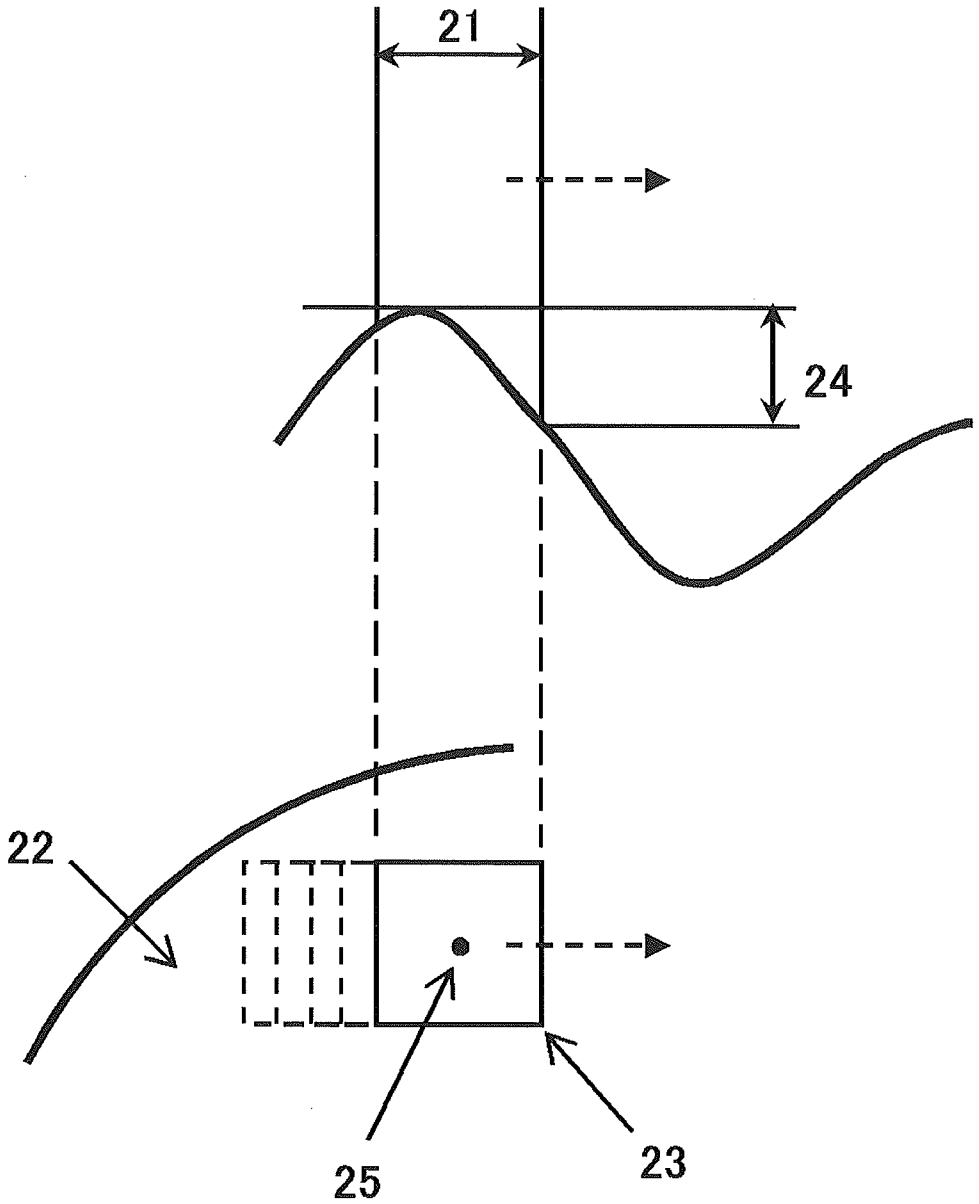


FIG. 21

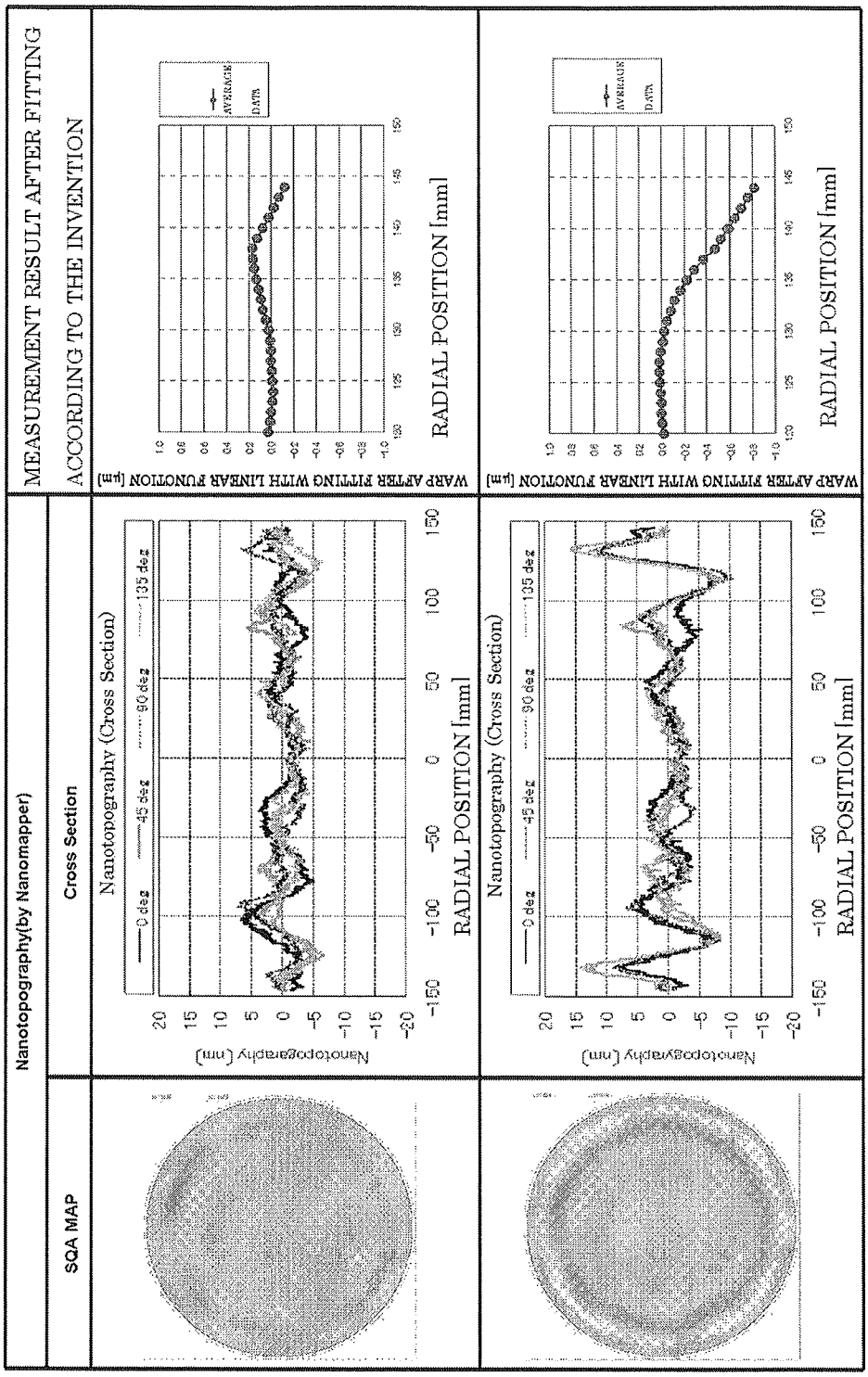
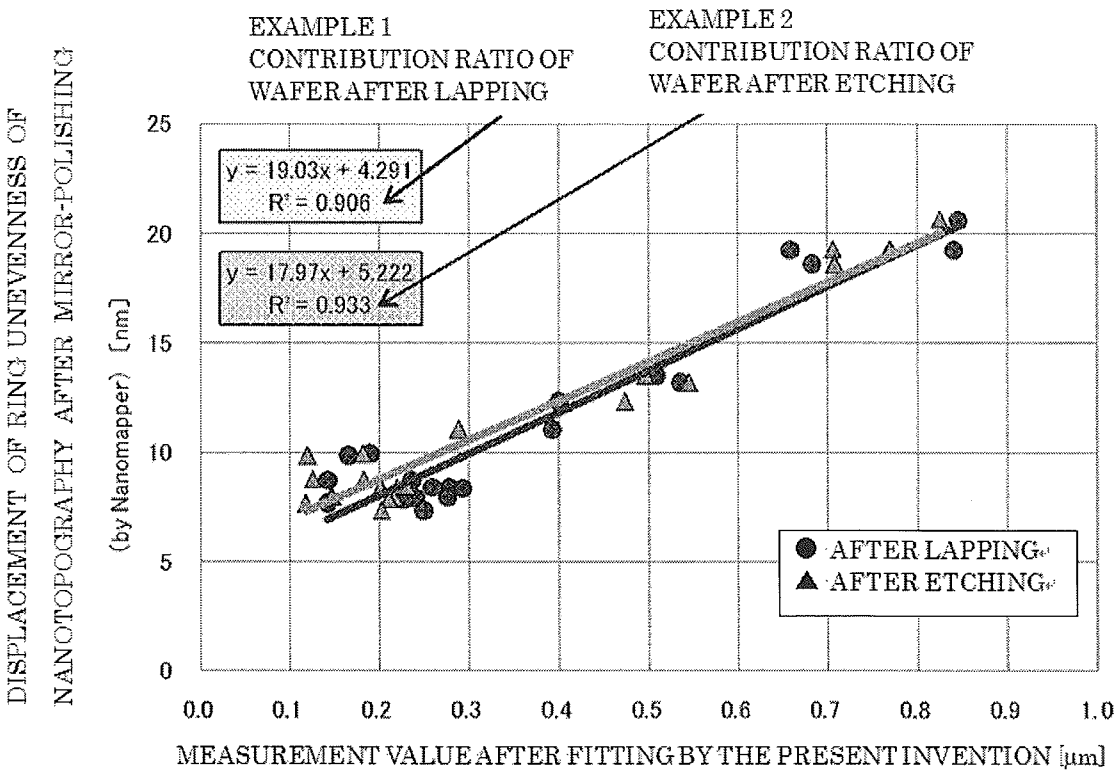

Nanotopography(by Nanomapper)
SQA MAP
Cross Section
MEASUREMENT RESULT AFTER FITTING ACCORDING TO THE INVENTION
Nanotopography (Cross Section)
0 deg
45 deg
90 deg
135 deg
Nanotopography [nm]
RADIAL POSITION [mm]
WARP AFTER FITTING WITH LINEAR FUNCTION [μm]
AVERAGE
DATA

FIG. 22


EXAMPLE 1
CONTRIBUTION RATIO OF
WAFER AFTER LAPPING
EXAMPLE 2
CONTRIBUTION RATIO OF
WAFER AFTER ETCHING
y = 19.03x + 4.291
R² = 0.906
y = 17.97x + 5.222
R² = 0.933
AFTER LAPPING
AFTER ETCHING
DISPLACEMENT OF RING UNEVENNESS OF NANOTOPOGRAPHY AFTER MIRROR-POLISHING (by Nanomapper) [nm]
MEASUREMENT VALUE AFTER FITTING BY THE PRESENT INVENTION [μm]
0
5
10
15
20
25
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0