FIG.1

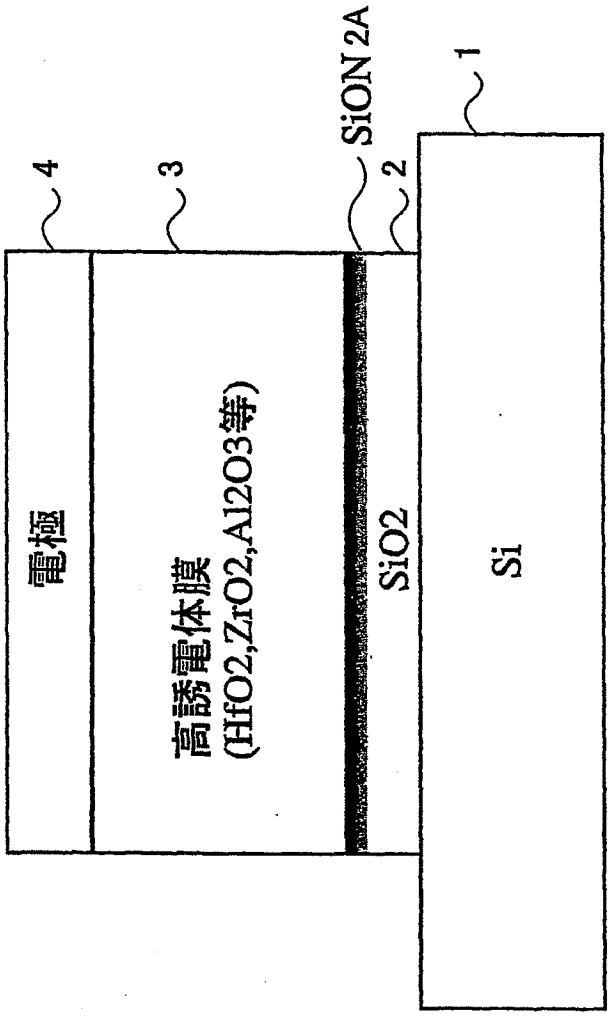


FIG.2

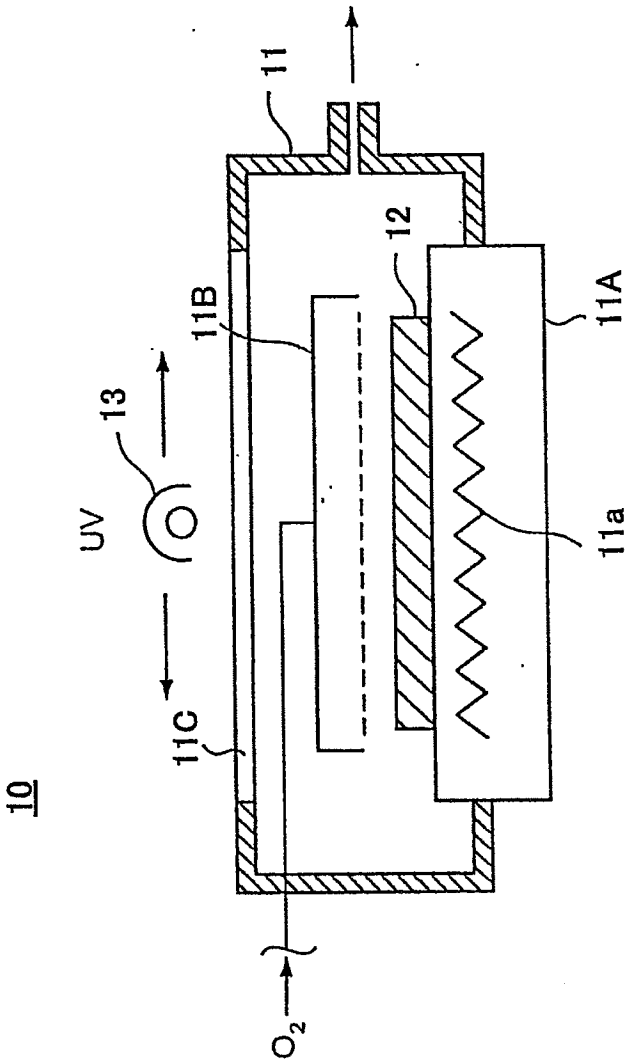
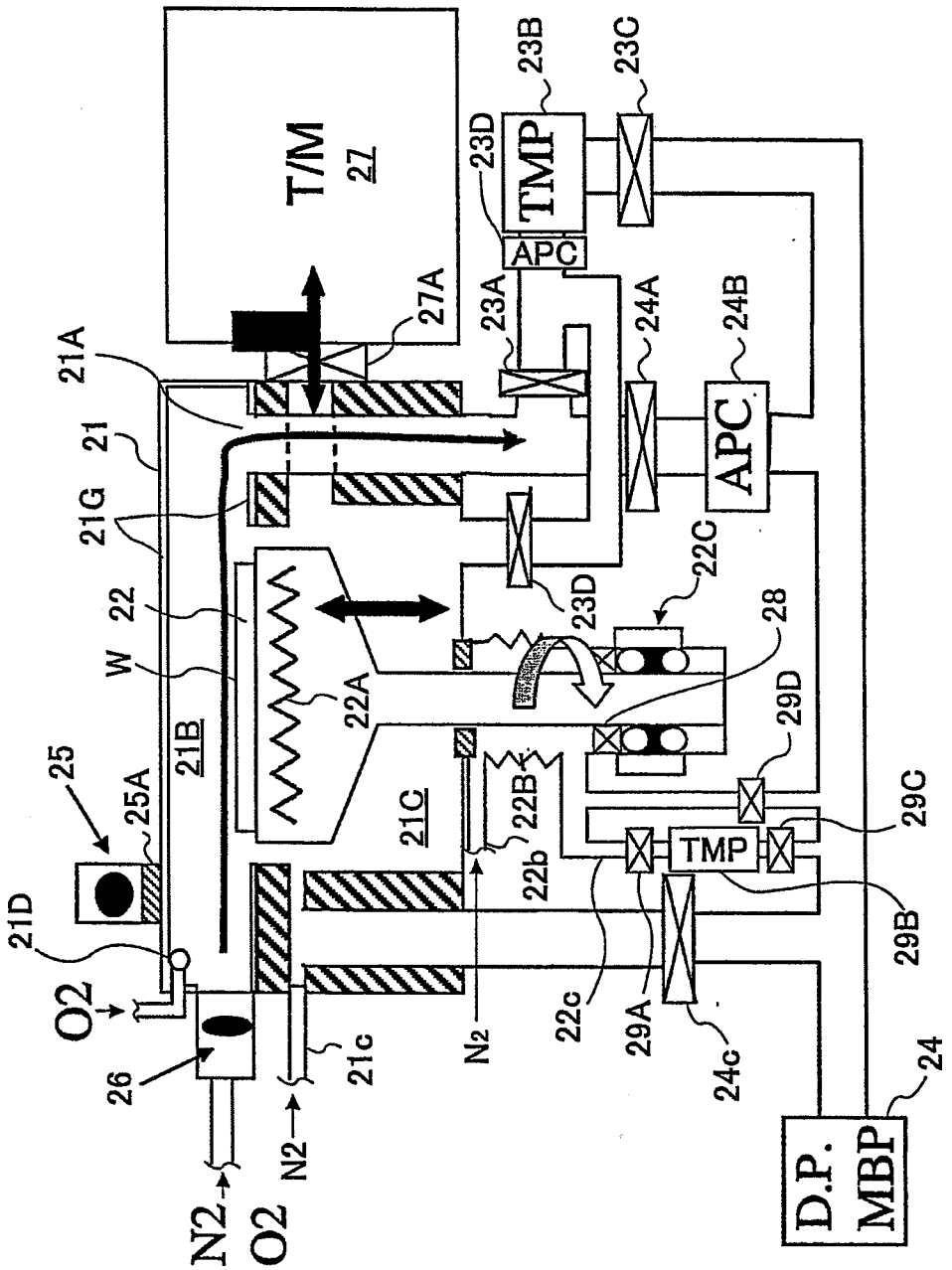


FIG.3


20
T/M
27
27A
TMP
APC
23A
23B
23C
23D
24A
24B
APC
21A
21
21G
W
22
22A
22C
28
29D
21B
25
25A
21C
22B
22b
TMP
29C
29B
21D
O2
26
N2
22c
29A
24c
24
D.P.
MBP
N2
O2

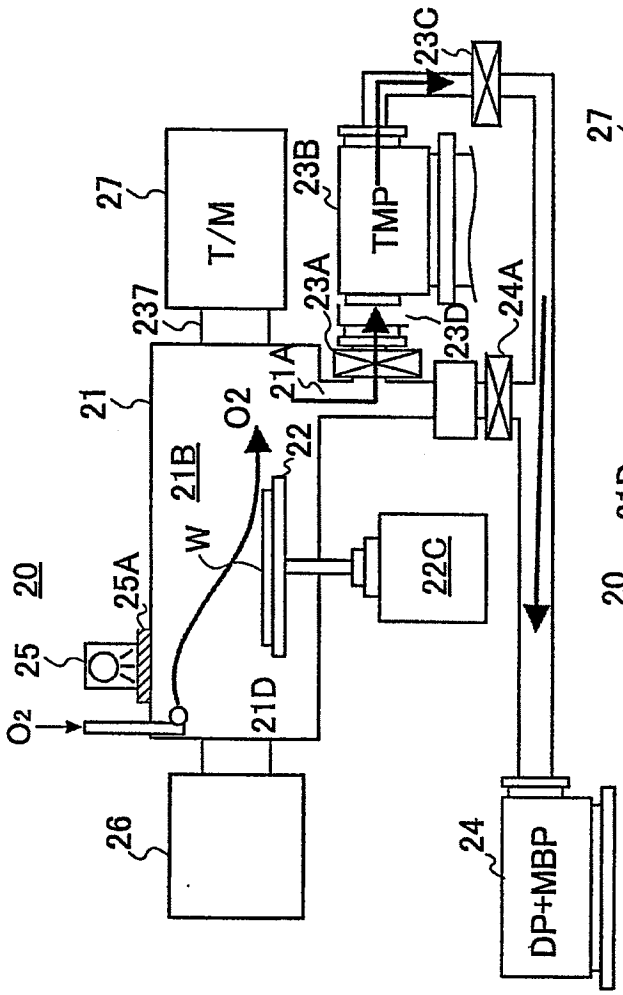

O2
25
20
25A
W
21B
O2
22
21
21A
23A
23B
TMP
23C
23D
24A
27
T/M
237
21D
22C
26
24
DP+MBP

FIG.4A

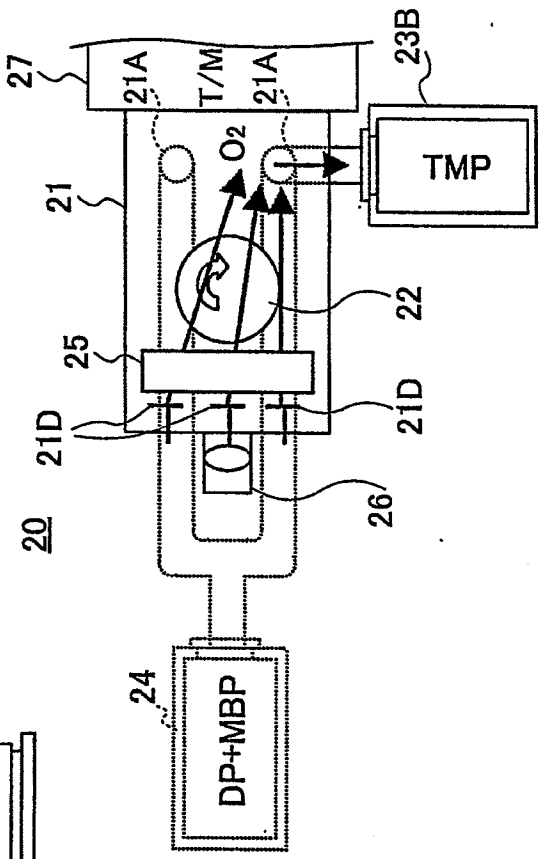

27
21A
T/M
21A
23B
TMP
O2
21
22
25
21D
21D
20
26
24
DP+MBP

FIG.4B

FIG.5

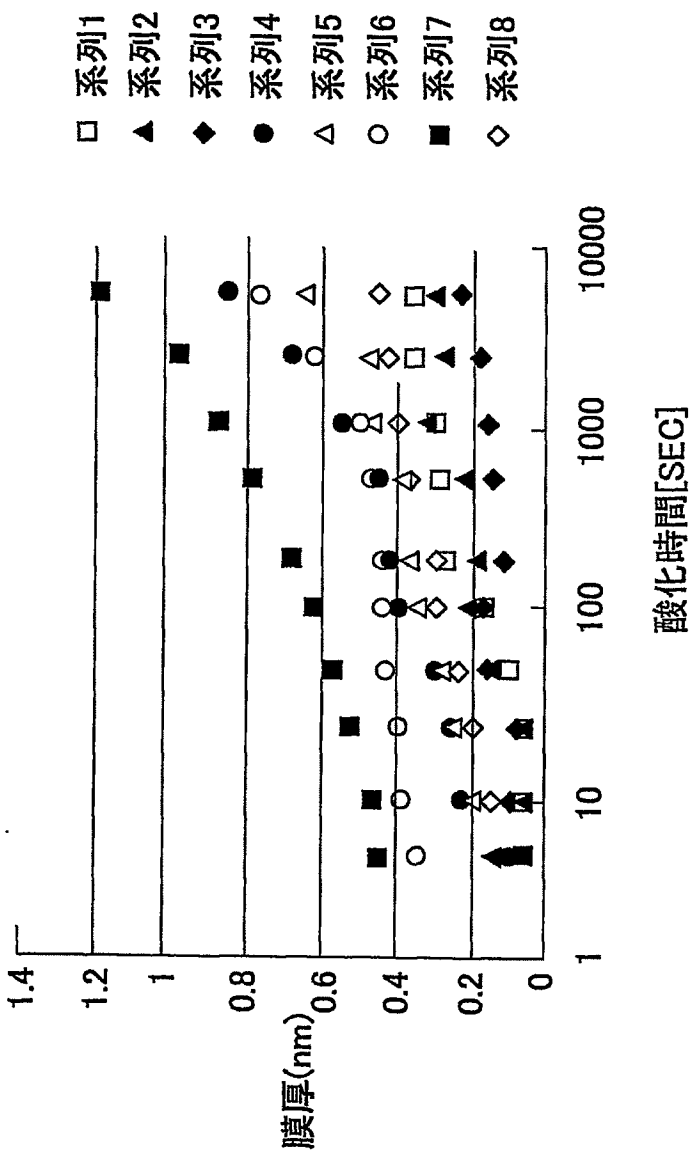

系列1
系列2
系列3
系列4
系列5
系列6
系列7
系列8
膜厚(nm)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
10
100
1000
10000
酸化時間[SEC]

FIG.6

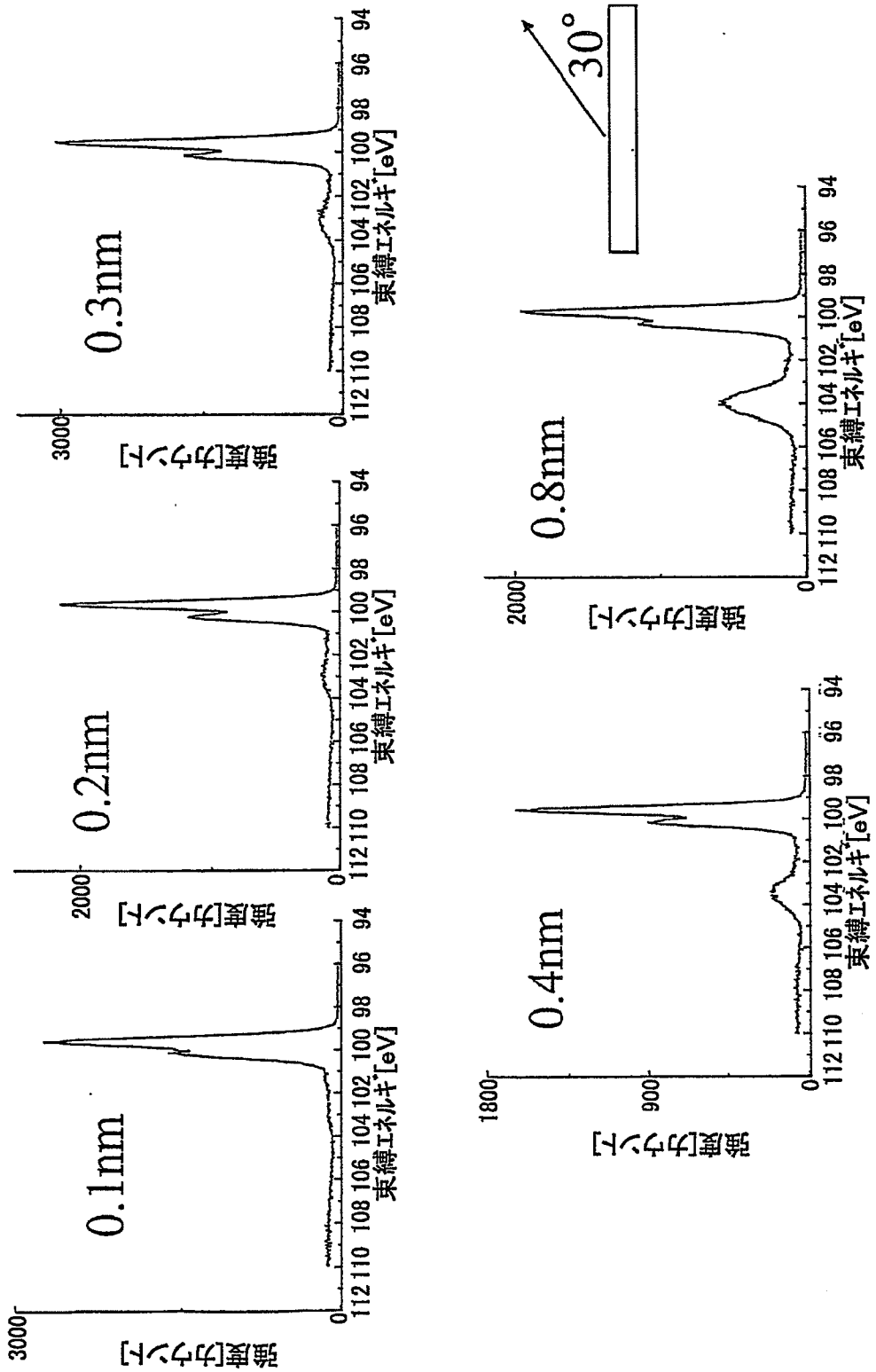
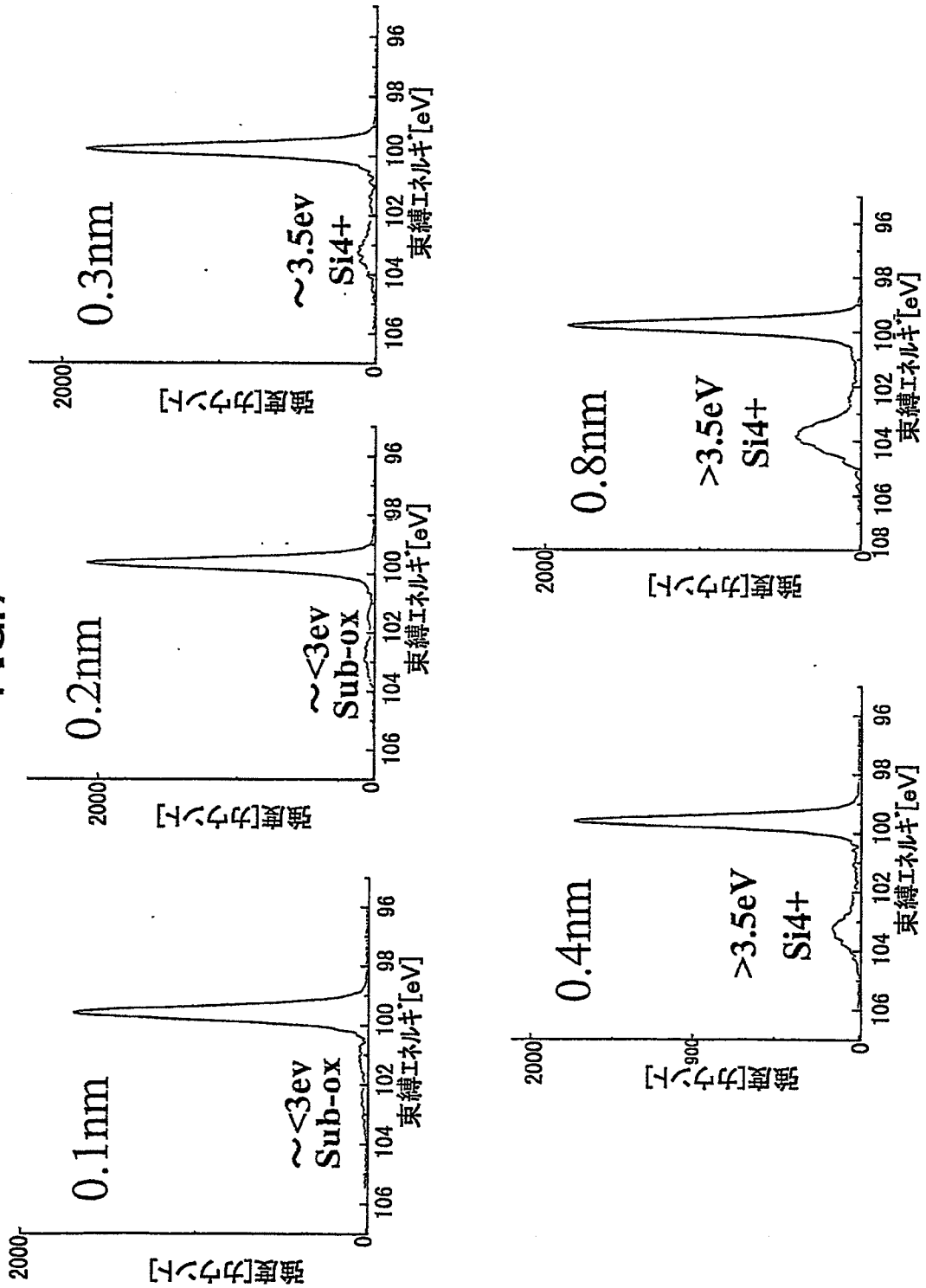
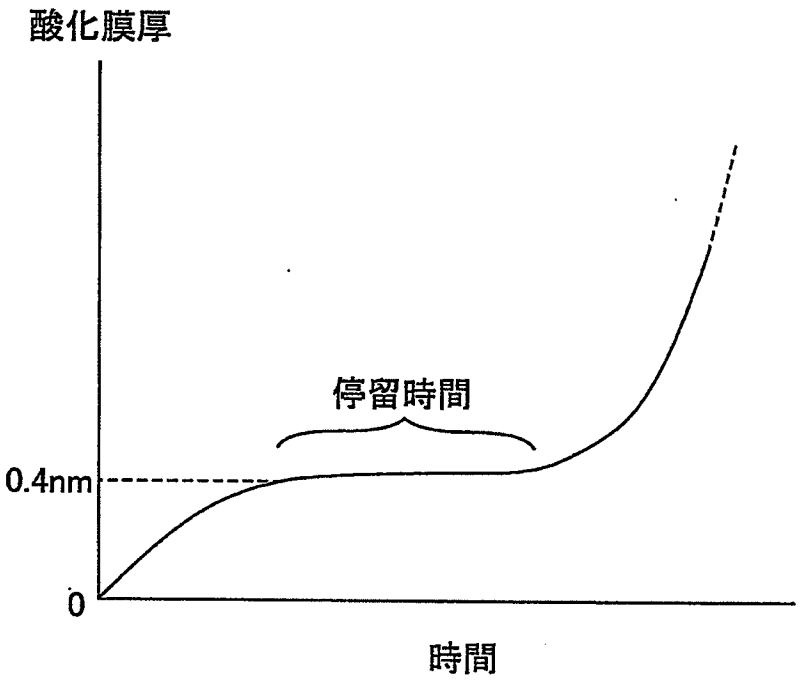

0.1nm
0.2nm
0.3nm
0.4nm
0.8nm
30°
強度[カウント]
束縛エネルギ[eV]
3000
2000
1800
900
0
112 110 108 106 104 102 100 98 96 94

FIG.7


0.1nm
~<3ev
Sub-ox
0.2nm
~<3ev
Sub-ox
0.3nm
~3.5ev
Si4+
0.4nm
>3.5eV
Si4+
0.8nm
>3.5eV
Si4+
強度[カウント]
束縛エネルギー[eV]

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FIG.8



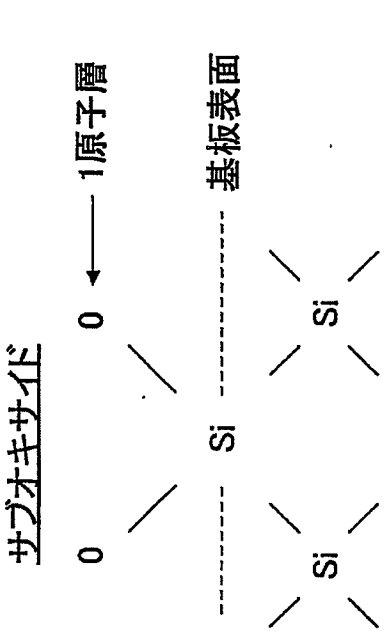


FIG.9A

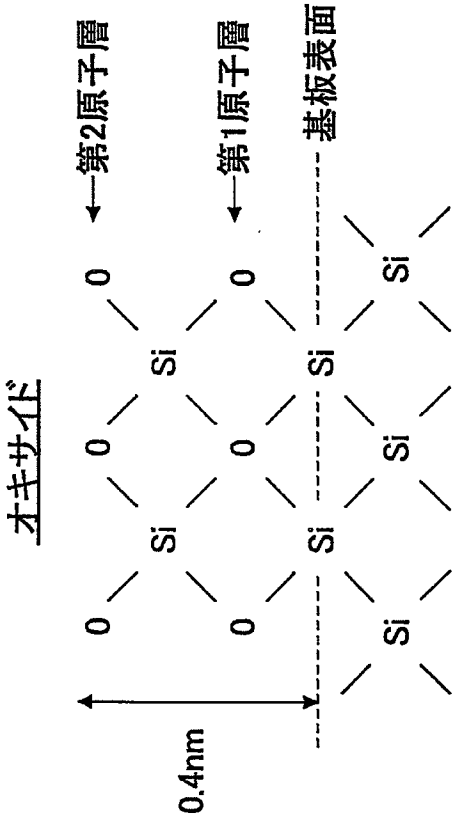
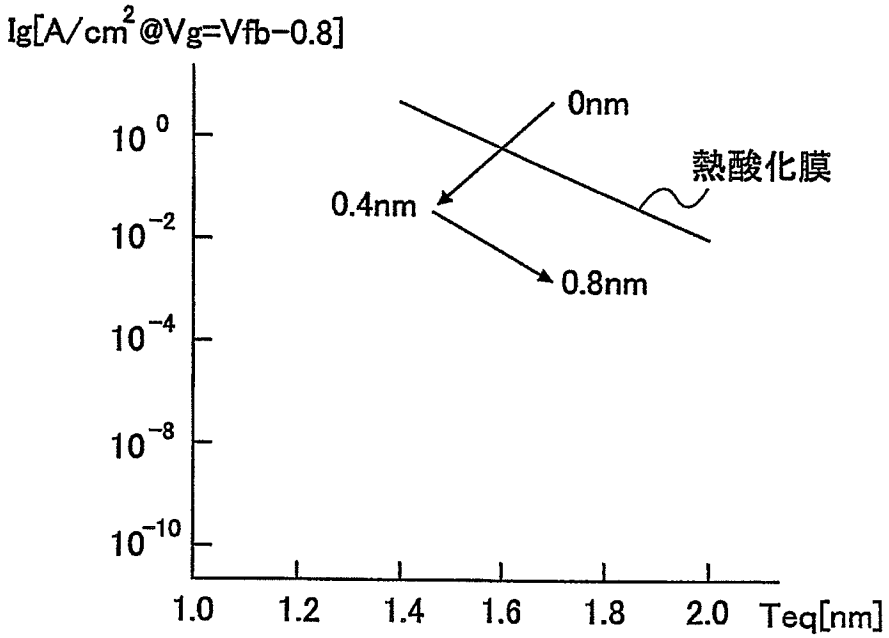


FIG.9B

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FIG.10



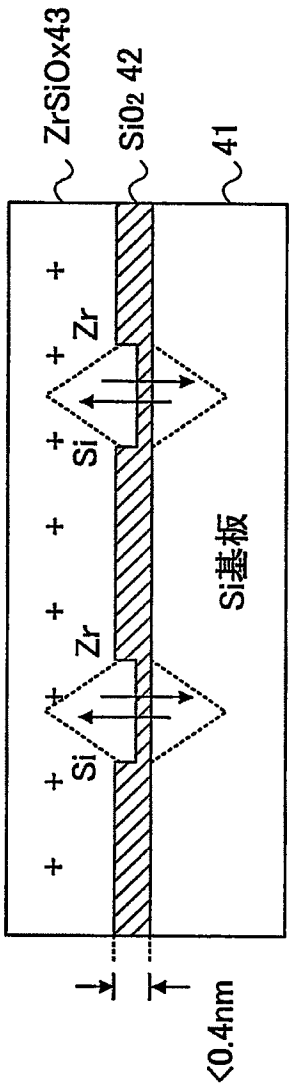


FIG.11A

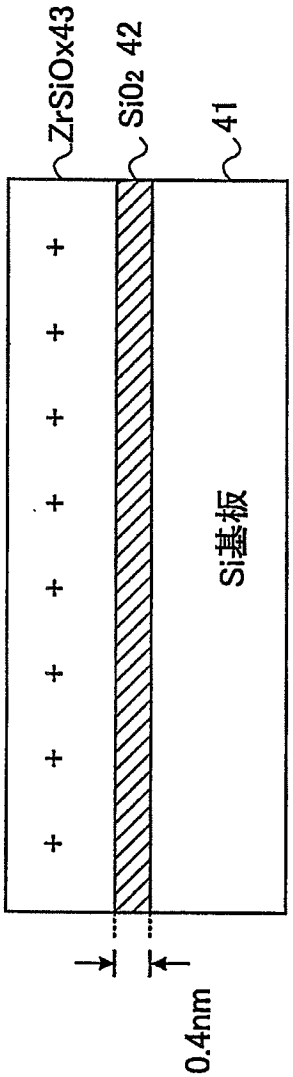


FIG.11B

FIG.12A

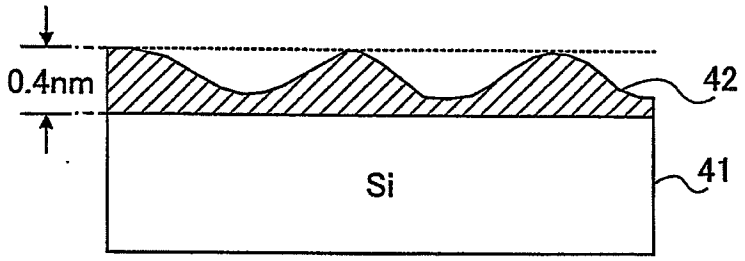


FIG.12B

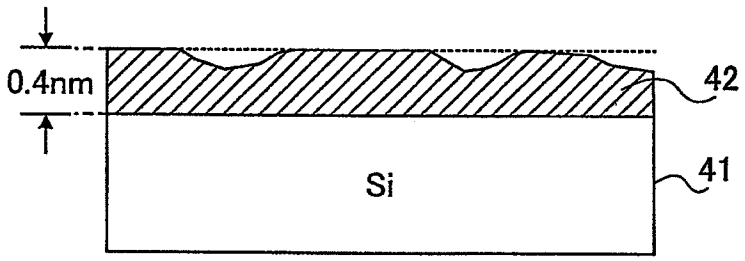


FIG.12C

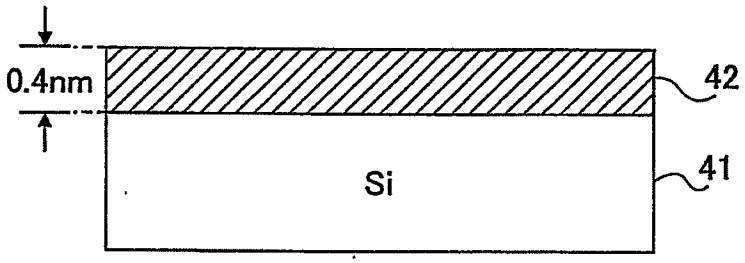
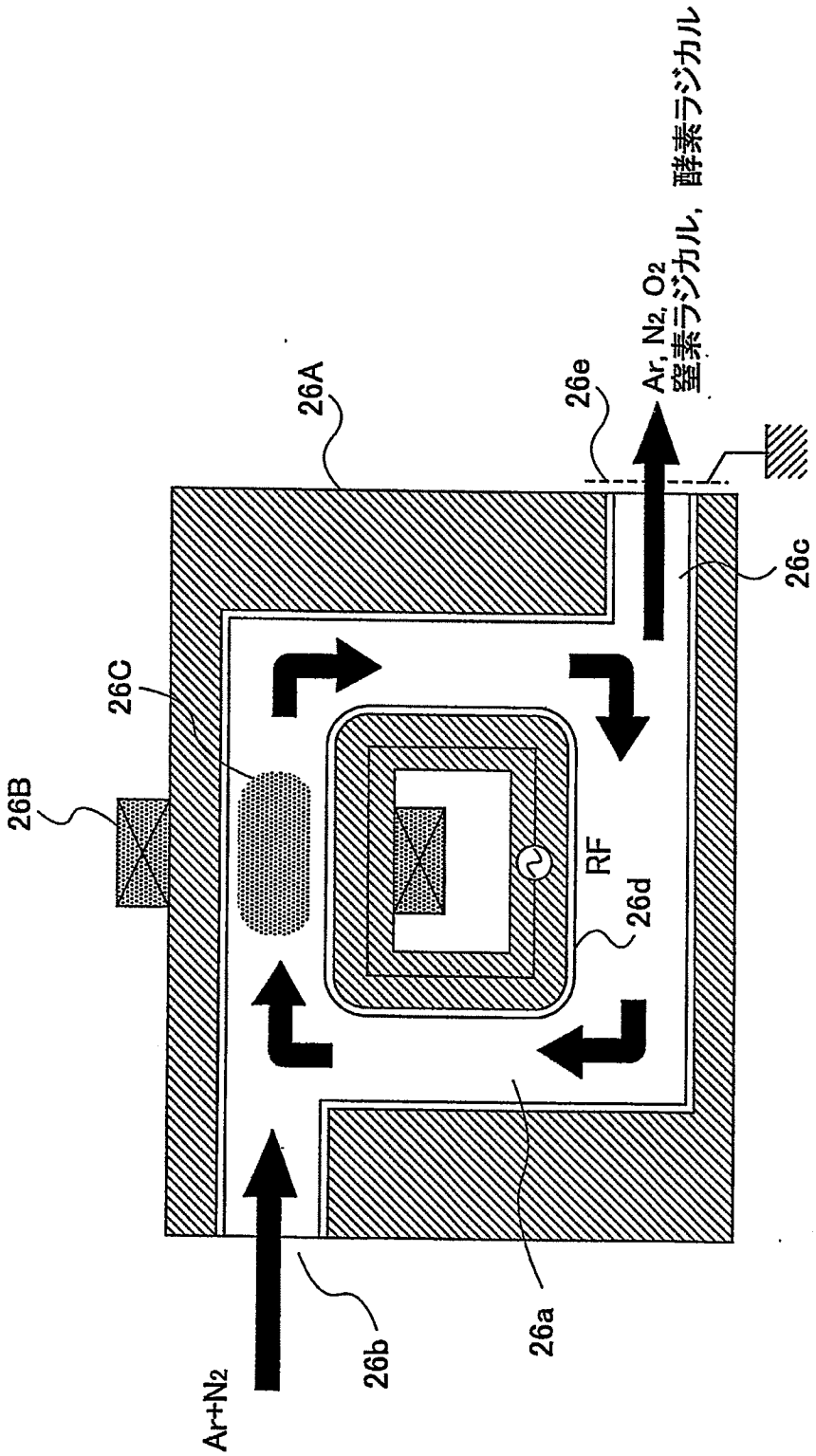


FIG.13


26
26A
26e
Ar, N2, O2
窒素ラジカル，酵素ラジカル
26c
26C
26B
RF
26d
Ar+N2
26b
26a

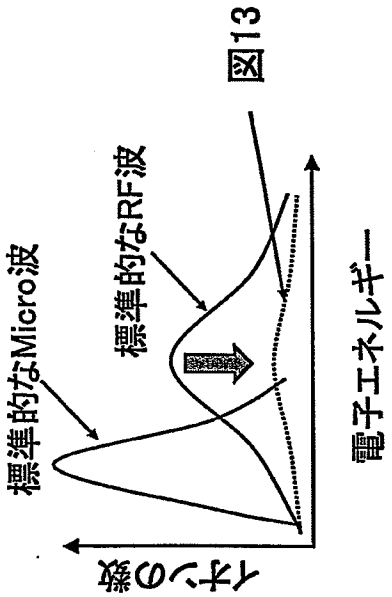


FIG.14A

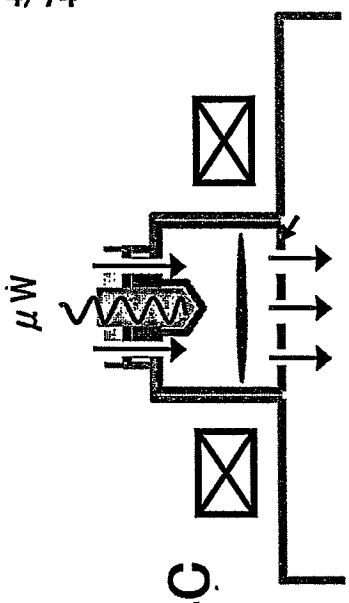


FIG.14C

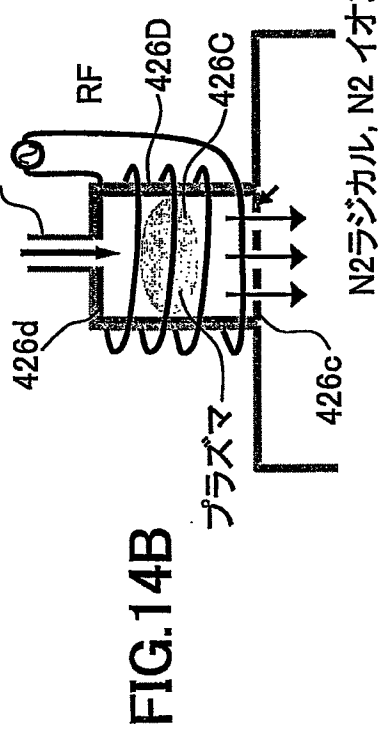
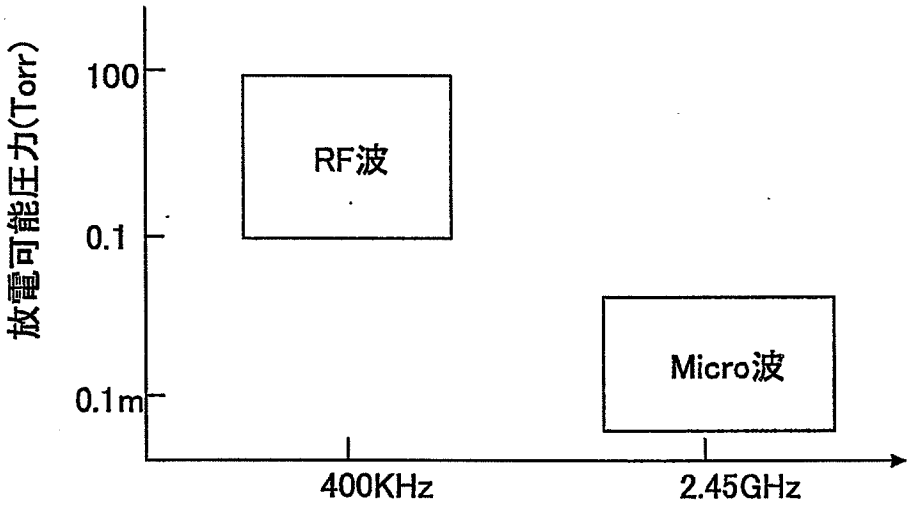


FIG.14B

FIG.15



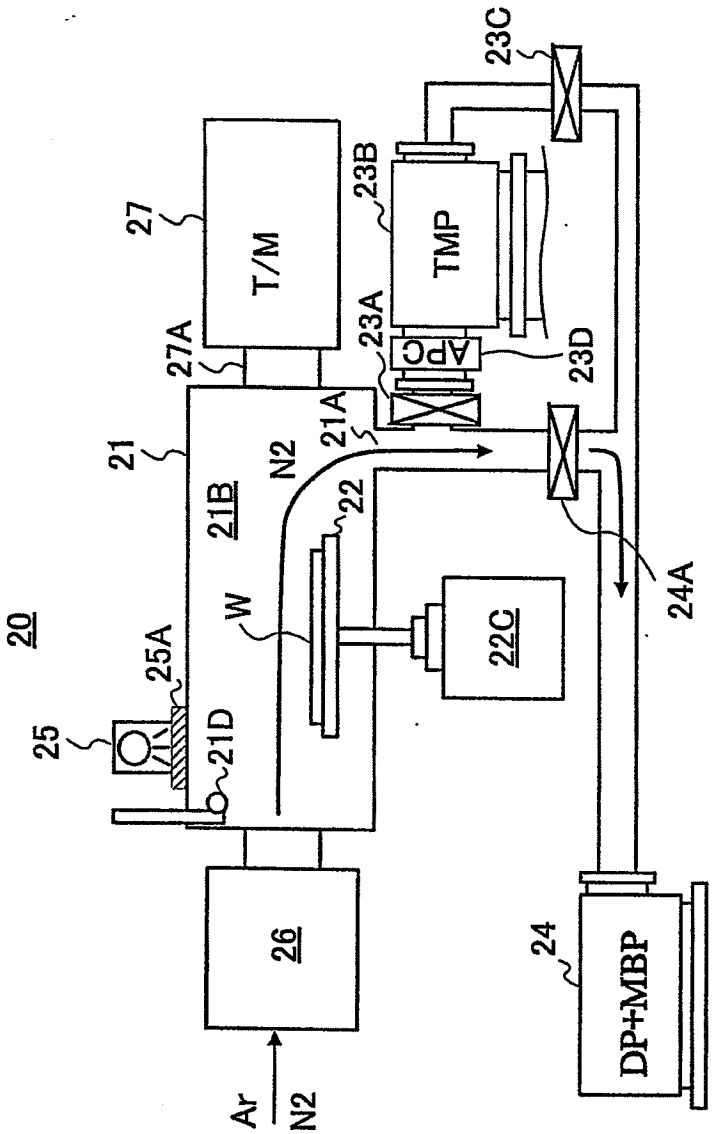

20
25
25A
21D
W
21B
21
27
27A
T/M
23B
TMP
23A
APC
23D
23C
21A
N2
22
22C
24A
24
DP+MBP
26
Ar
N2

FIG.16A

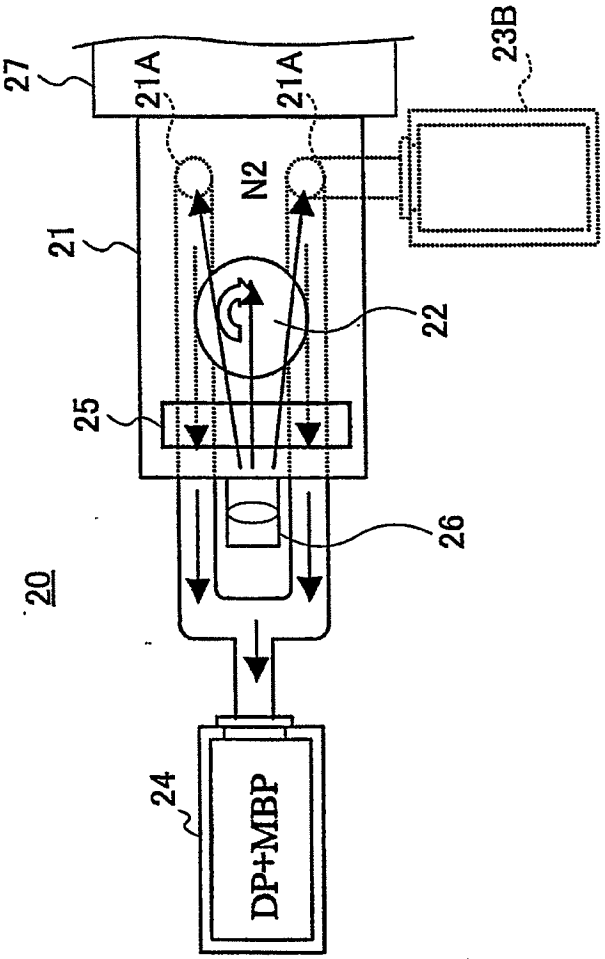


FIG.16B

FIG.17A

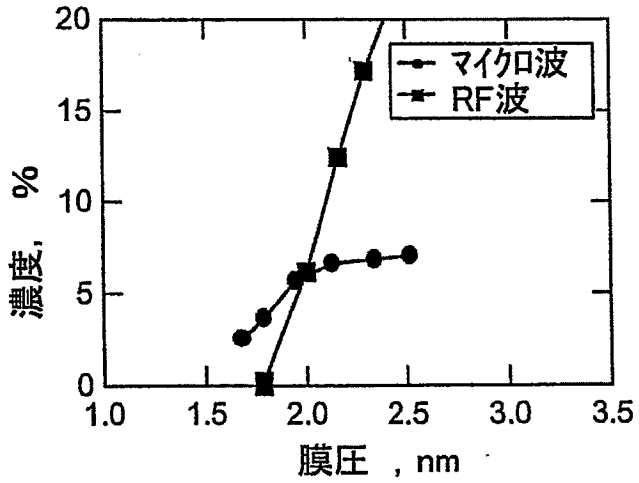


FIG.17B

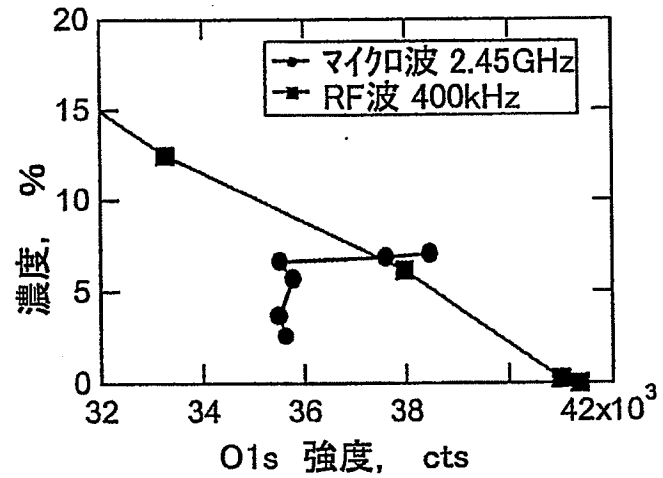


FIG.18

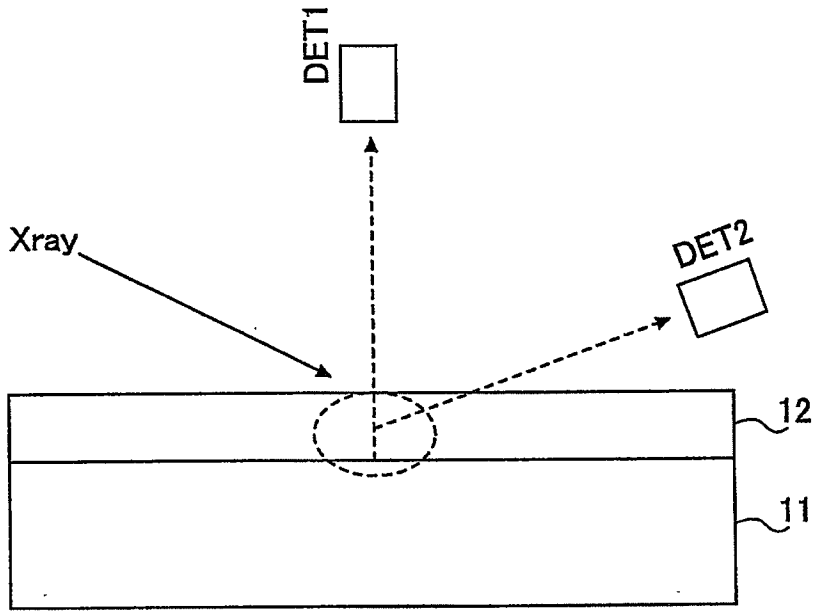


FIG.19

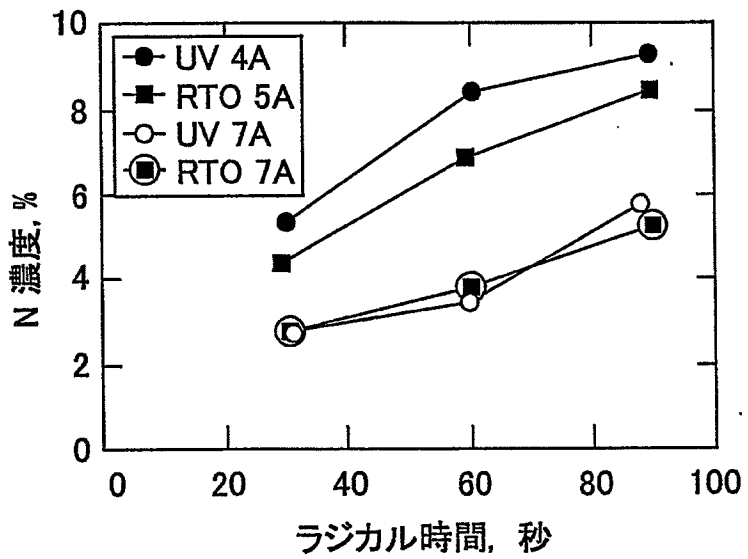

UV 4A
RTO 5A
UV 7A
RTO 7A
N 濃度, %
0
2
4
6
8
10
0
20
40
60
80
100
ラジカル時間, 秒

FIG.20

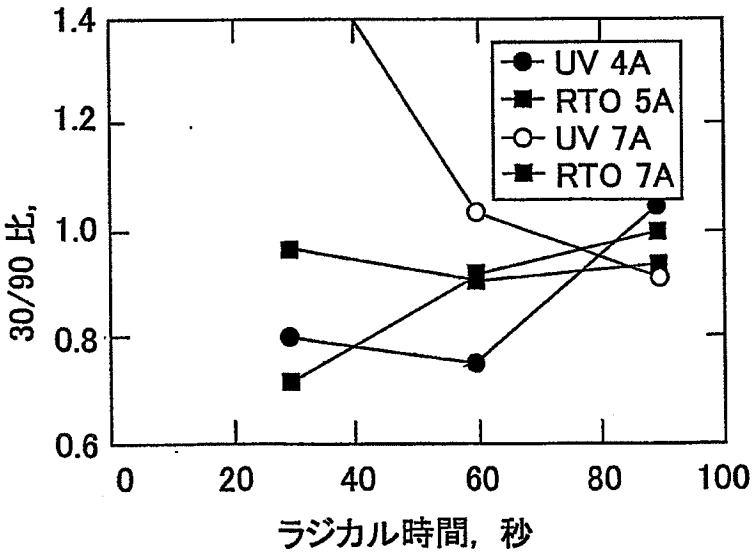

UV 4A
RTO 5A
UV 7A
RTO 7A
30/90 比,
0.6
0.8
1.0
1.2
1.4
0
20
40
60
80
100
ラジカル時間, 秒

FIG.21

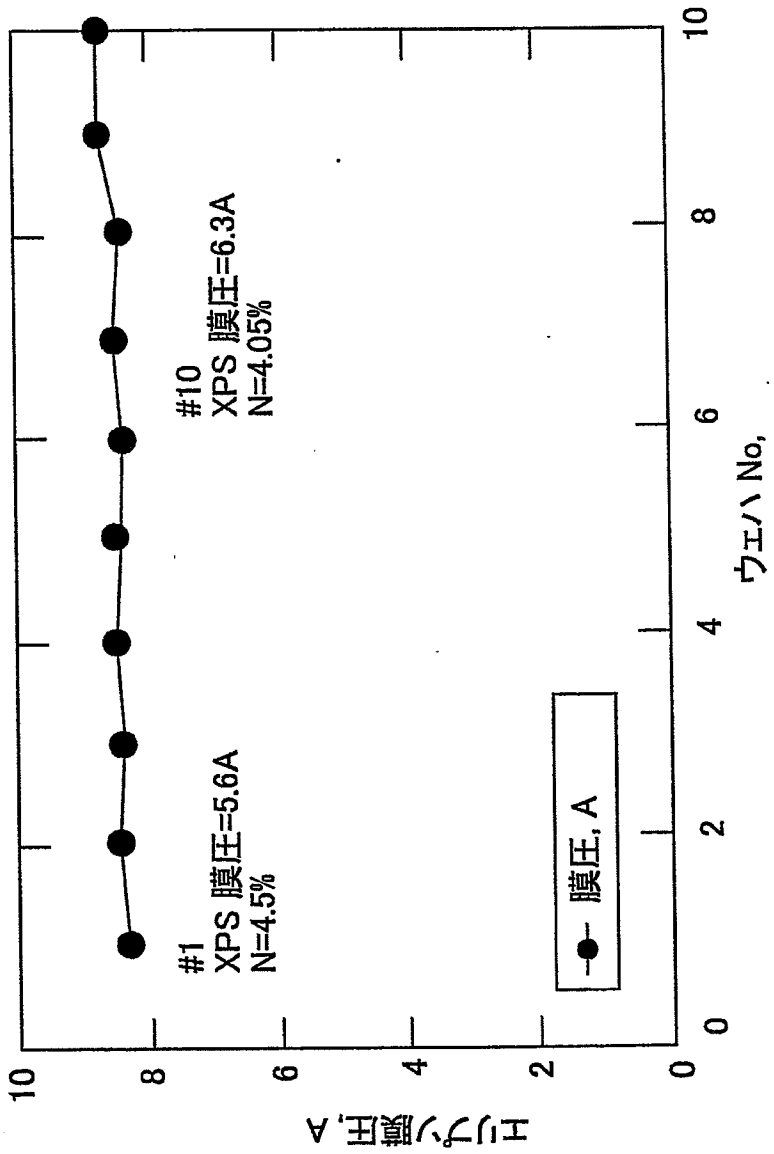


FIG.22

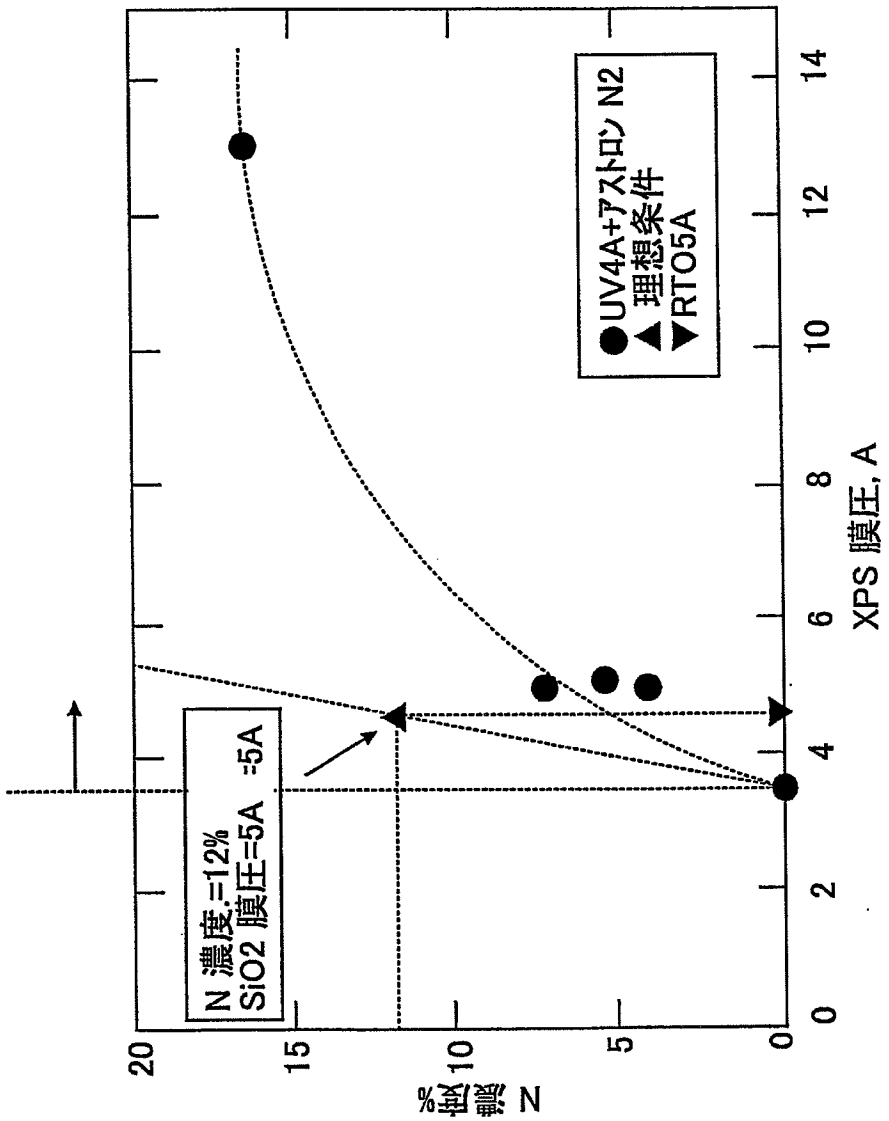

●UV4A+アストロン N2
▲理想条件
▼RTO5A
N 濃度.=12%
SiO2 膜圧=5A =5A
N 濃度%
XPS 膜圧, A
0
5
10
15
20
0
2
4
6
8
10
12
14

FIG.23A

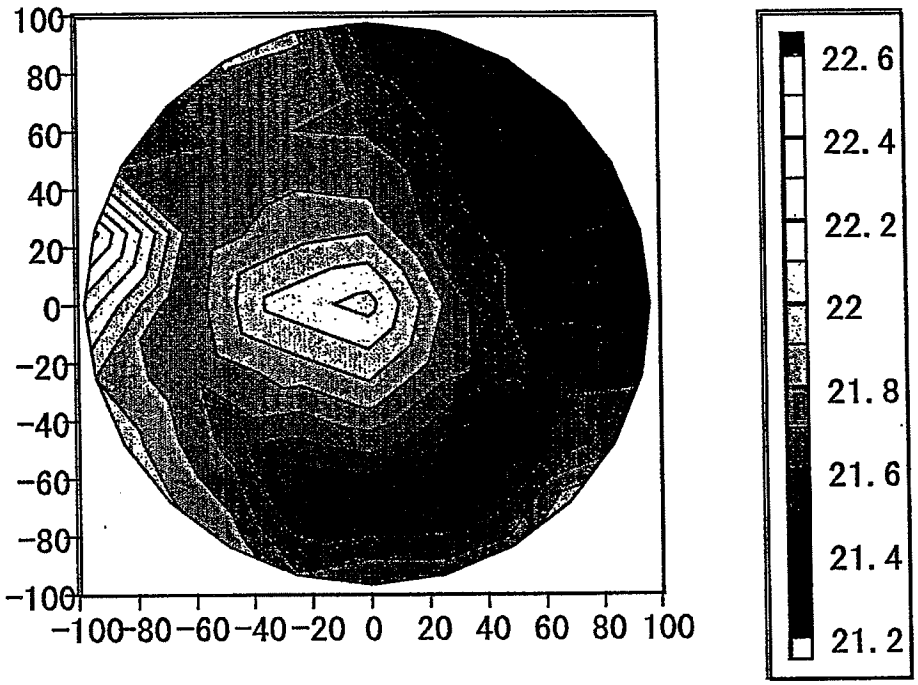


FIG.23B

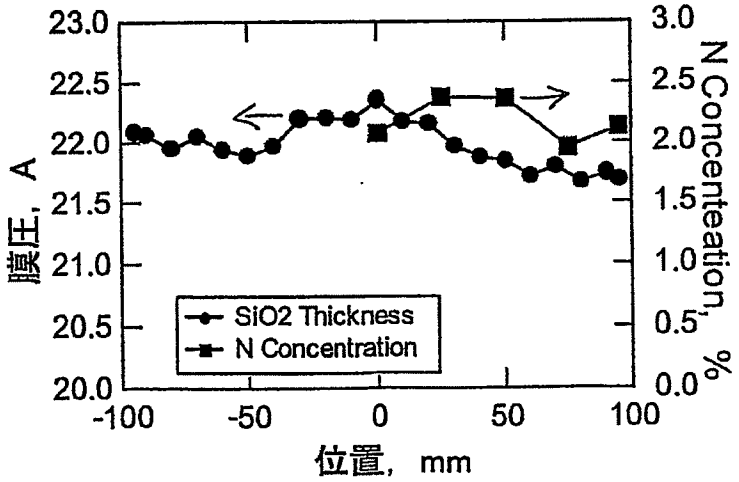
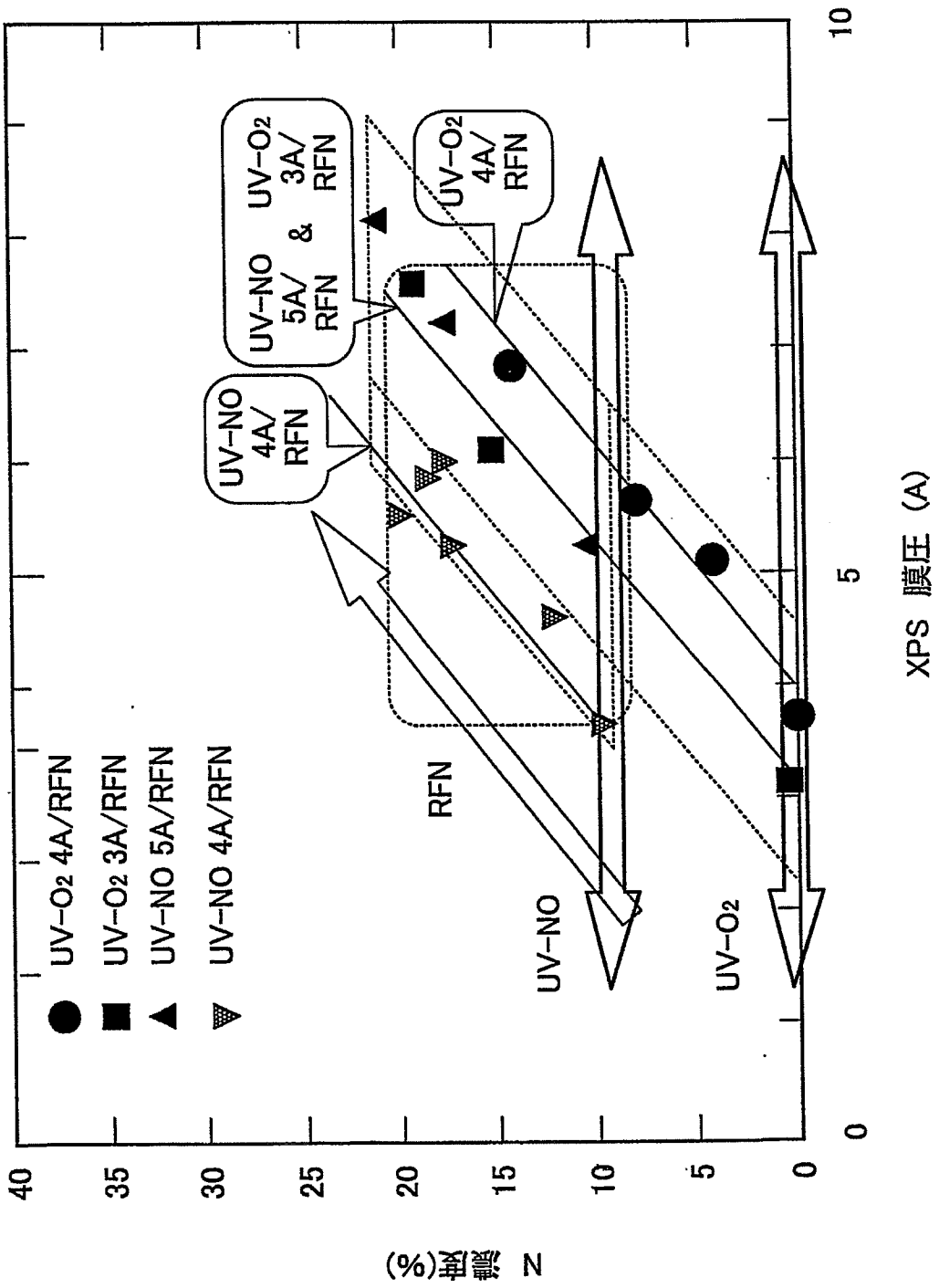


FIG.24


UV-O2 4A/RFN
UV-O2 3A/RFN
UV-NO 5A/RFN
UV-NO 4A/RFN
UV-NO 4A/ RFN
UV-NO 5A/ RFN & UV-O2 3A/ RFN
UV-O2 4A/ RFN
RFN
UV-NO
UV-O2
N 濃度(%)
XPS 膜圧 (A)
0
5
10
15
20
25
30
35
40

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FIG.25

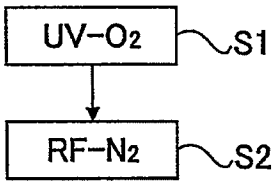


FIG.26A

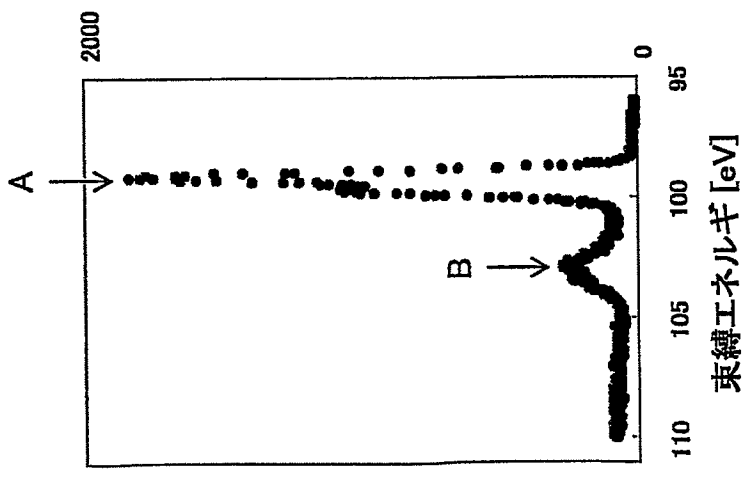


FIG.26B

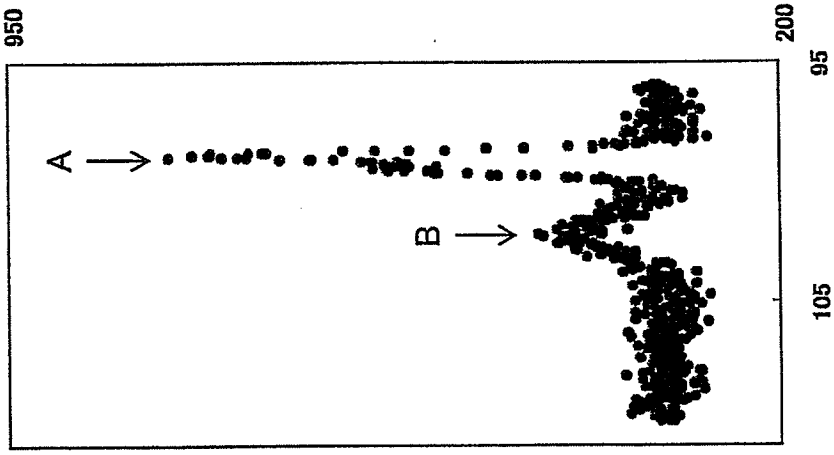


FIG.26C

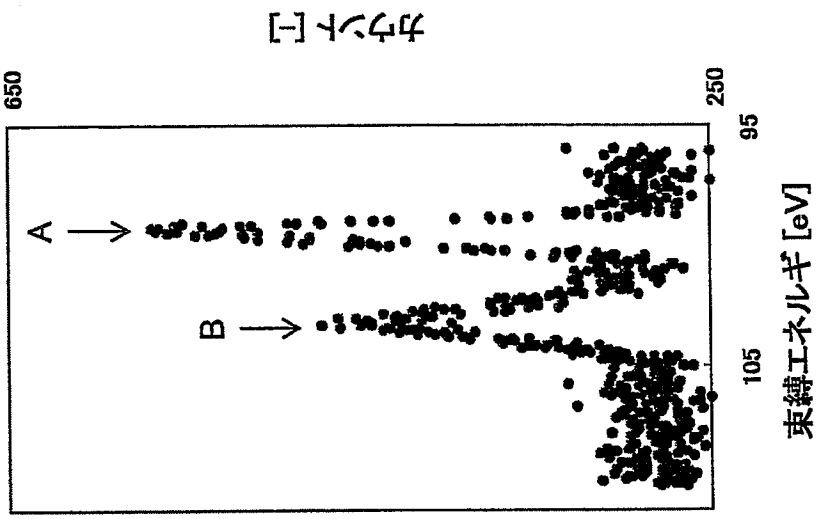


FIG.27

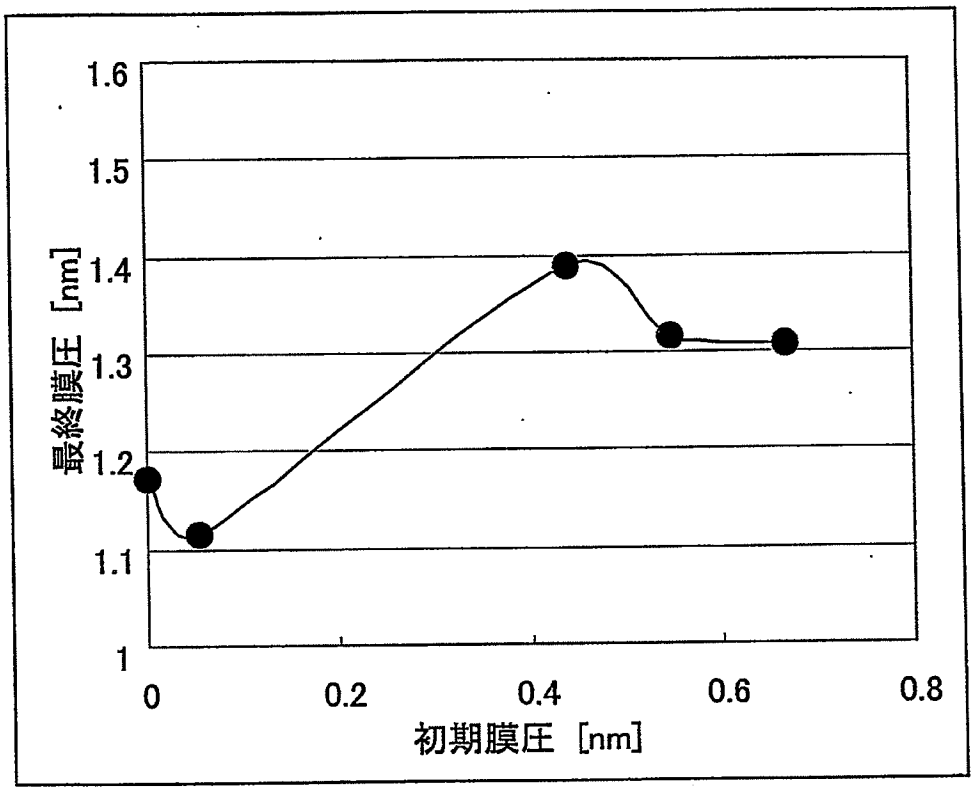


FIG.28B

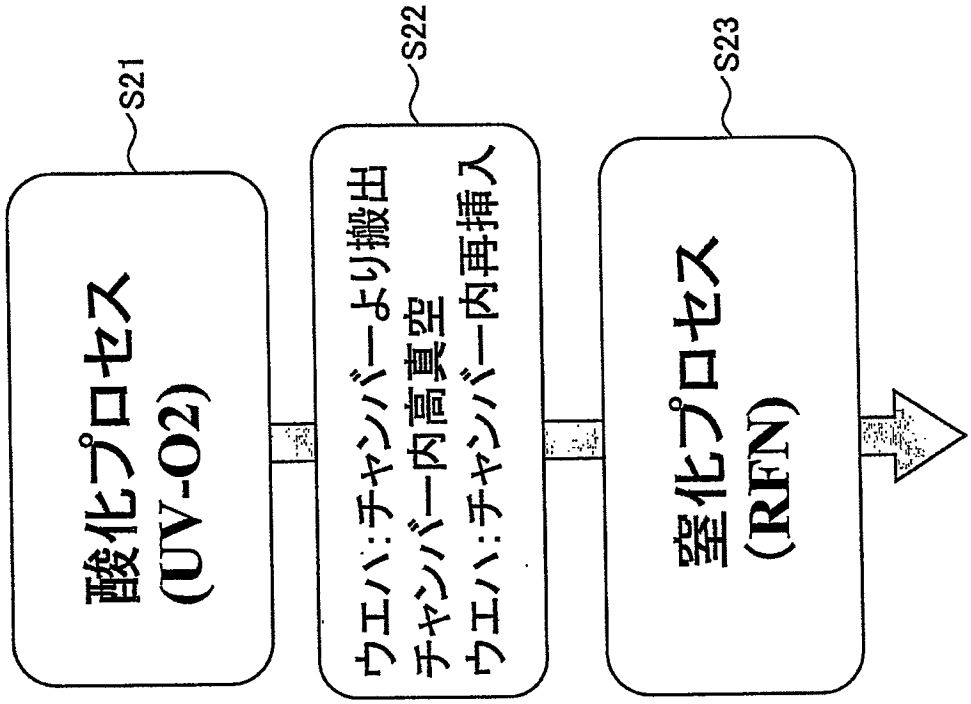


FIG.28A

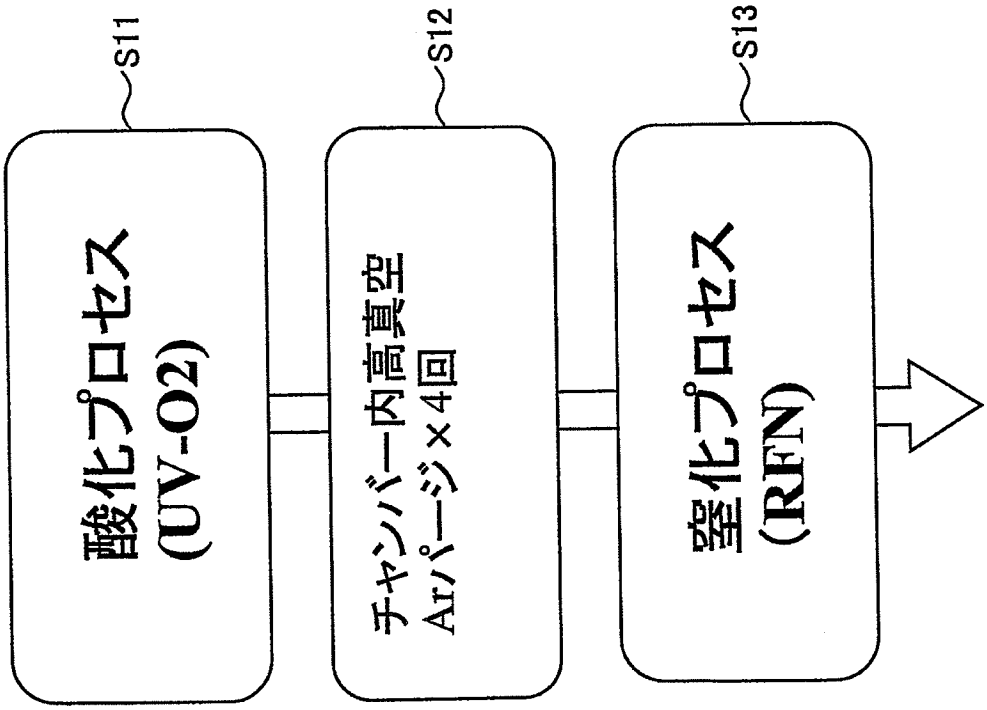


FIG.29A

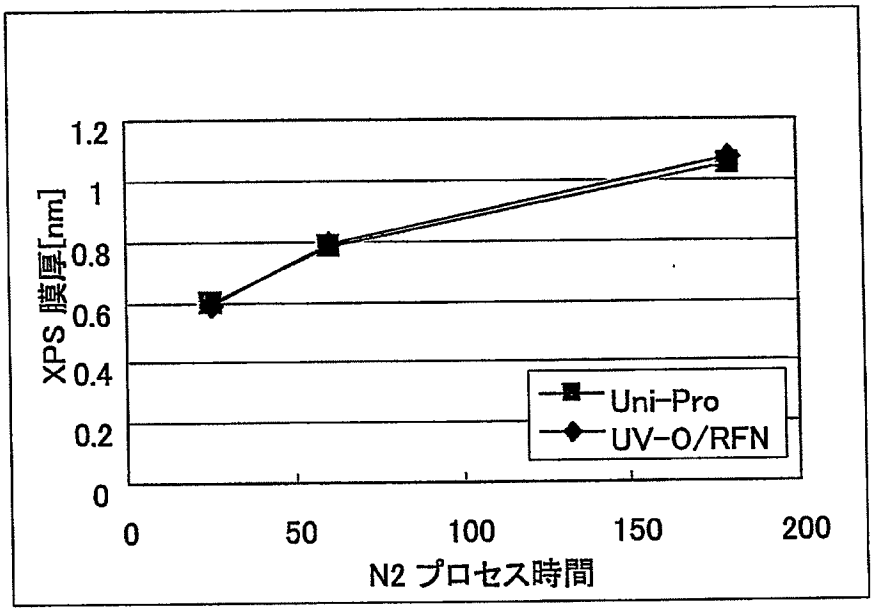


FIG.29B

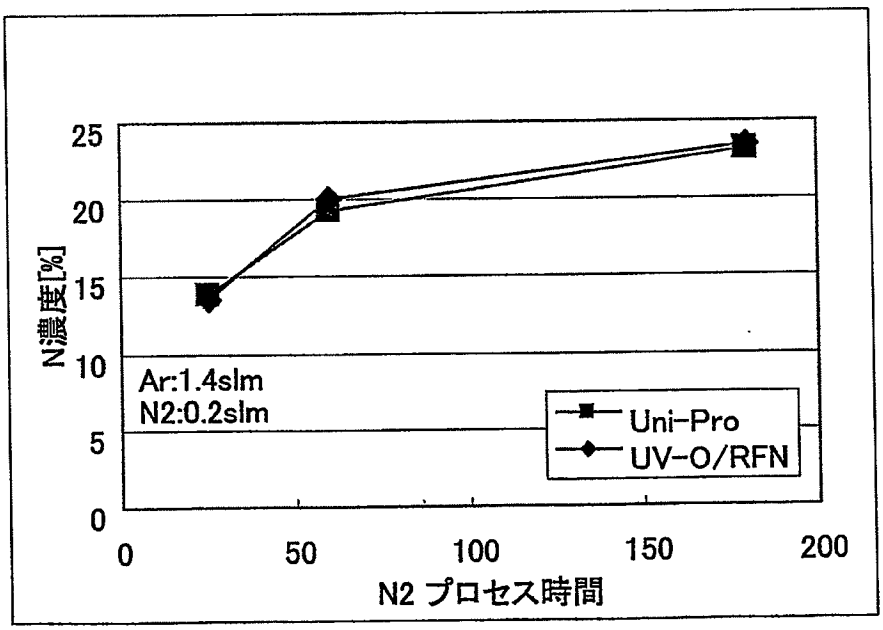


FIG.30B

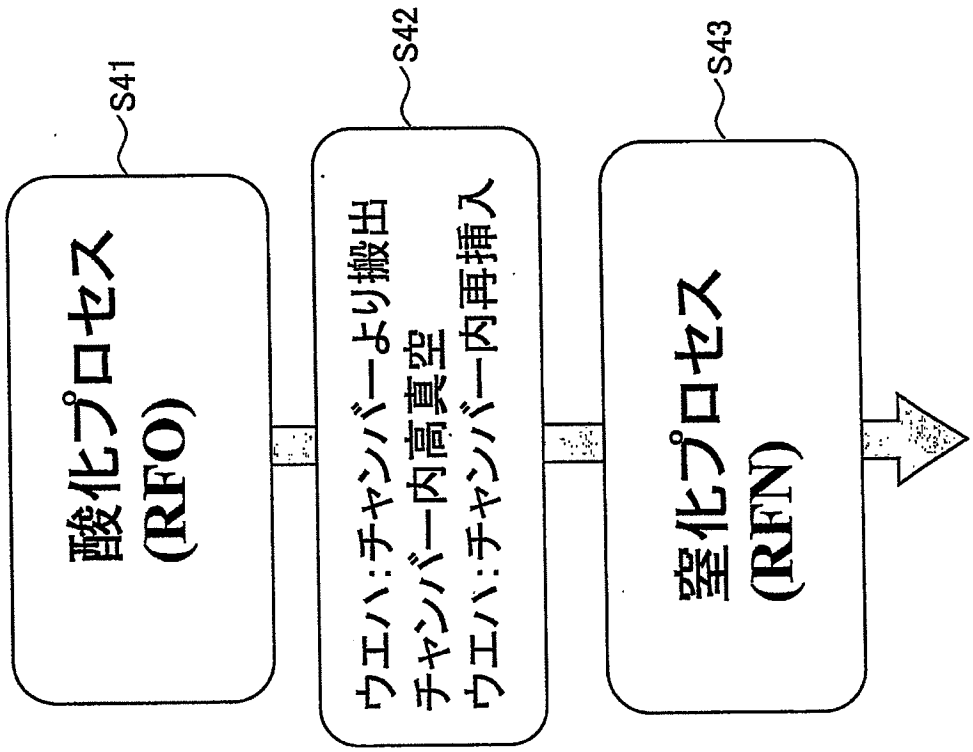


FIG.30A

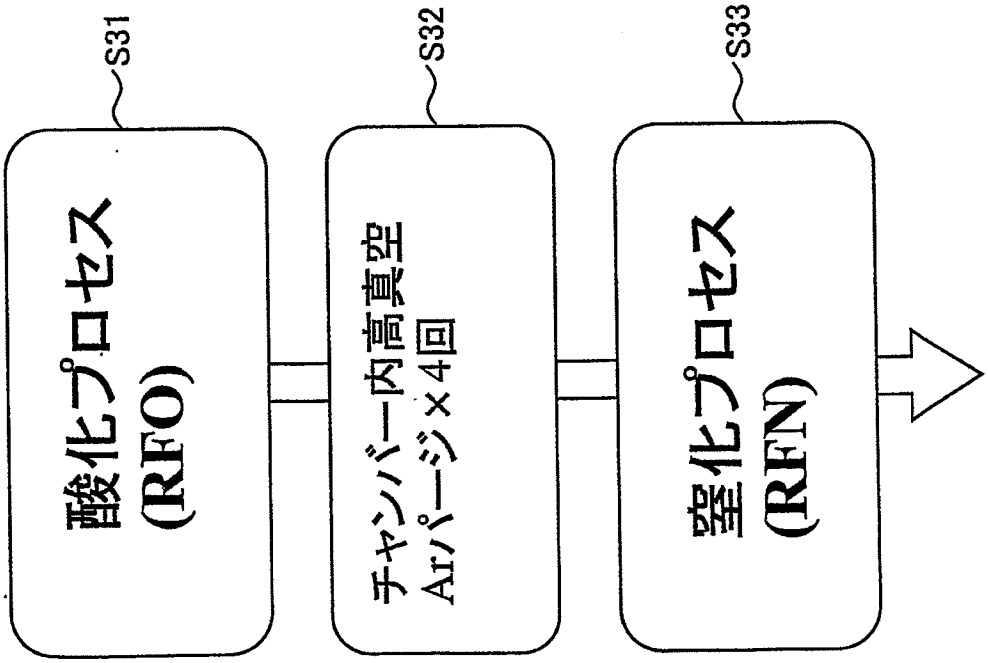


FIG.31A

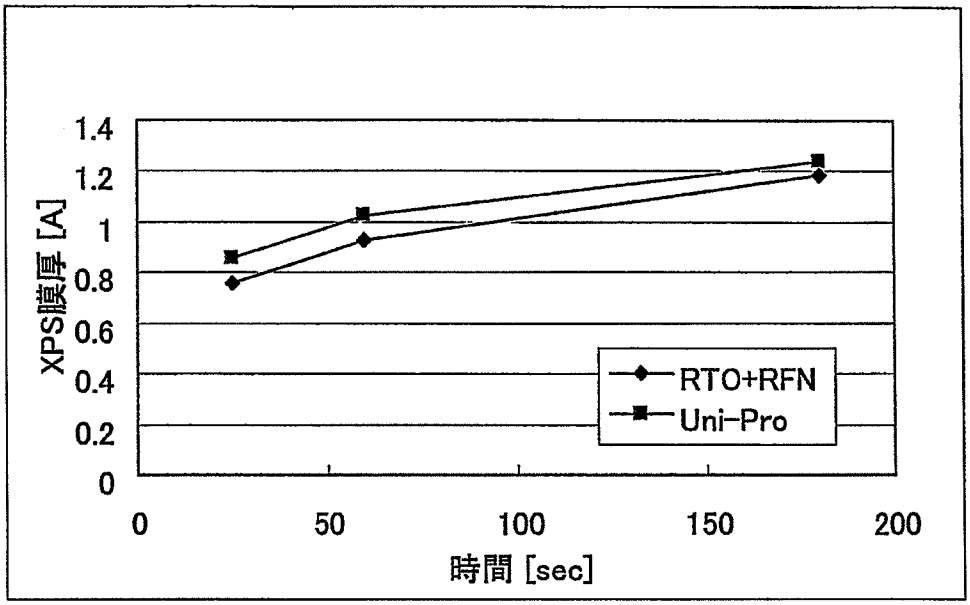


FIG.31B

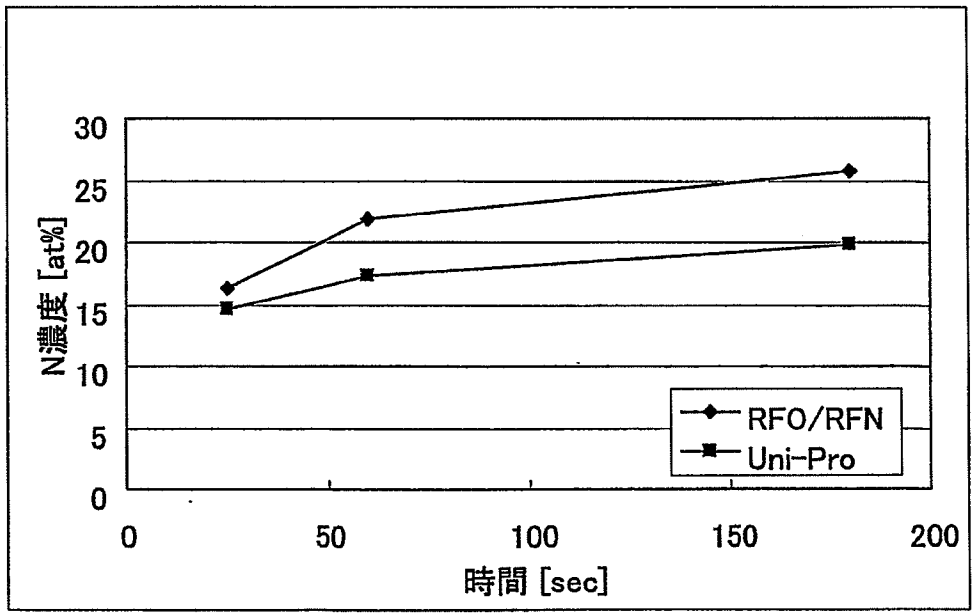


FIG.32

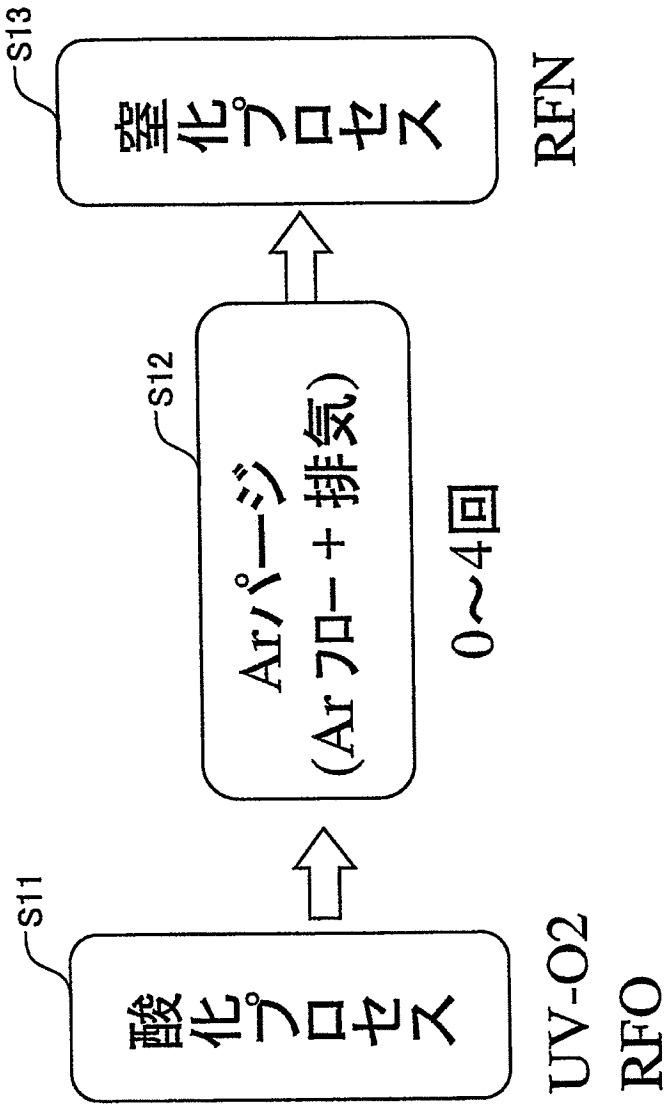


FIG.33A

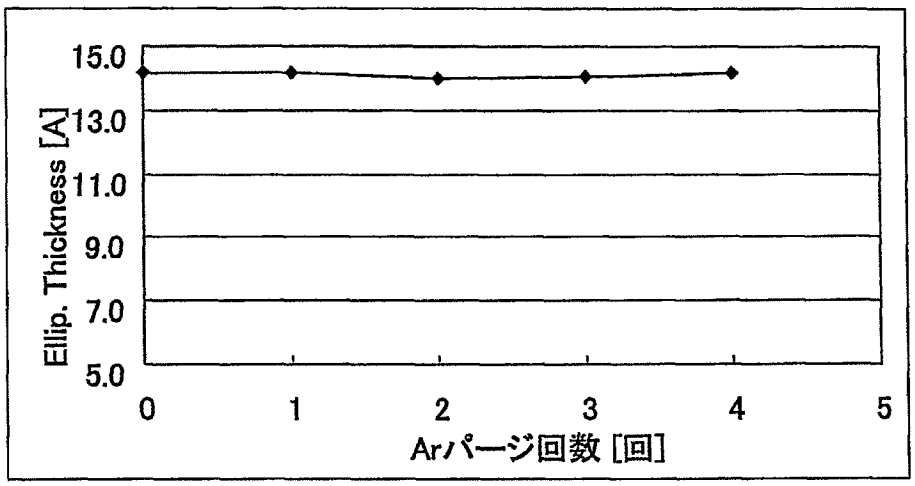


FIG.33B

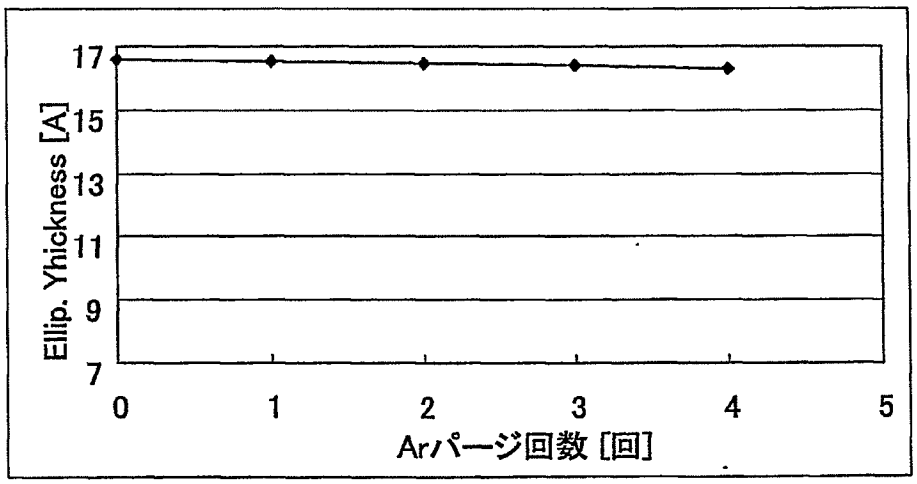
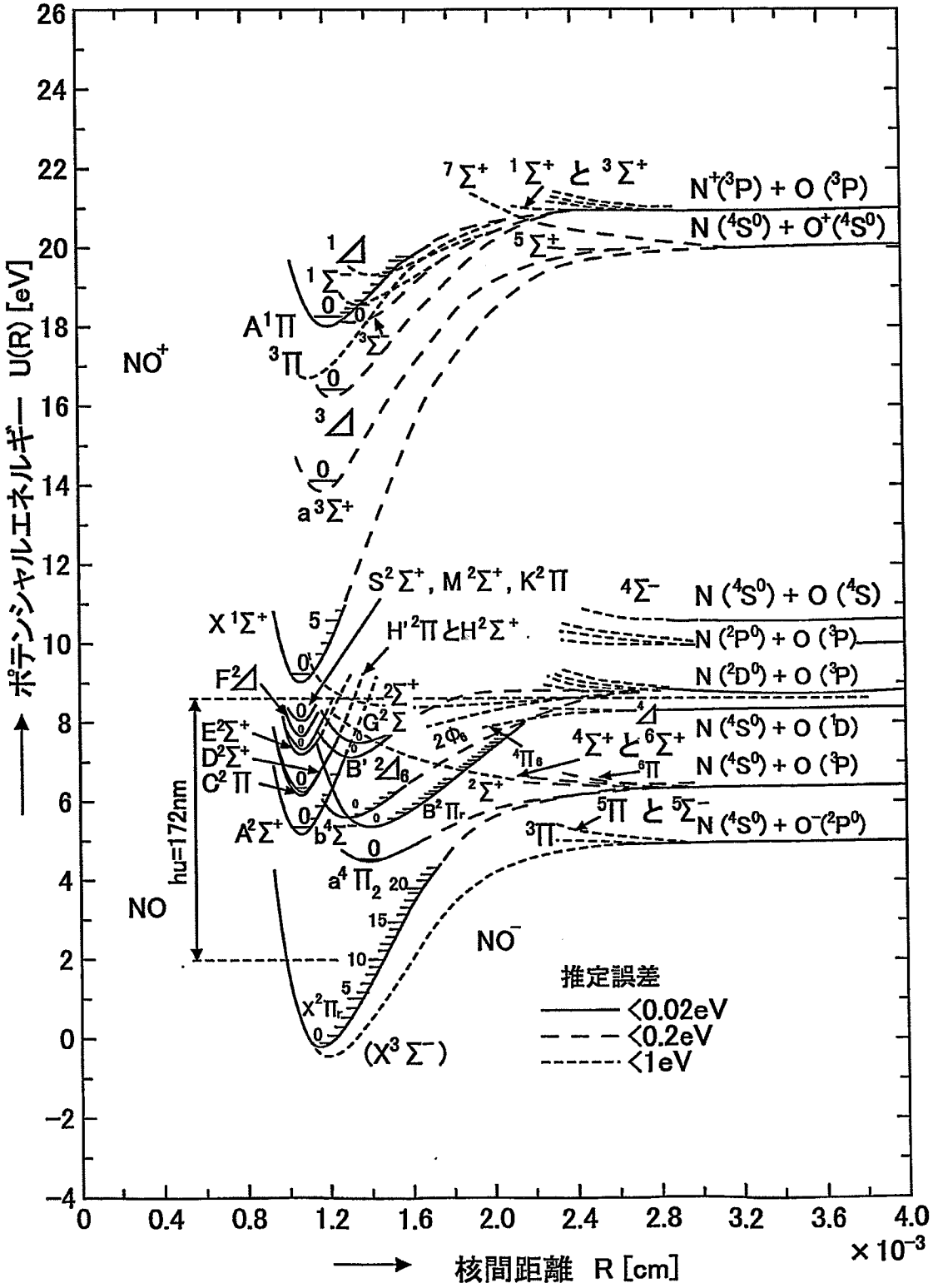


FIG.34


ポテンシャルエネルギー U(R) [eV]
核間距離 R [cm]
×10⁻³
NO⁺
NO
NO⁻
hν=172nm
A¹Π
³Π
³Δ
a³Σ⁺
X¹Σ⁺
F²Δ
E²Σ⁺
D²Σ⁺
C²Π
A²Σ⁺
b⁴Σ⁻
a⁴Π
X²Π
(X³Σ⁻)
S²Σ⁺, M²Σ⁺, K²Π
H'²Π と H²Σ⁺
G²Σ⁻
B'²Δ
B²Π
²Φ
⁴Π
²Σ⁺
⁴Σ⁻
⁵Π と ⁵Σ⁻
³Π
⁷Σ⁺ ¹Σ⁺ と ³Σ⁺
⁵Σ⁺
⁴Σ⁺ と ⁶Σ⁺
⁶Π
N⁺(³P) + O (³P)
N (⁴S⁰) + O⁺(⁴S⁰)
N (⁴S⁰) + O (⁴S)
N (²P⁰) + O (³P)
N (²D⁰) + O (³P)
N (⁴S⁰) + O (¹D)
N (⁴S⁰) + O (³P)
N (⁴S⁰) + O⁻(²P⁰)
推定誤差
<0.02eV
<0.2eV
<1eV

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FIG.35

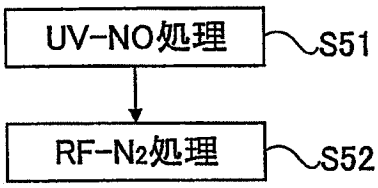


FIG.36

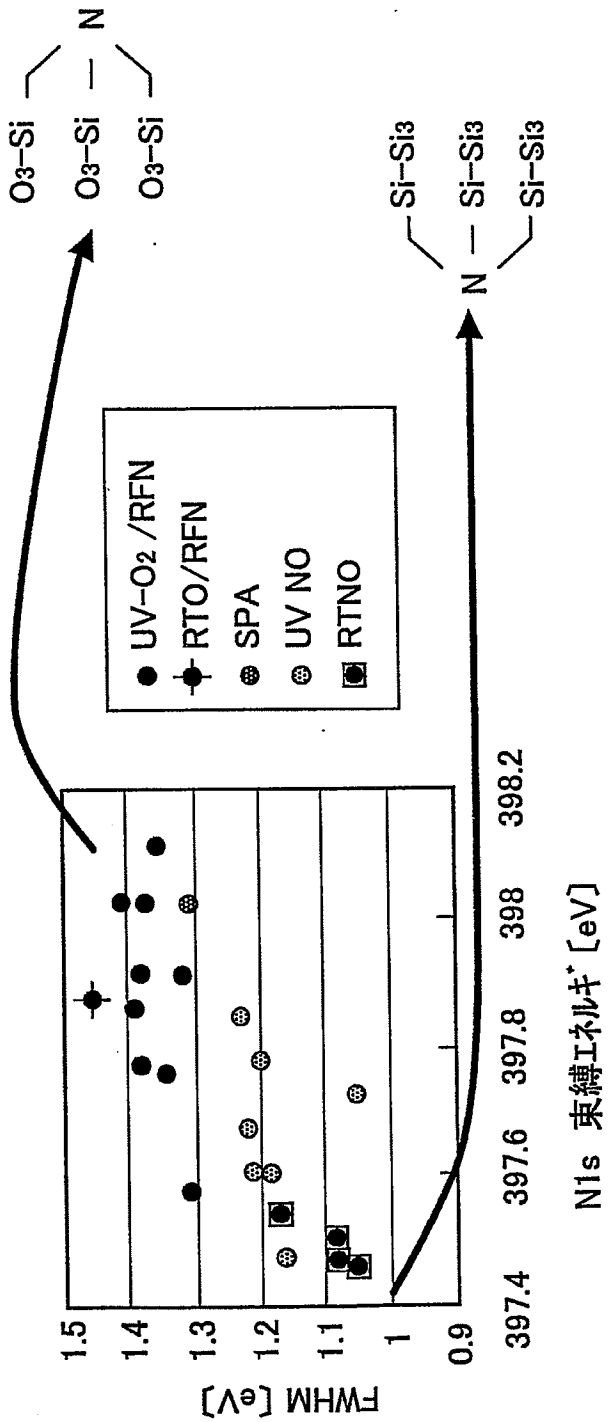

O3–Si
O3–Si — N
O3–Si
Si–Si3
N — Si–Si3
Si–Si3
UV–O2 /RFN
RTO/RFN
SPA
UV NO
RTNO
FWHM [eV]
1.5
1.4
1.3
1.2
1.1
1
0.9
397.4
397.6
397.8
398
398.2
N1s 束縛エネルギー [eV]

FIG.37A

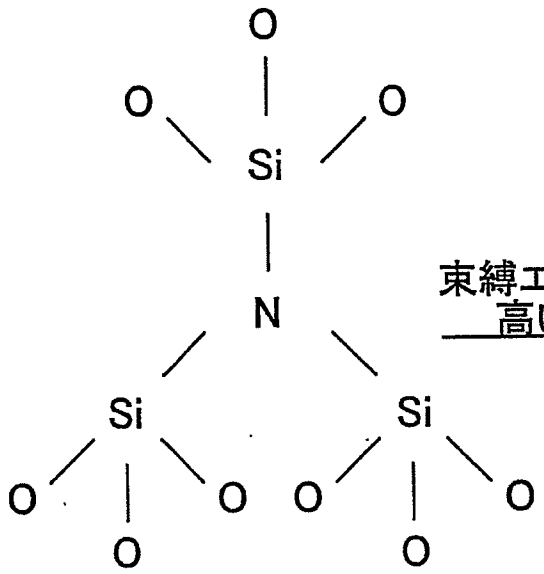


FIG.37B

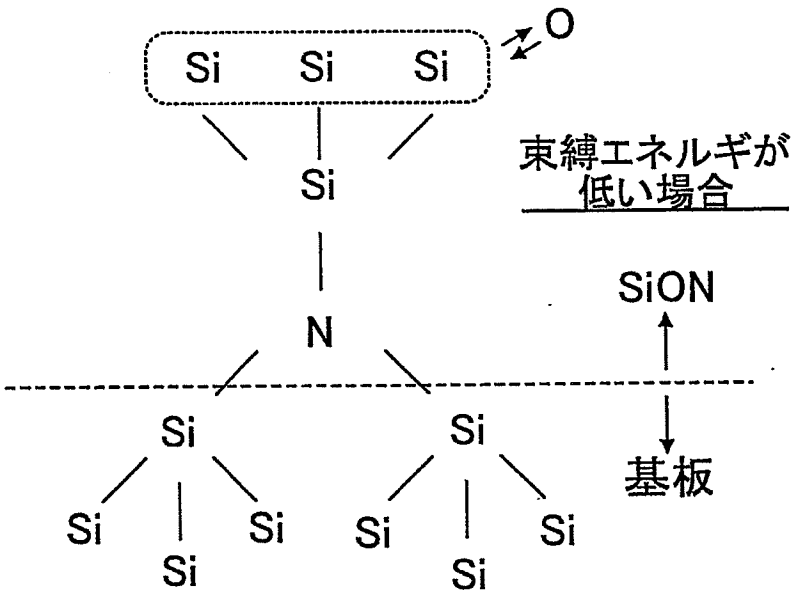
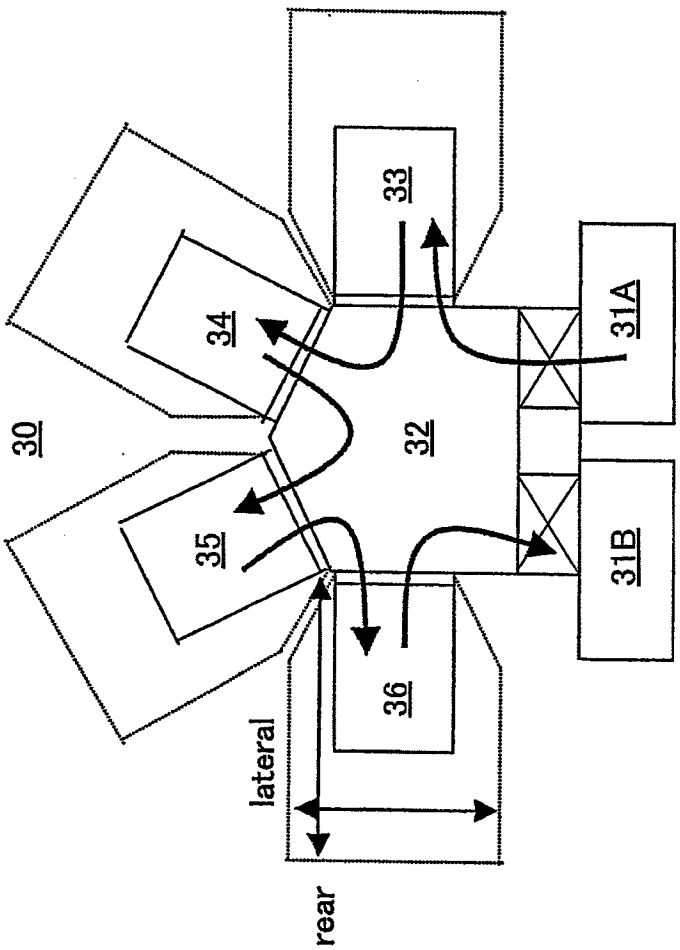


FIG.38



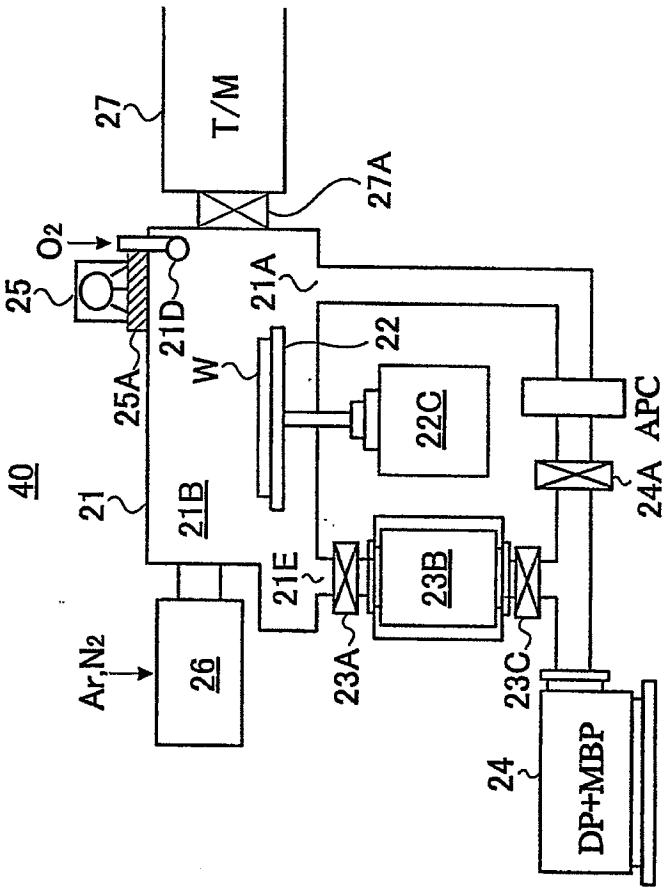


FIG.39A

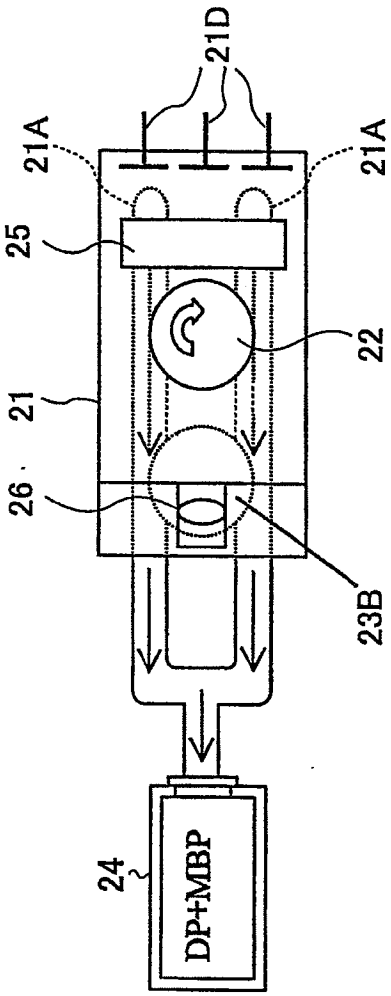


FIG.39B

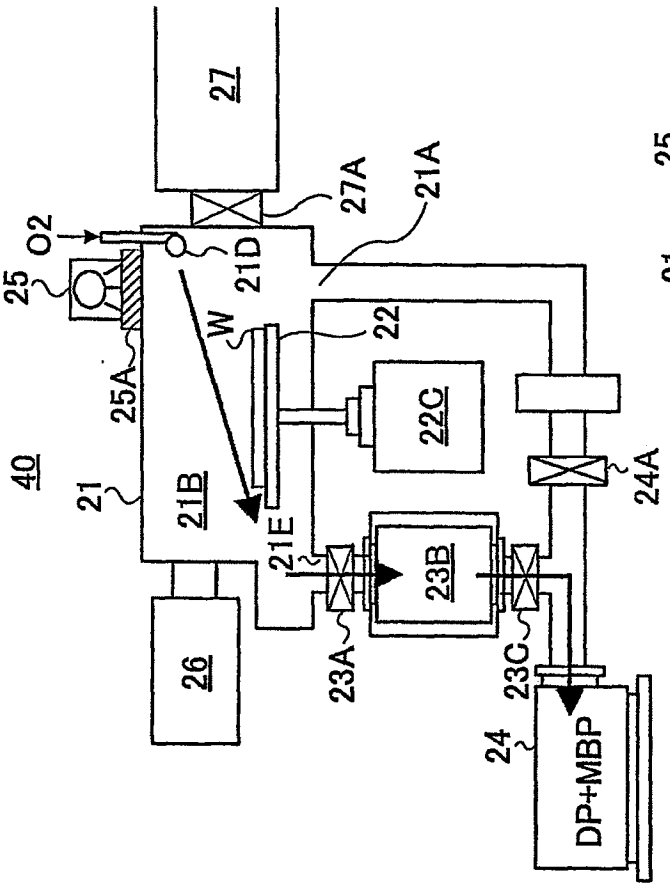


FIG.40A

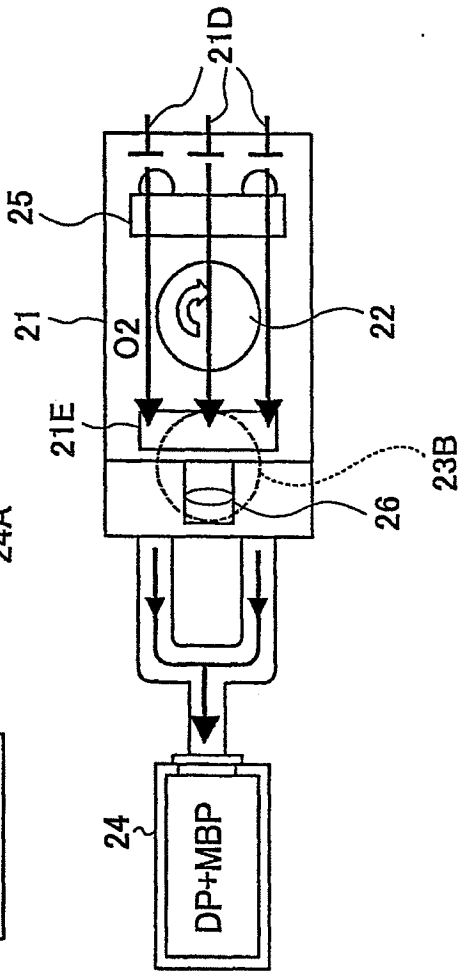


FIG.40B

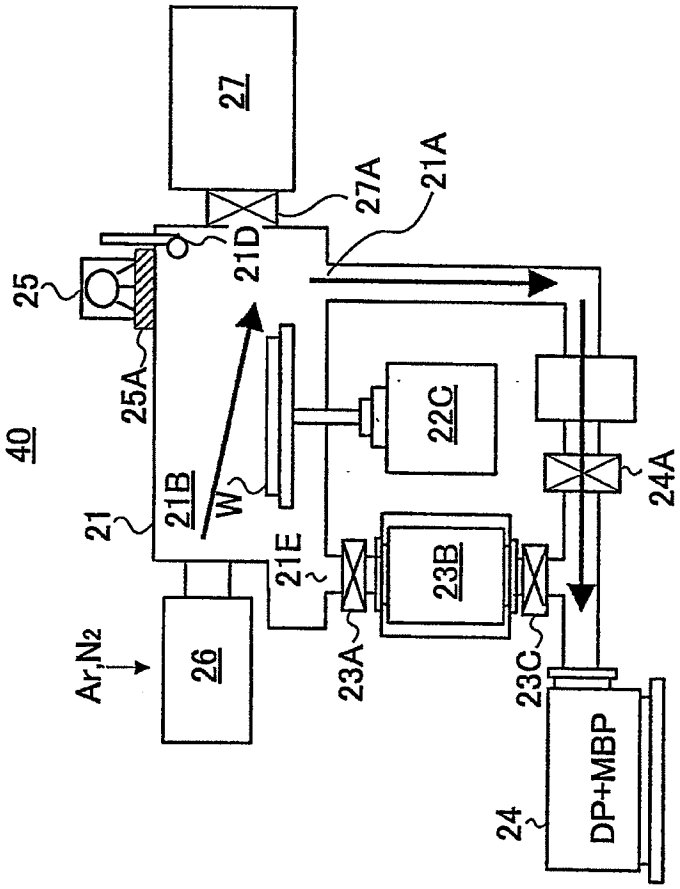


FIG.41A

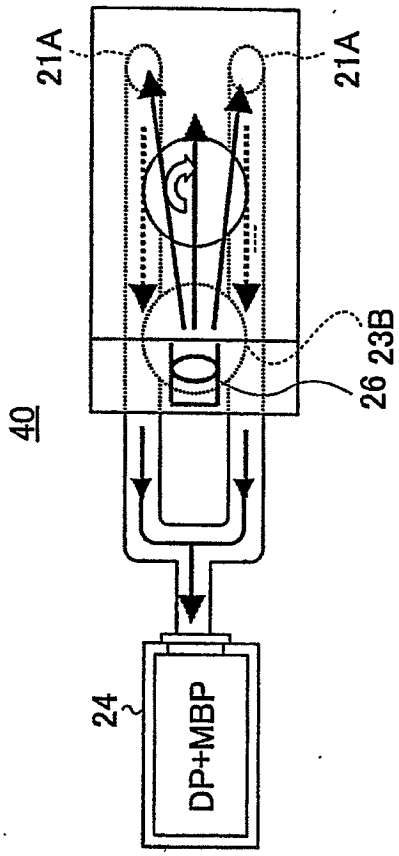
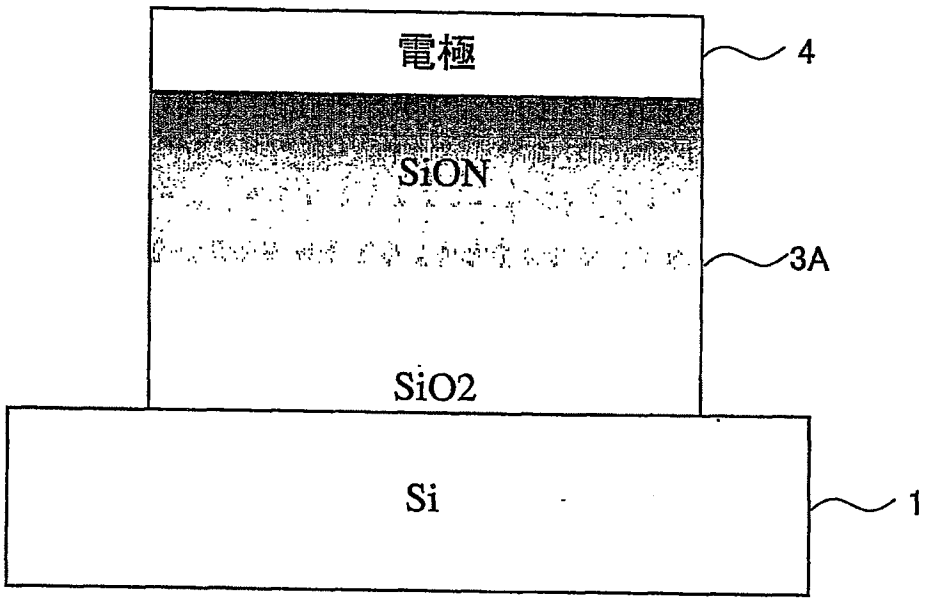


FIG.41B

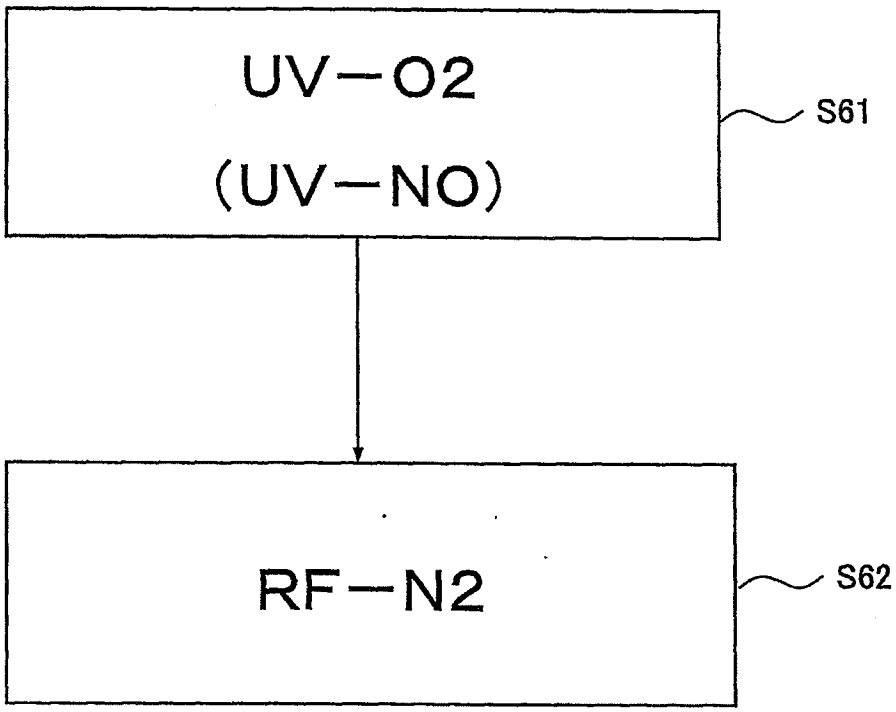
29 MAY 2006

FIG.42



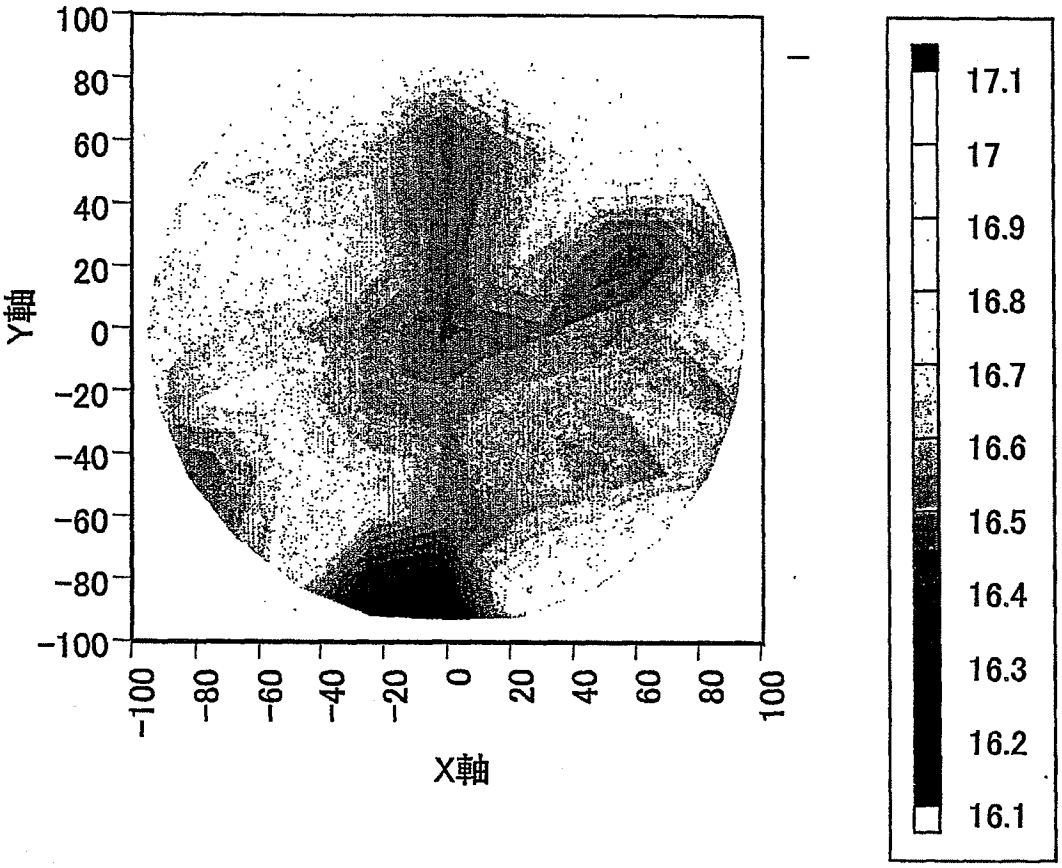
2 9 MAY 2006

FIG.43



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FIG.44



σ Unif.=0.72%

FIG.45A

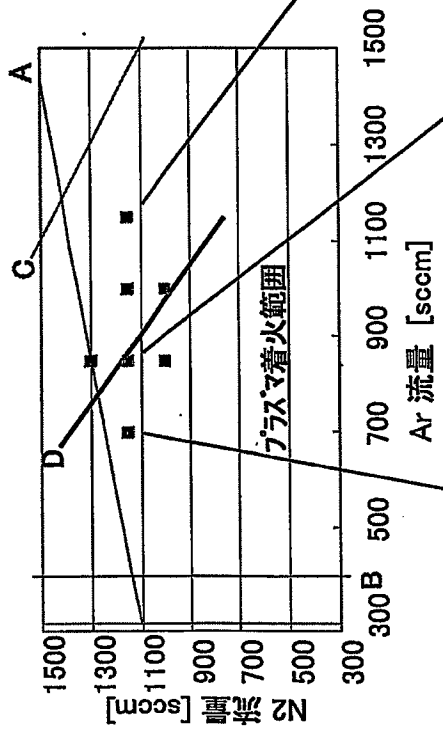


FIG.45C

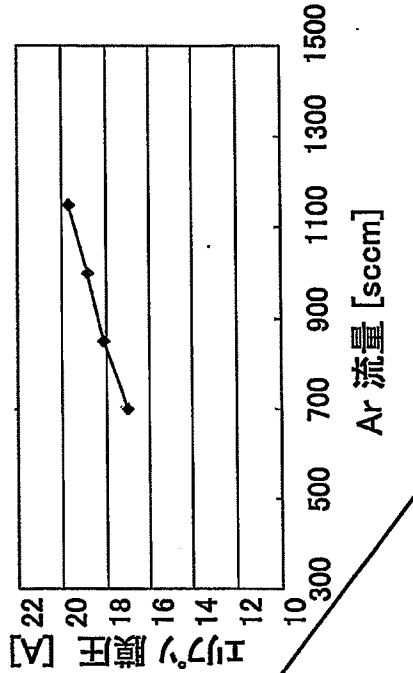


FIG.45B

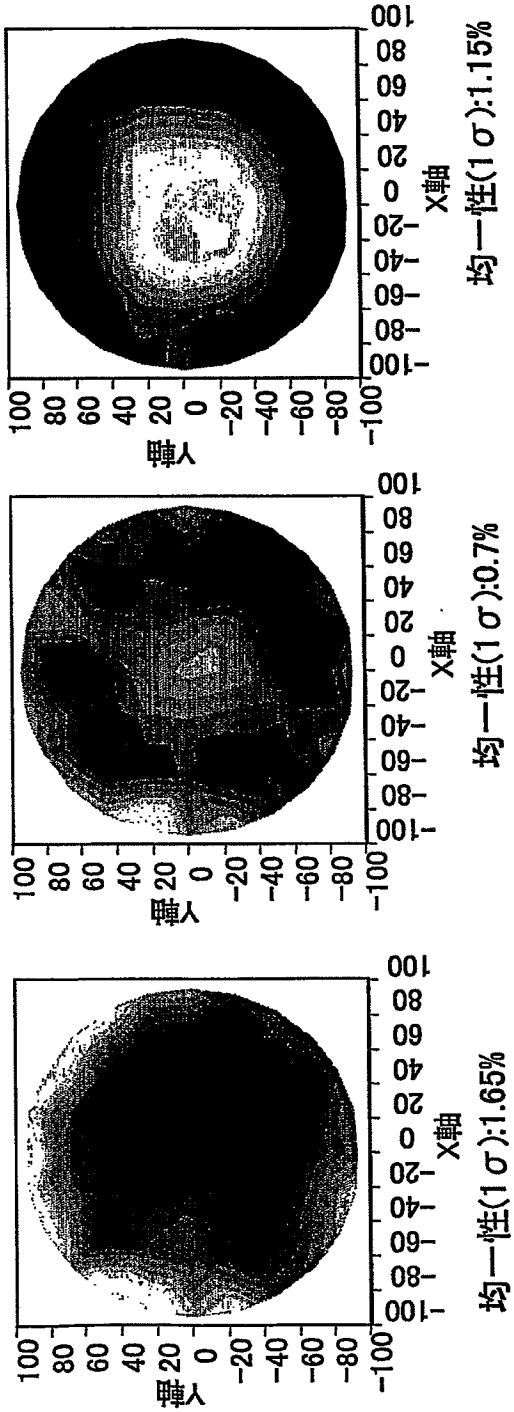


FIG.46A

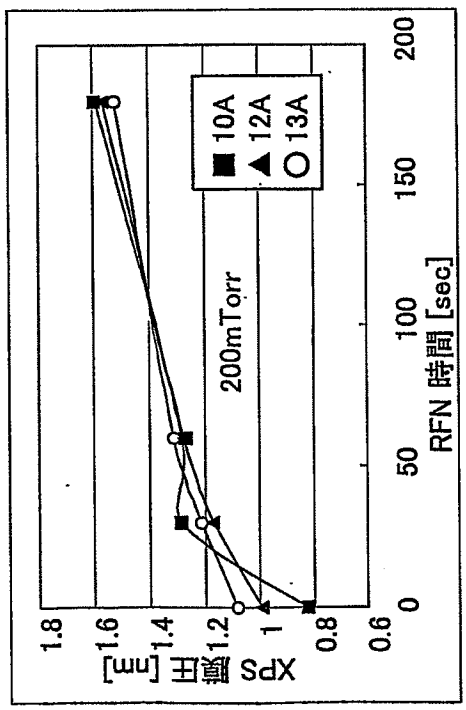


FIG.46B

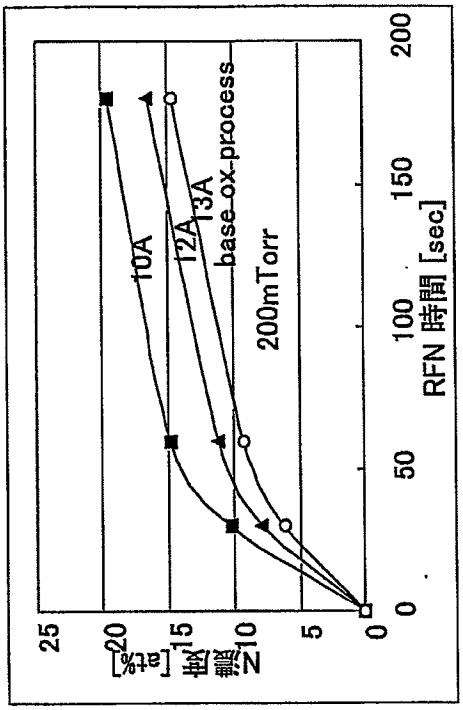


FIG.46C

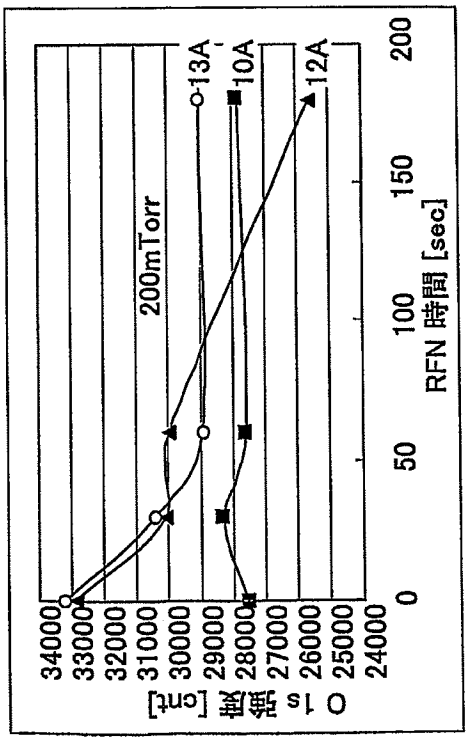


FIG.46D

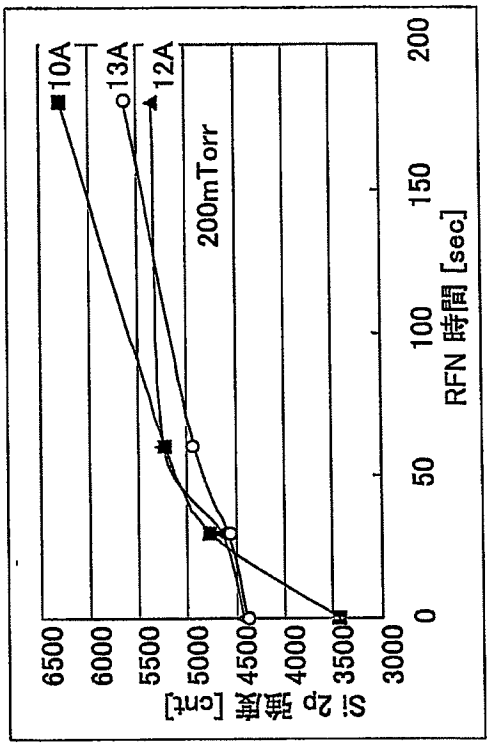


FIG.47A

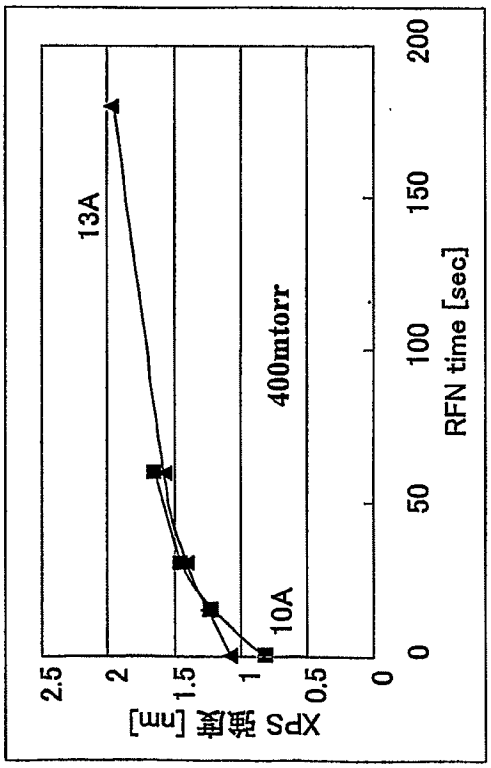


FIG.47B

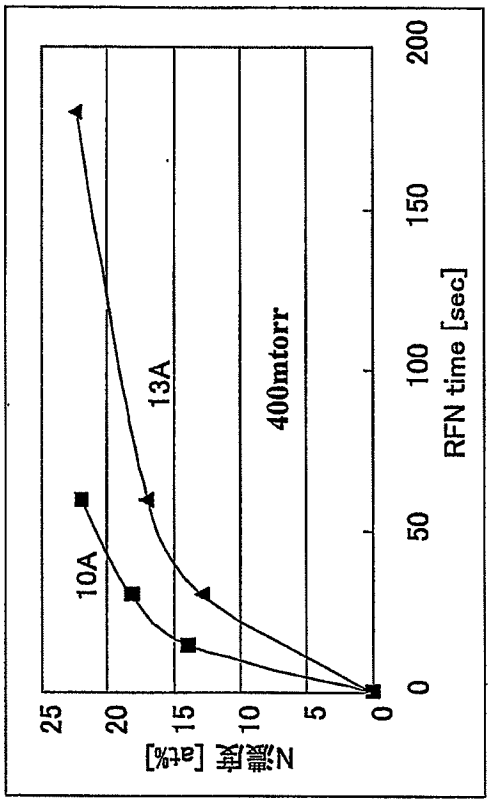


FIG.47C

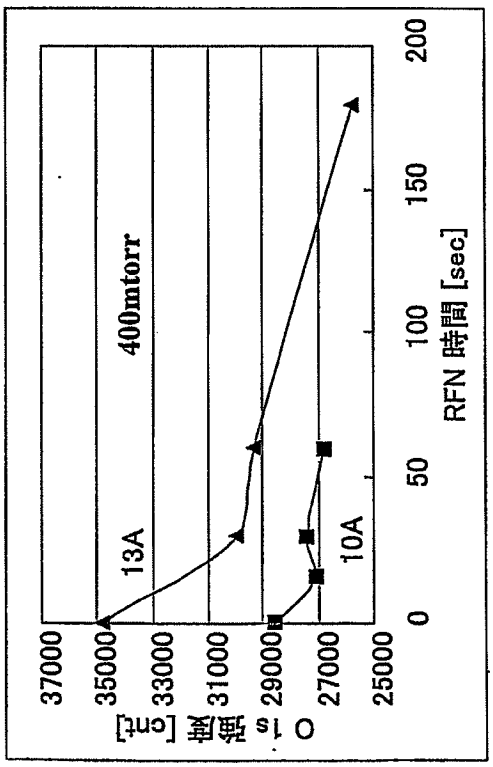


FIG.47D

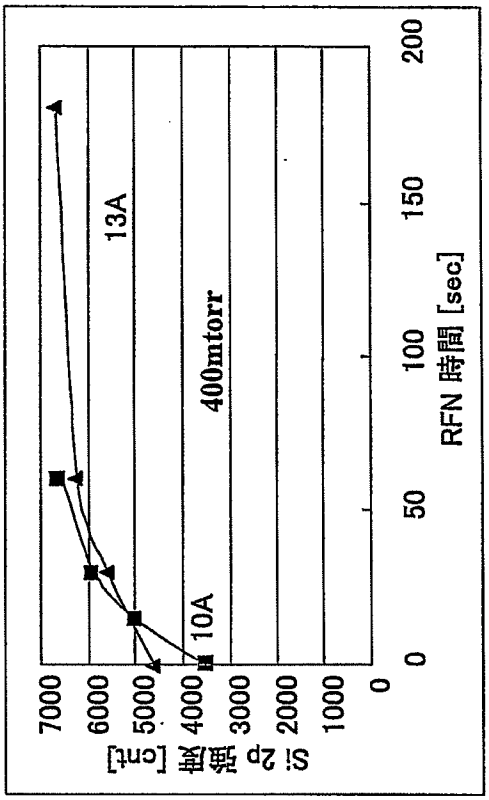


FIG.48A

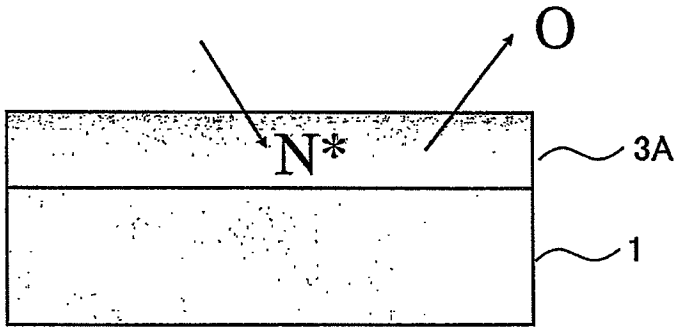


FIG.48B

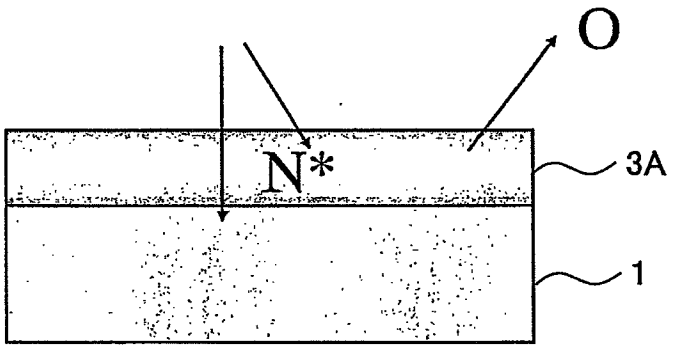


FIG.49B

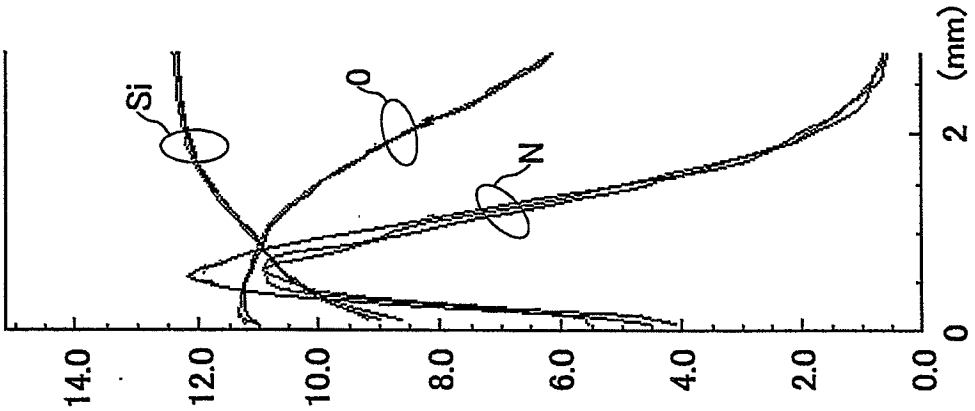


FIG.49A

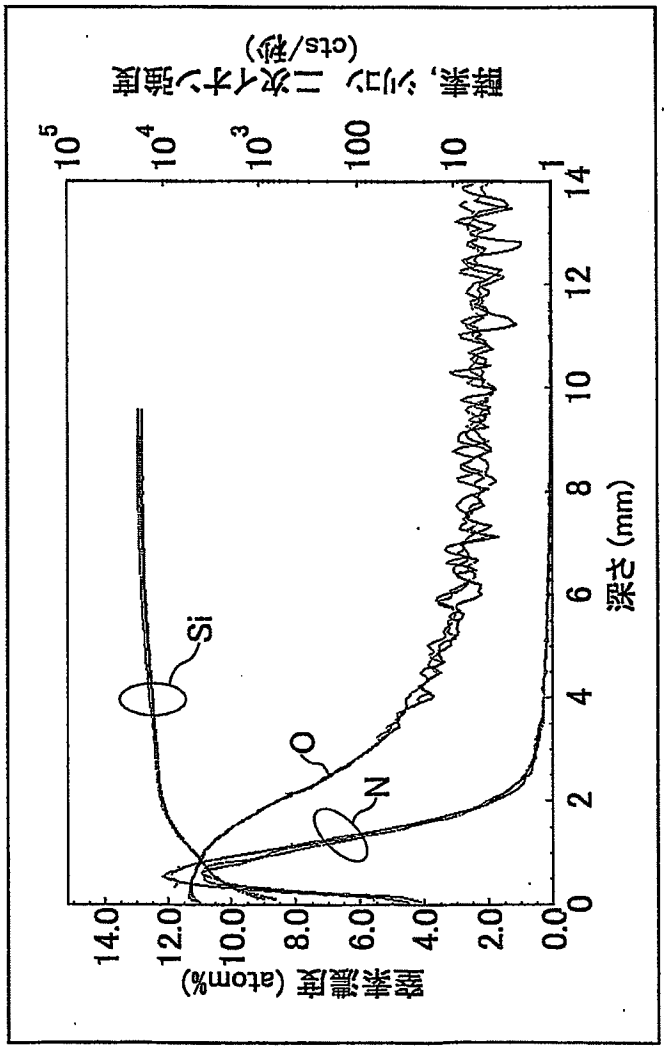


FIG.50B

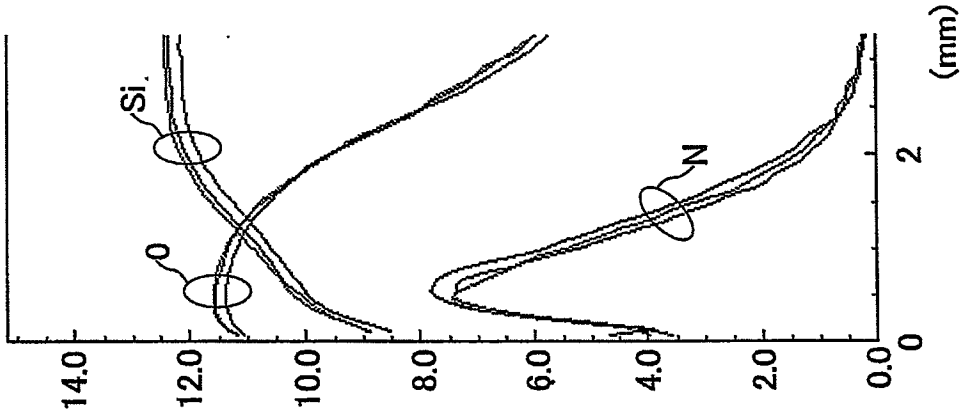


FIG.50A

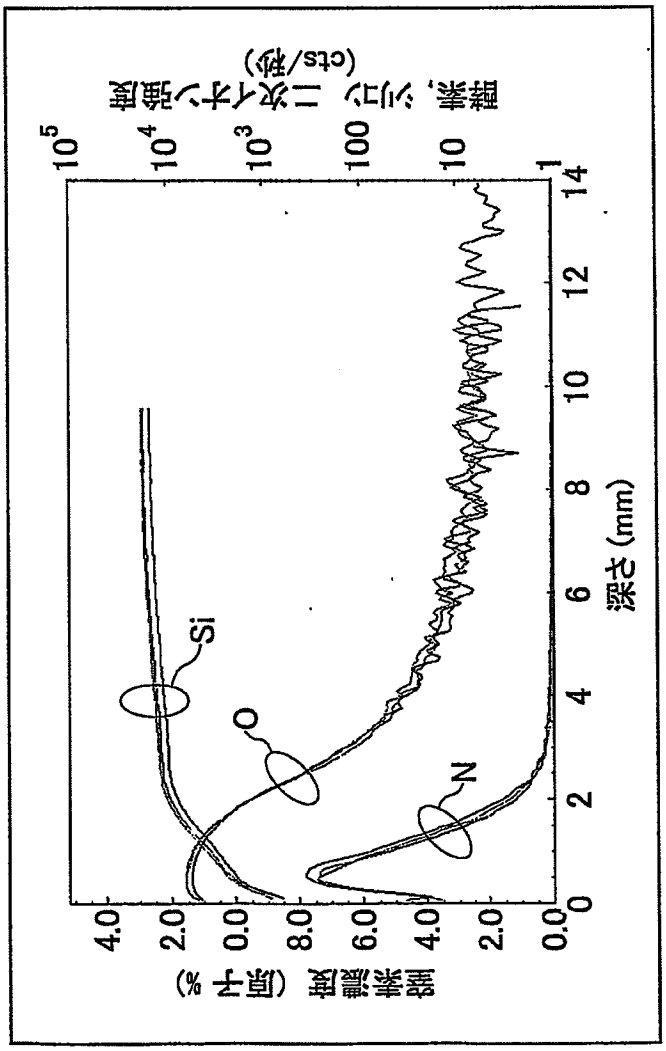


FIG.51

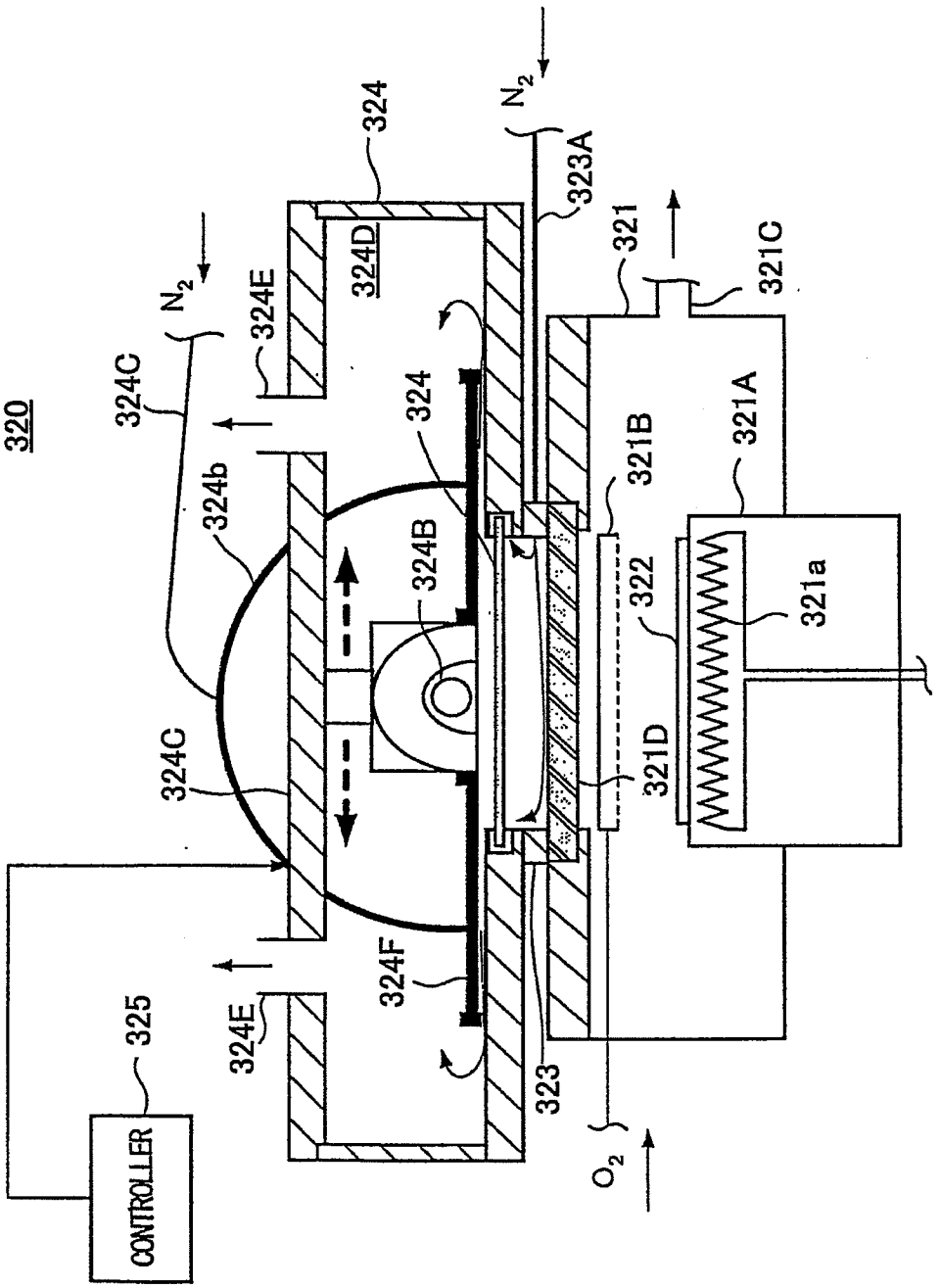

320
324
N_2
323A
321
321C
324D
324E
N_2
324C
324
324b
324B
321B
321A
322
321a
324C
321D
324F
324E
325
323
O_2
CONTROLLER

FIG.52A

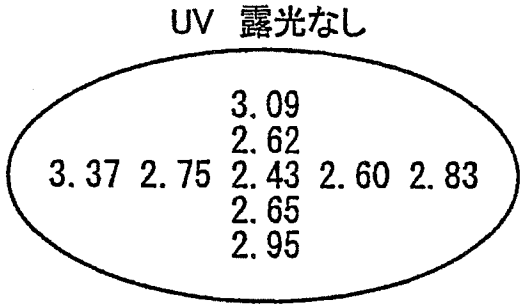


FIG.52B

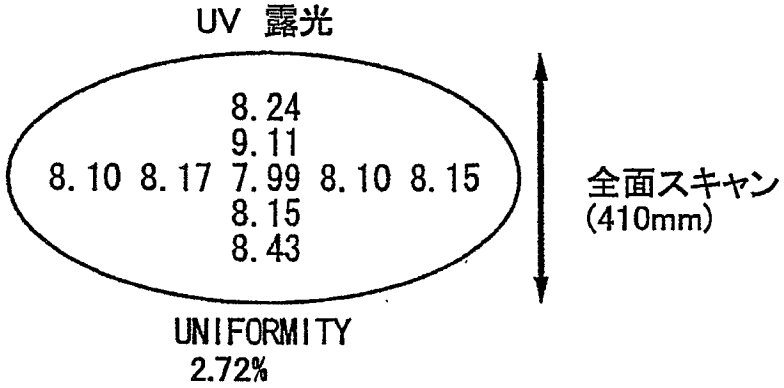


FIG.52C

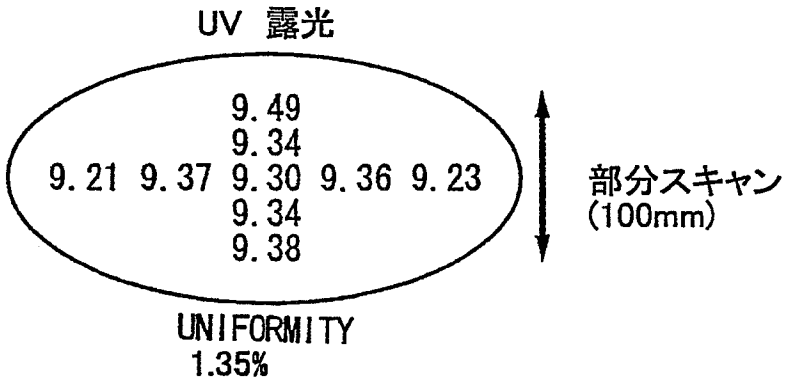


FIG.53

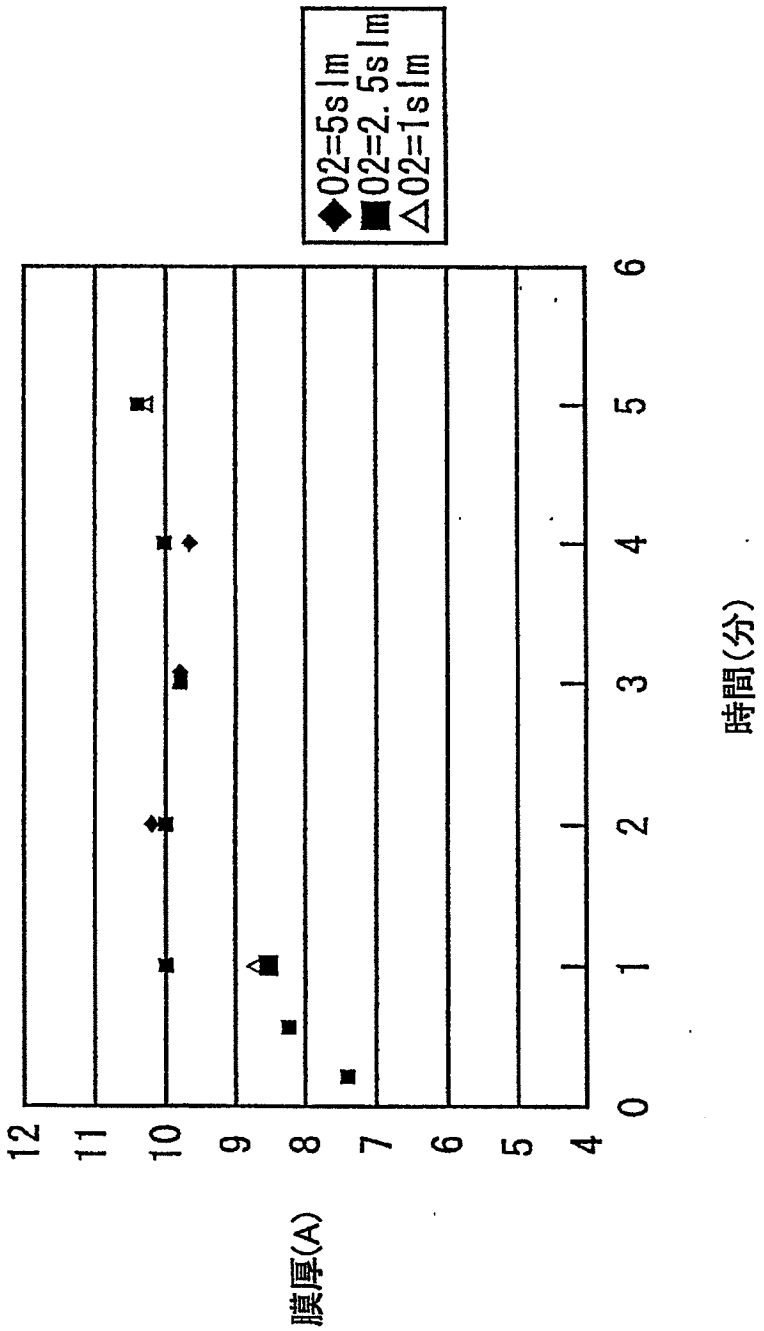
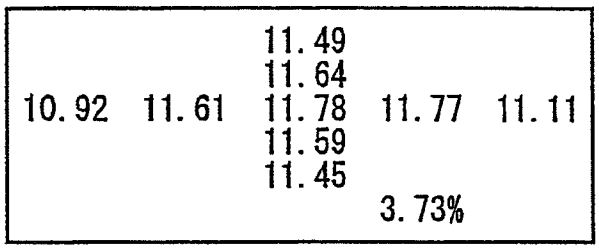
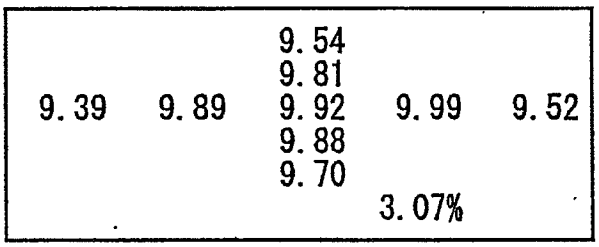


FIG.54A



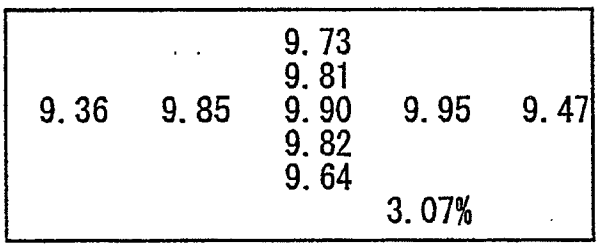
Δ y =0.0mm

FIG.54B



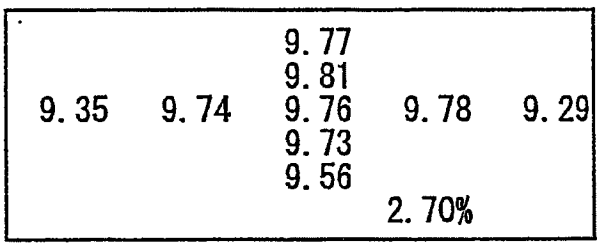
Δ y =12.5mm

FIG.54C



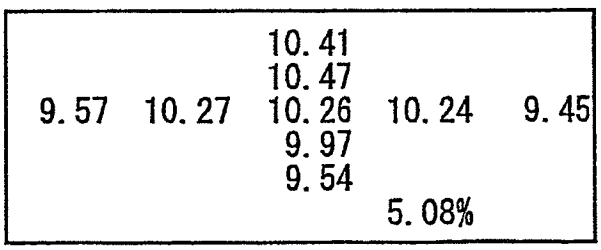
Δ y =25.0mm

FIG.54D



Δ y =37.5mm

FIG.54E



Δ y =50.0mm

FIG.55A

6.70	6.72	6.81 6.75 6.78 6.72 6.84 1.08%	6.82	6.83

FIG.55B

7.86	7.91	7.87 7.96 8.04 7.93 7.87 1.30%	8.03	8.07

FIG.55C

8.54	8.66	8.51 8.63 8.66 8.60 8.48 1.11%	8.67	8.49

FIG.55D

8.92	9.04	8.92 9.01 9.06 9.05 8.86 1.21%	9.08	9.94

FIG.55E

9.85	10.42	10.21 10.41 10.40 10.34 9.61 4.57%	10.54	10.1

FIG.56A

		5.10 4.75			NO UV
4.95	4.79	4.72 4.86 5.11	4.79	4.99	
			4.03%		

FIG.56B

		8.81 8.63			RTO
8.06	8.50	8.46 8.43 8.15	8.43	8.04	
			4.57%		

FIG.57

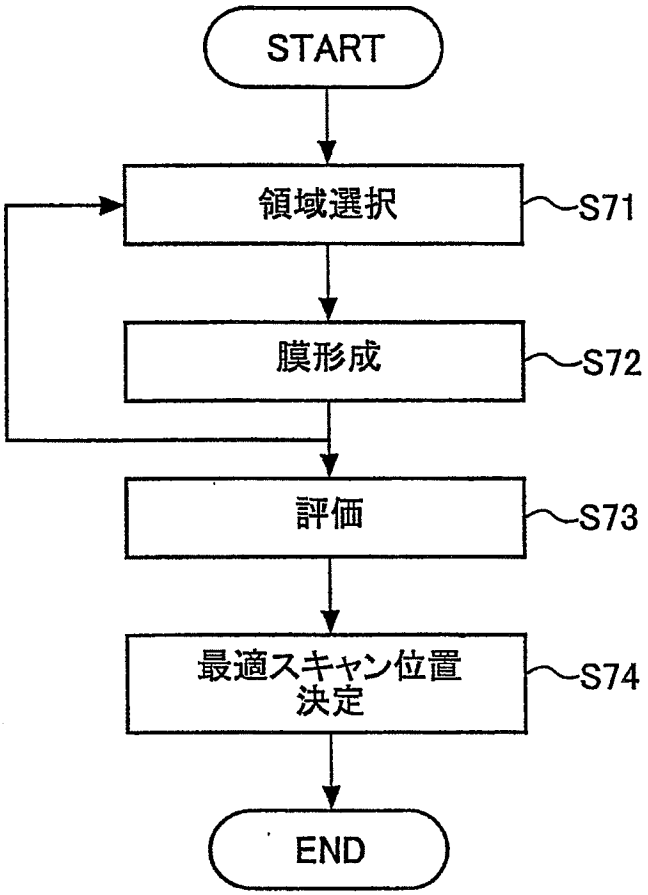


FIG.58

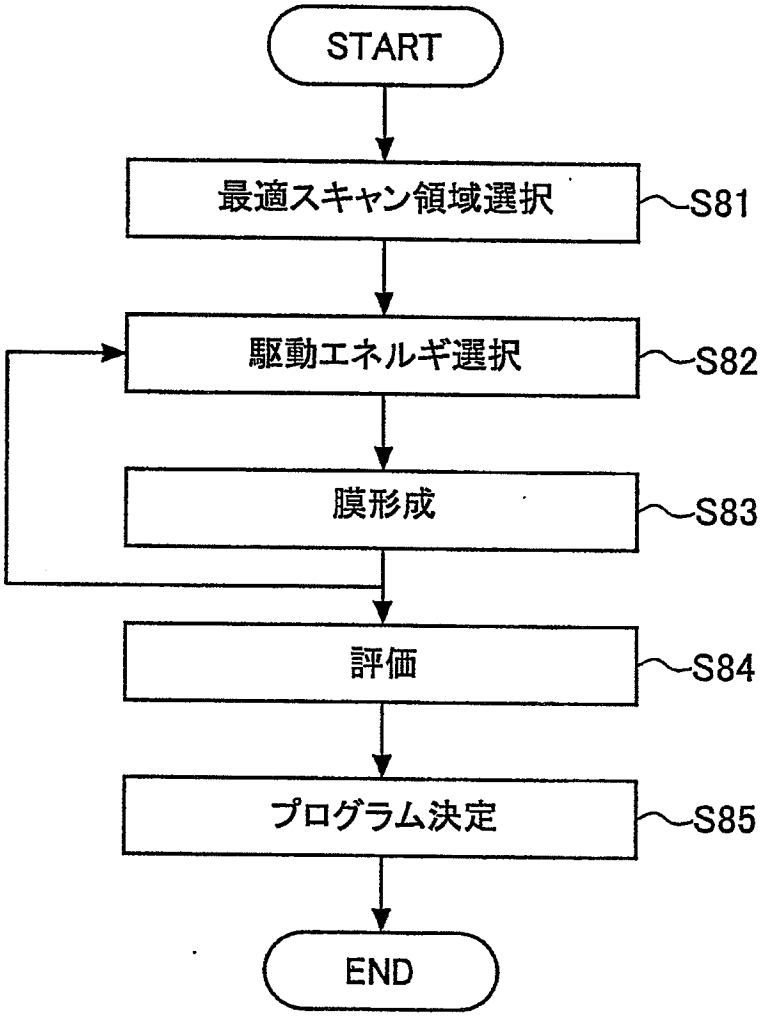

START
最適スキャン領域選択
S81
駆動エネルギ選択
S82
膜形成
S83
評価
S84
プログラム決定
S85
END

FIG.59

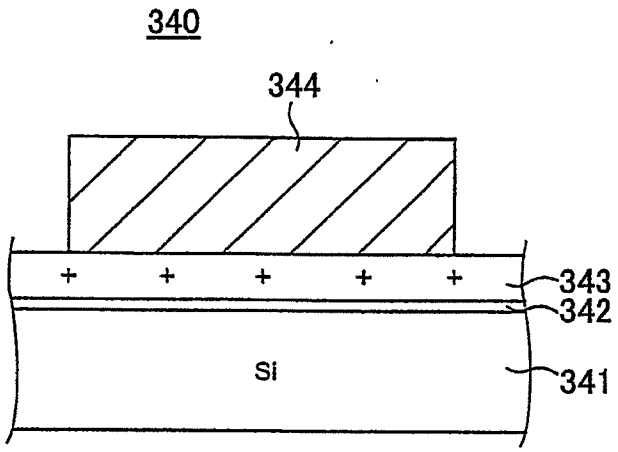


FIG.60

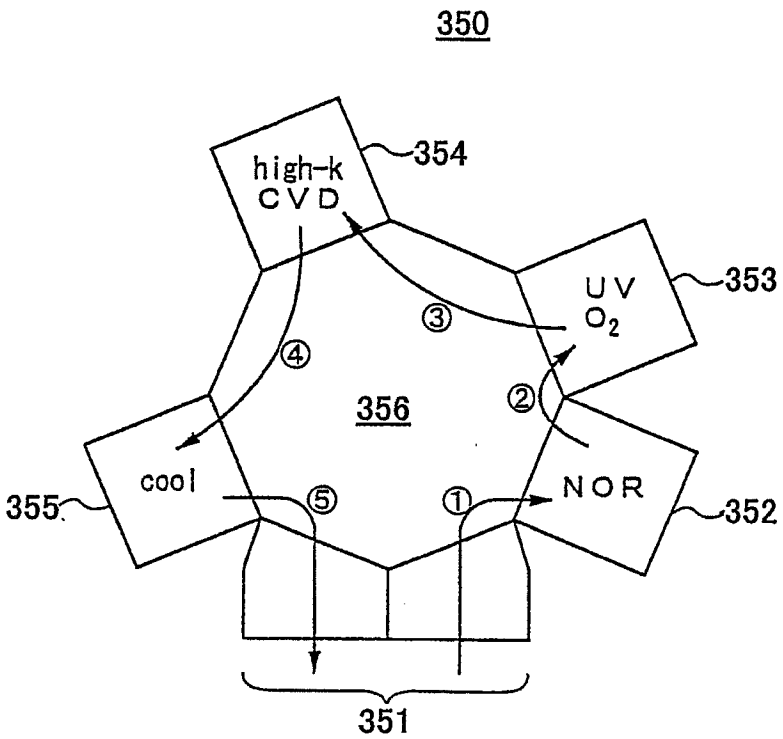


FIG.61

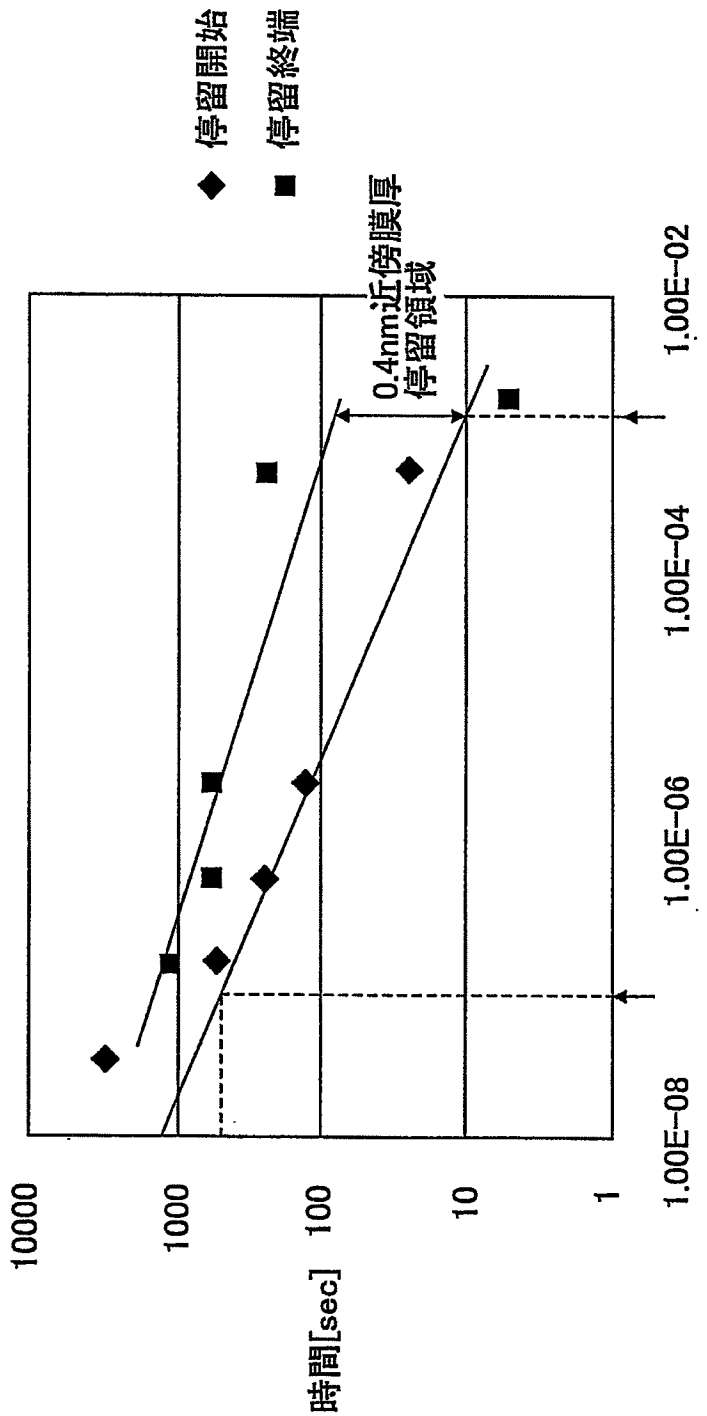

停留開始
停留終端
0.4nm近傍膜厚
停留領域
10000
1000
100
10
1
時間[sec]
1.00E-02
1.00E-04
1.00E-06
1.00E-08
ラジカル分圧[Torr]

FIG.62A

		7.54		
		6.34		
6.34	6.29	6.18	6.31	6.4
		6.29		
		7.2		
			10.37%	

Avg.6.549

FIG.62B

		9.46		
		8.85		
8.75	8.81	8.83	8.86	8.77
		8.89		
		9.27		
			3.95%	

Avg.8.947

FIG.63A

		7.19		
		6.74		
6.84	6.73	6.7	6.77	6.82
		6.76		
		7.04		
			3.52%	

Avg.6.848

FIG.63B

		7.24		
		7.14		
7.02	7.13	7.14	7.19	7.03
		7.15		
		7.2		
			1.53%	

Avg.7.141

FIG.64A

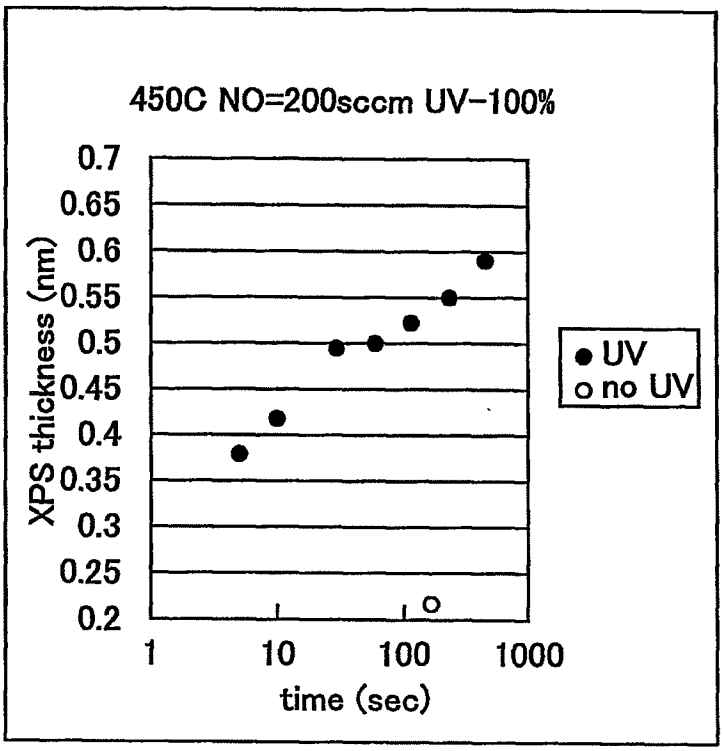


FIG.64B

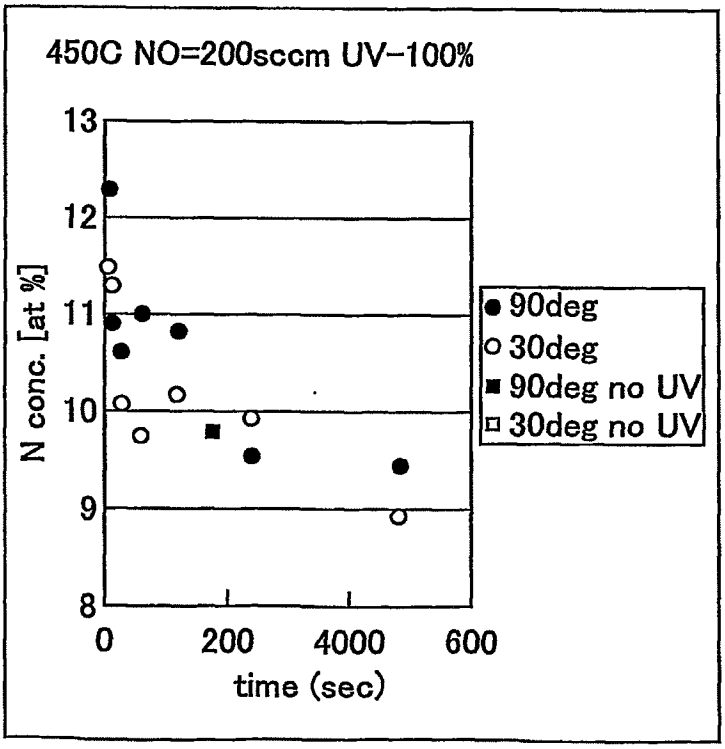


FIG.65A

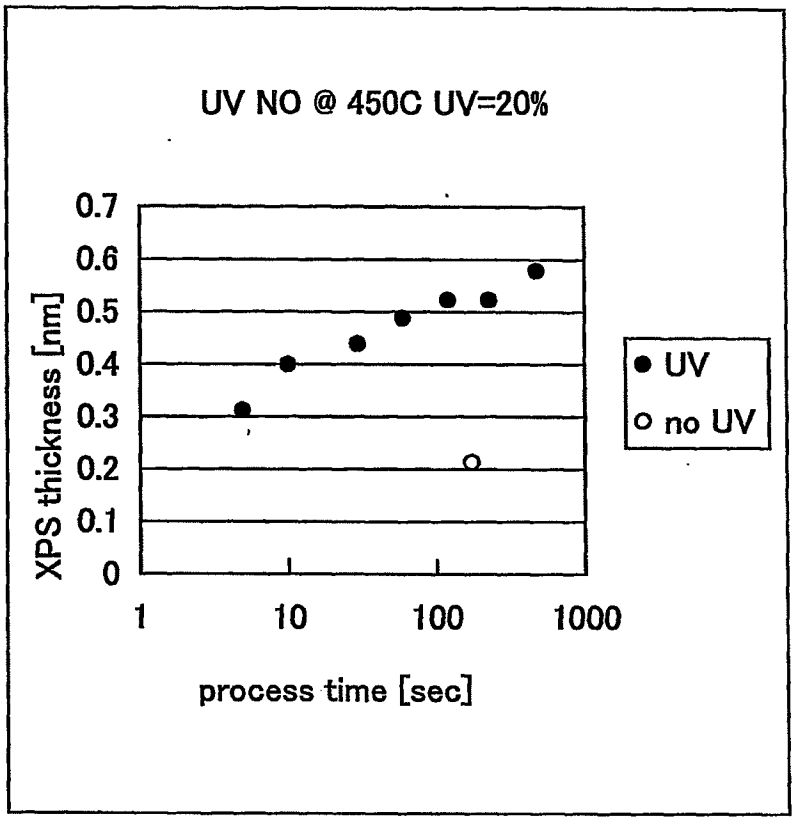


FIG.65B

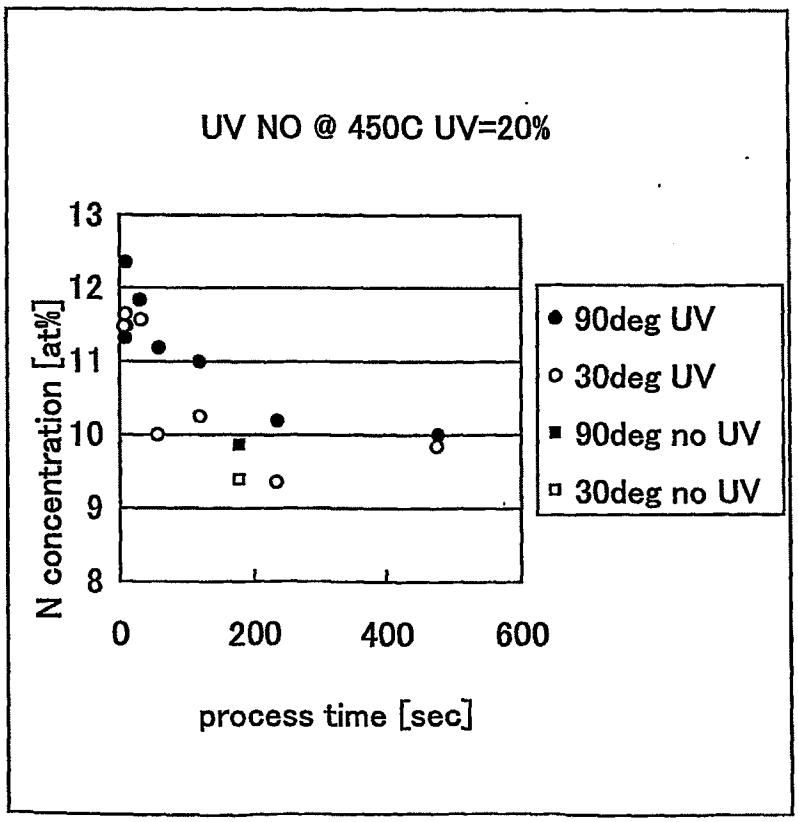


FIG.66A

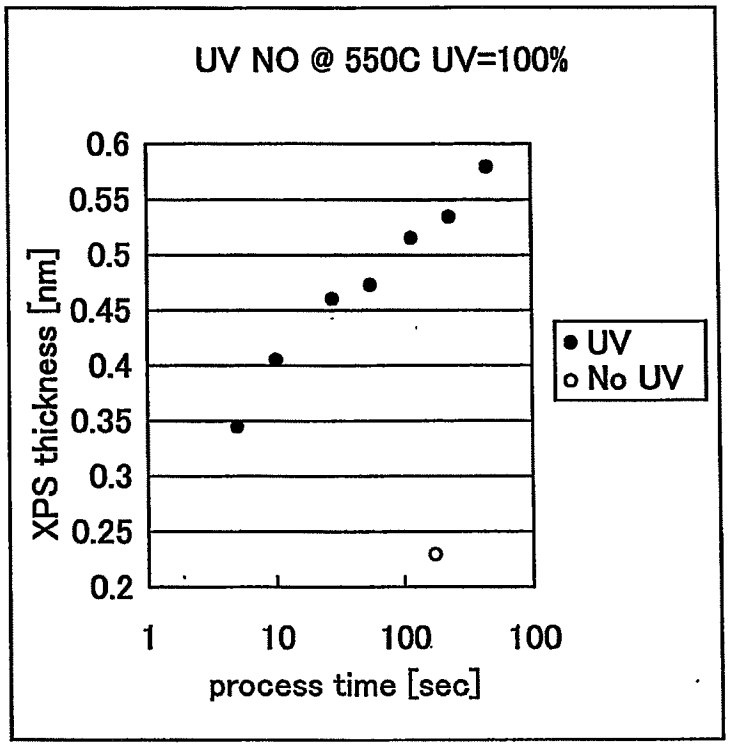


FIG.66B

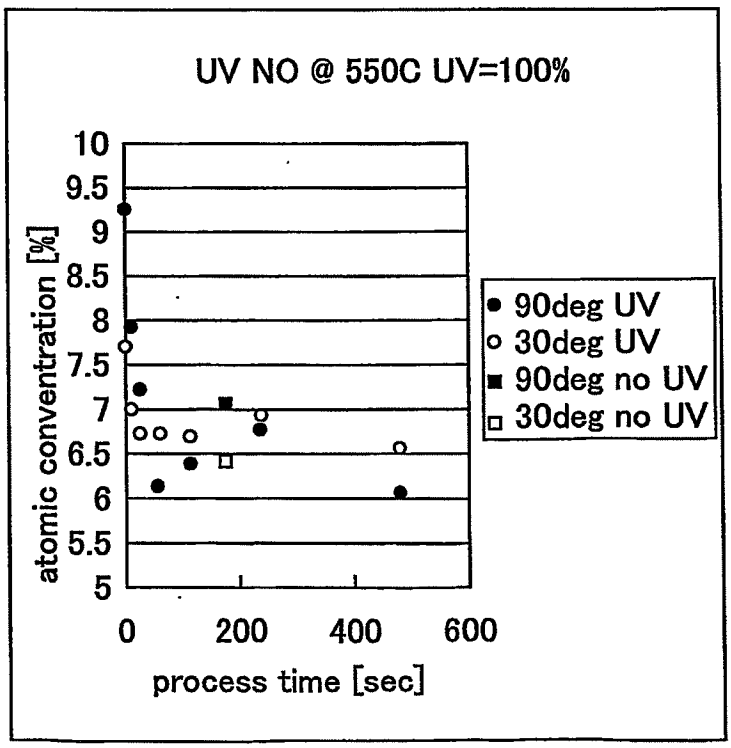


FIG.67

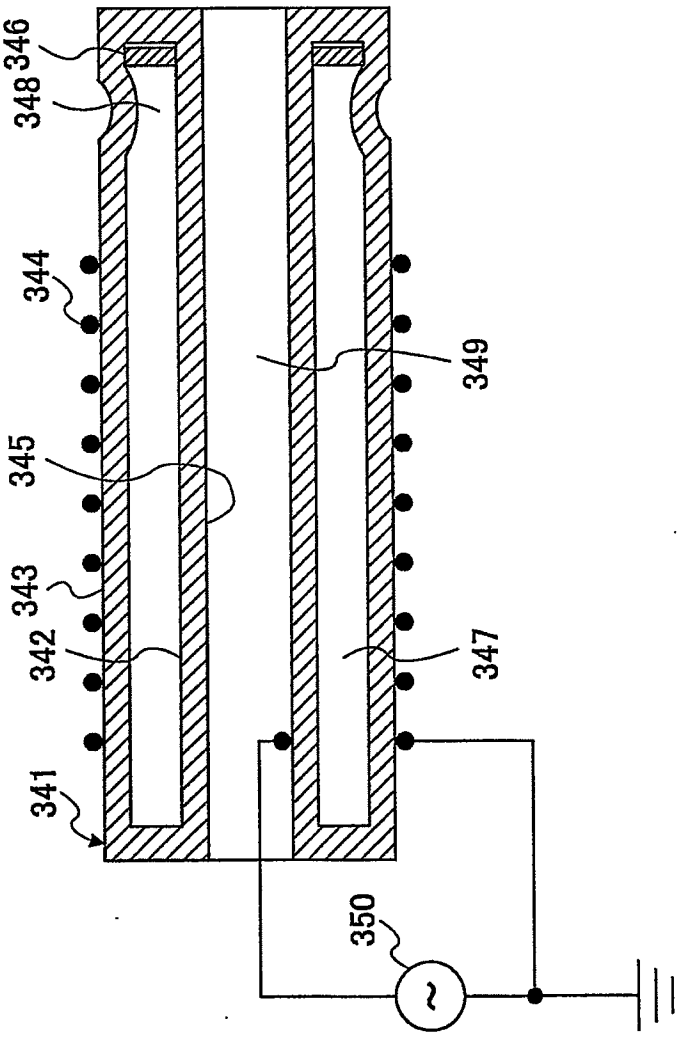


FIG.68A

7.09		7.88		7.05
	7.28	7.27	7.31	
7.05	7.35	7.09	7.35	7.03
	7.38	7.32	7.32	
8.15		7.72		8.2
			7.90%	

Avg.7.402

FIG.68B

7.26		7.56		7.22
	7.24	7.35	7.24	
7.31	7.39	7.13	7.37	7.23
	7.29	7.35	7.24	
7.53		7.54		7.56
			2.93%	

Avg.7.342

FIG.69B

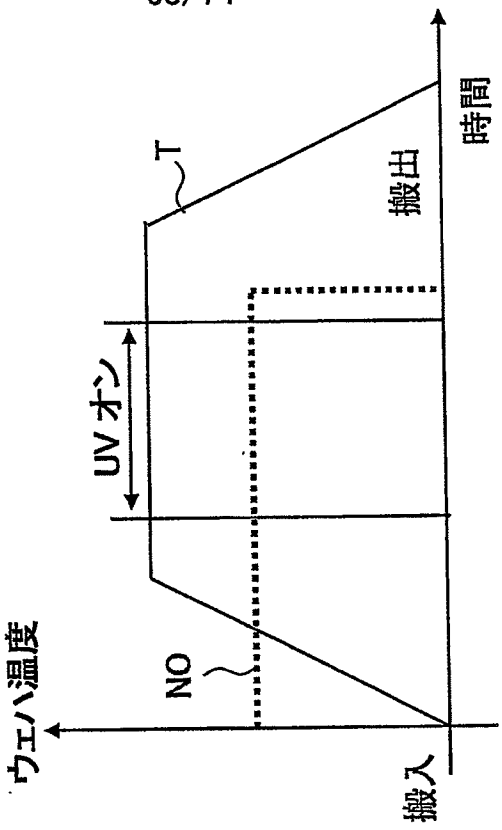
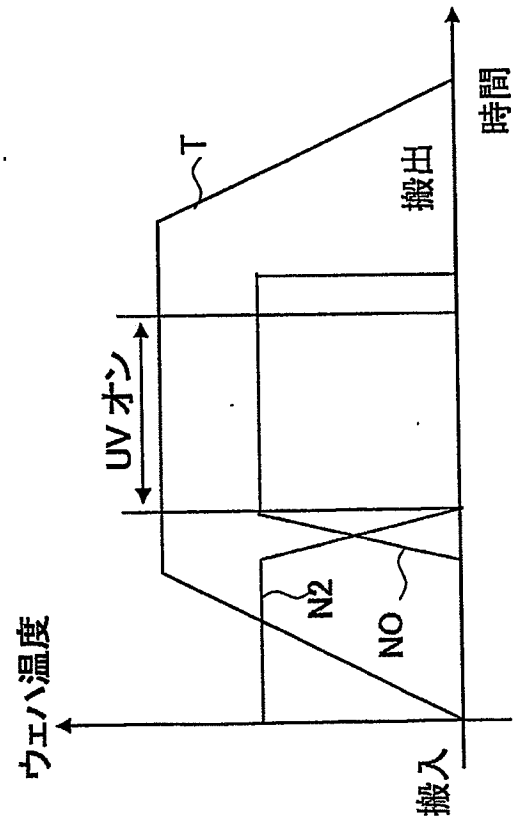


FIG.69A



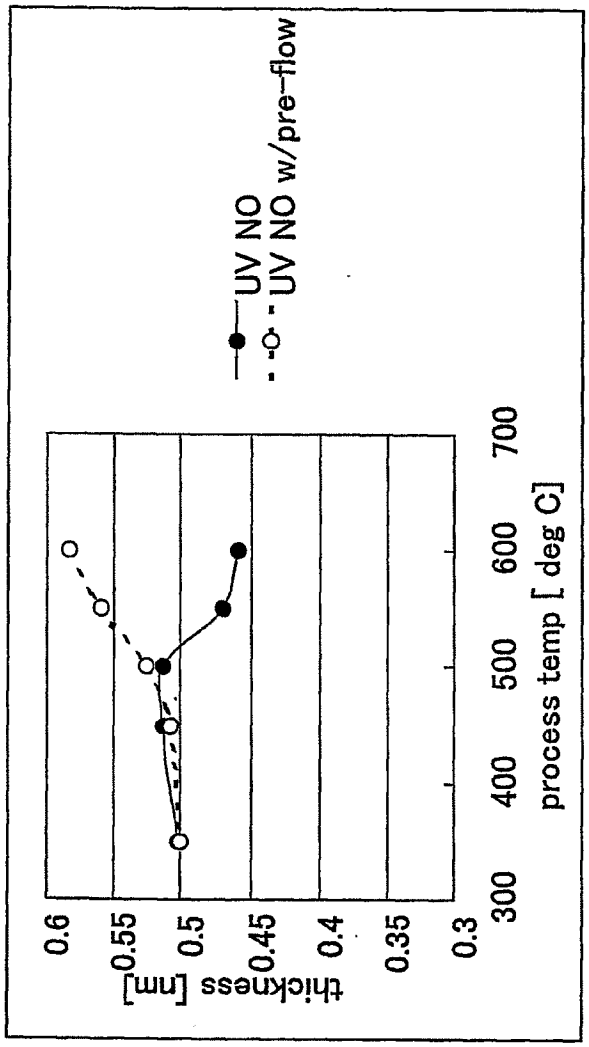


FIG.70A

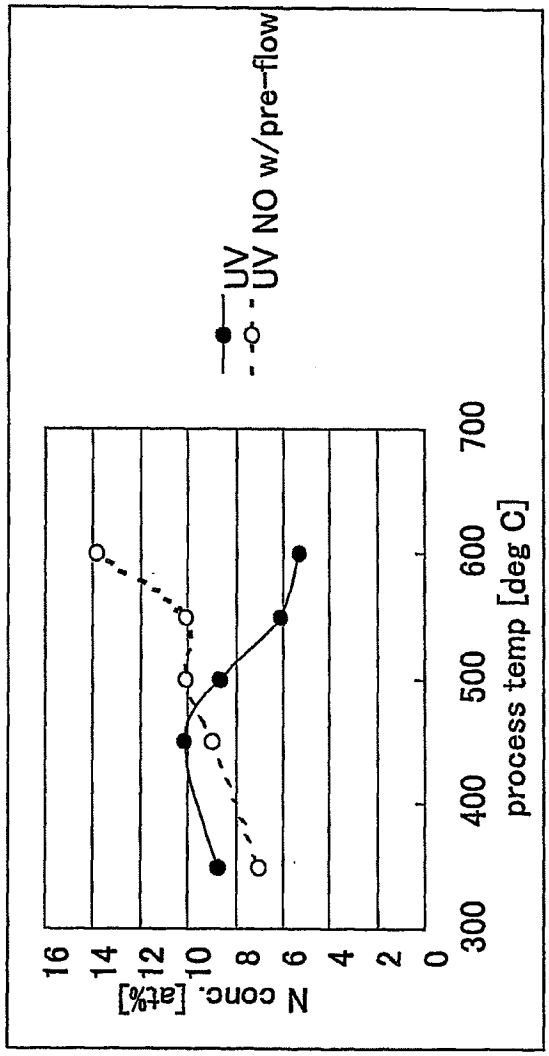


FIG.70B

FIG.71A

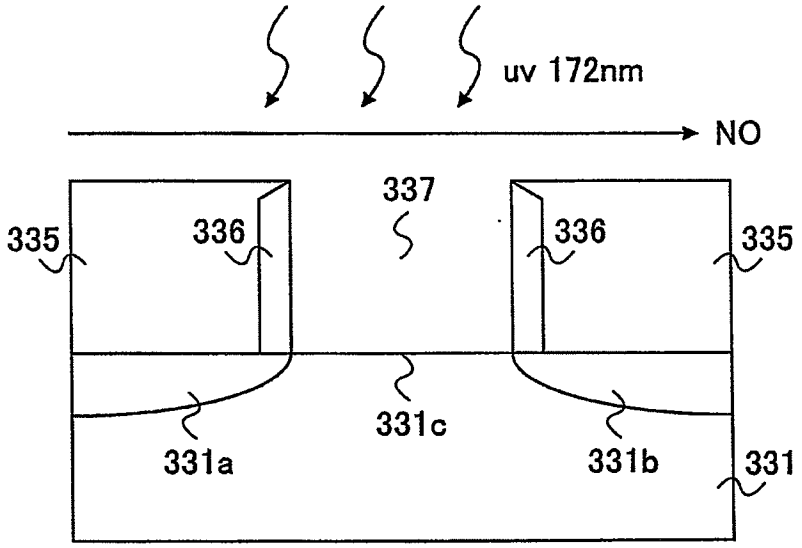


FIG.71B

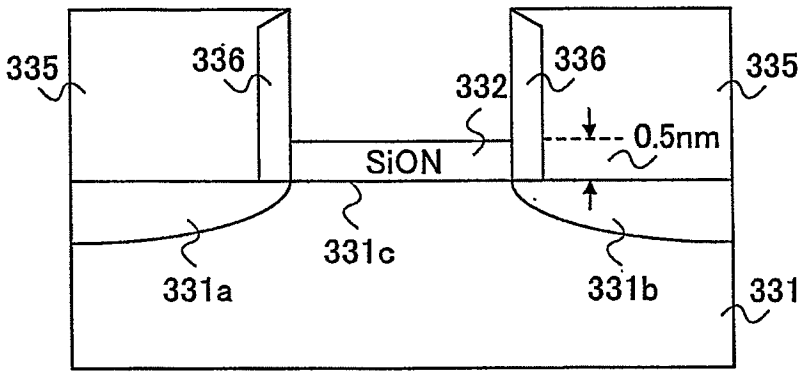


FIG.71C

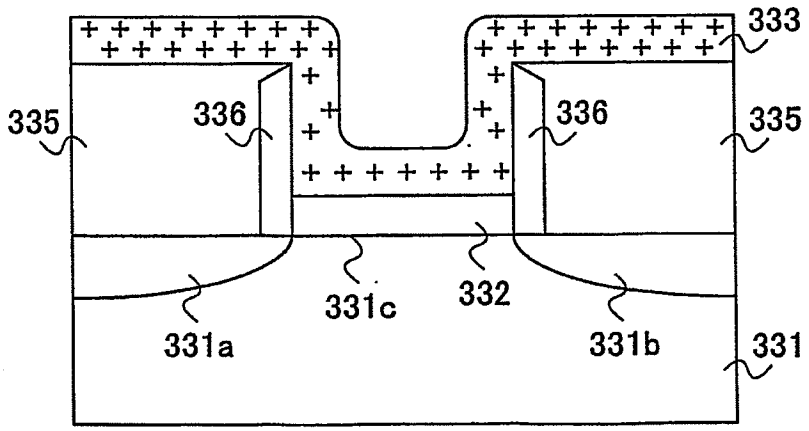


FIG.71D

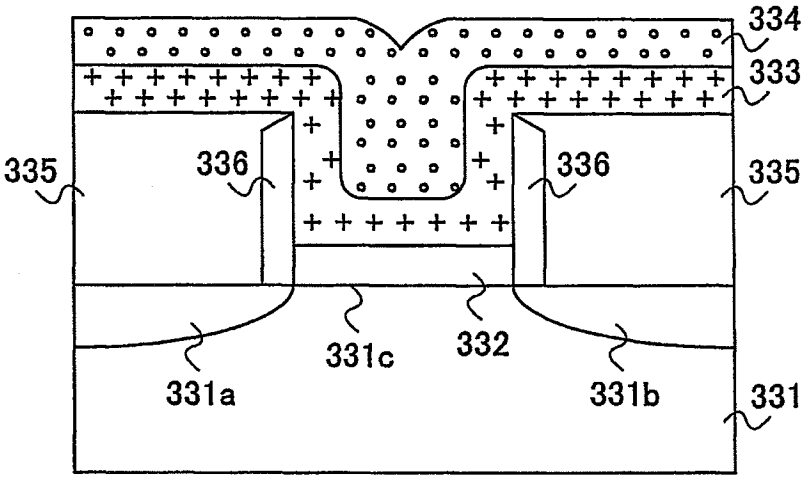


FIG.71E

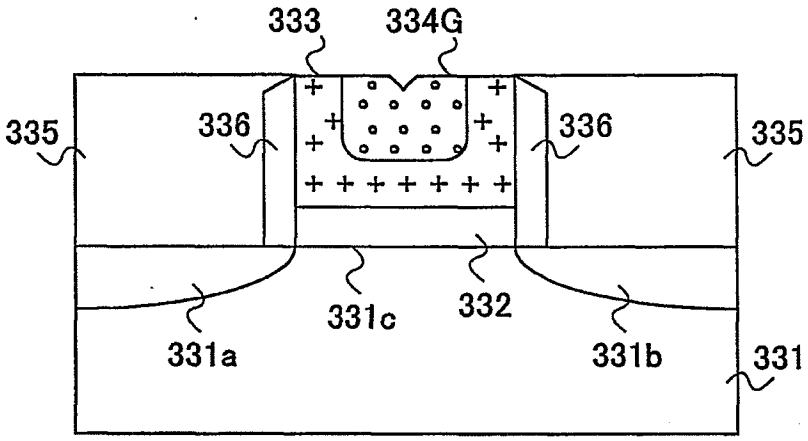


FIG.72

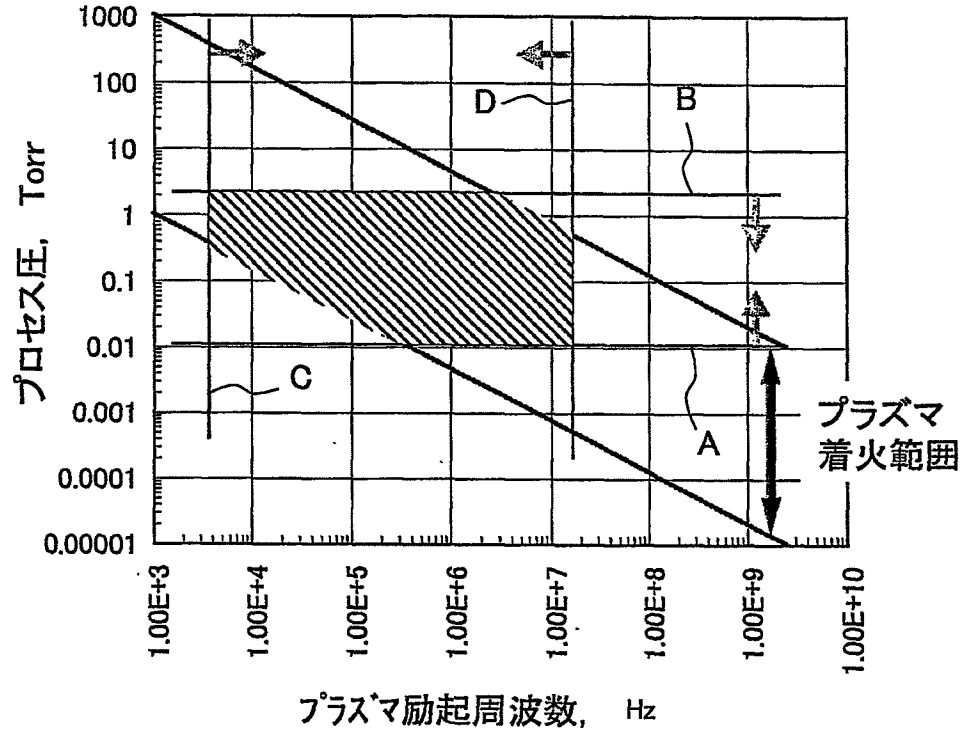

1000
100
10
1
0.1
0.01
0.001
0.0001
0.00001
プロセス圧, Torr
D
B
C
A
プラズマ
着火範囲
1.00E+3
1.00E+4
1.00E+5
1.00E+6
1.00E+7
1.00E+8
1.00E+9
1.00E+10
プラズマ励起周波数, Hz

FIG.73

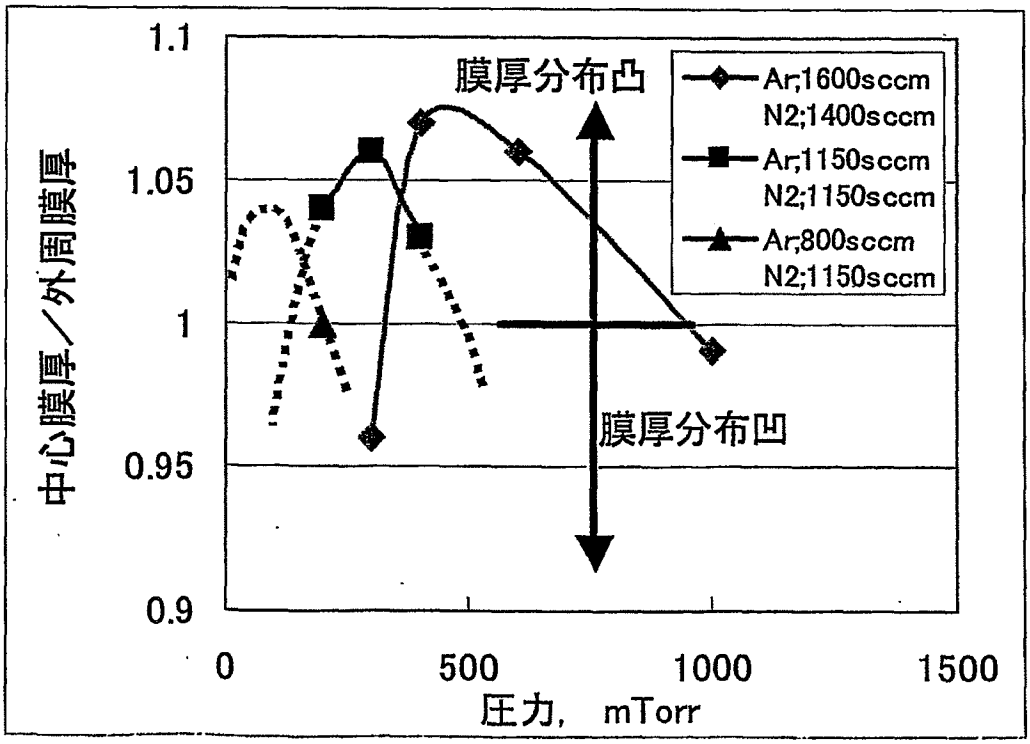

1.1
1.05
1
0.95
0.9
中心膜厚／外周膜厚
膜厚分布凸
膜厚分布凹
Ar;1600sccm
N2;1400sccm
Ar;1150sccm
N2;1150sccm
Ar;800sccm
N2;1150sccm
0
500
1000
1500
圧力, mTorr

FIG.74A

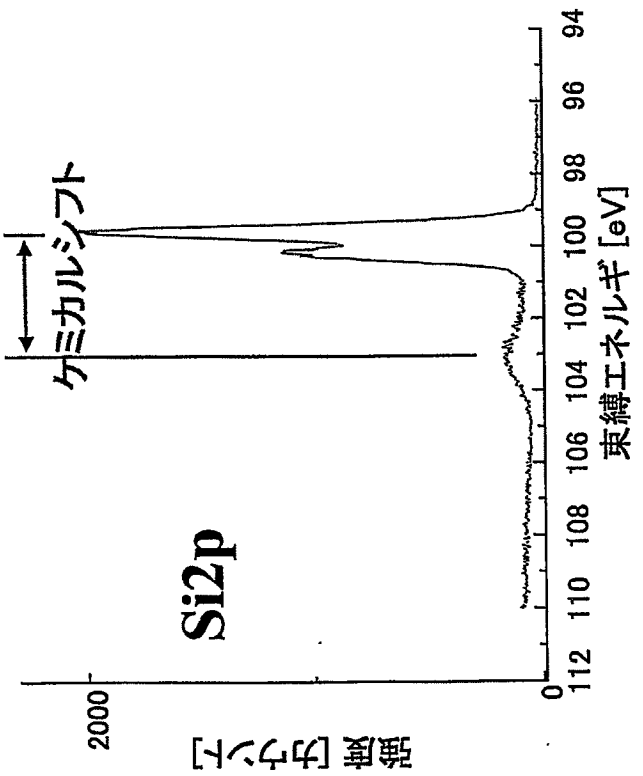


FIG.74B

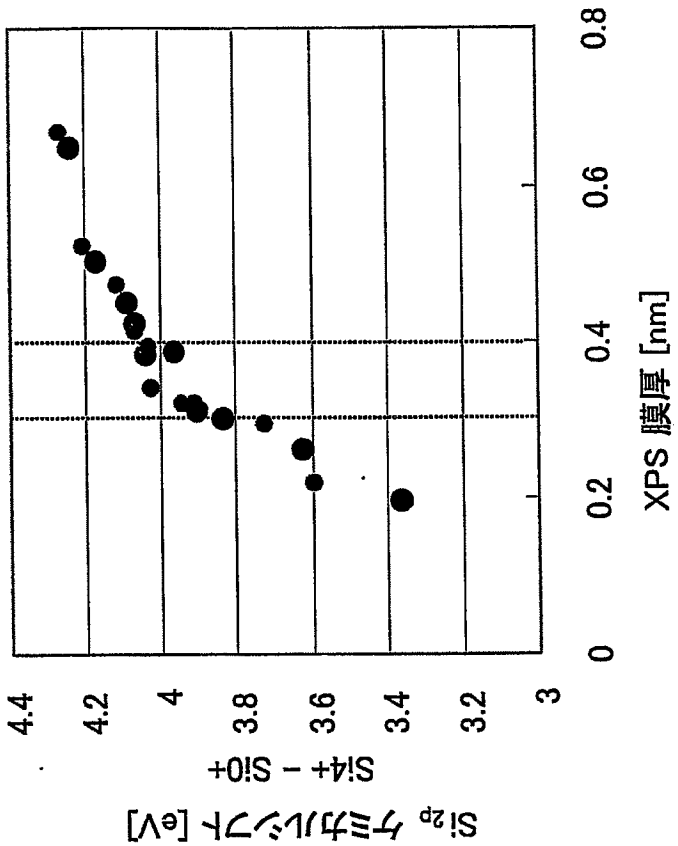


FIG.75

UV NO XPS膜厚 0.5nm

