(19) (KR)
(12) (B1)

(45) 2010 04 23
(11) 10-0954709
(24) 2010 04 19

(51) Int. Cl.
C23C 16/455 (2006.01)
(21) 10-2004-7005429
(22) ( ) 2002 10 09
2007 10 09
(85) 2004 04 13
(65) 10-2005-0034610
(43) 2005 04 14
(86) PCT/US2002/032057
(87) WO 2003/034463
2003 04 24
(30)
60/328,796 2001 10 15 (US)
10/024,208 2001 12 21 (US)
(56)
KR1020010043225 A*
US06230651 B1*
US06007330 A1*
US05522936 A1*
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94538
4650
(72)

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10549 14

94706 1503
( )
(74)

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(54) -

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(13) -
. (10), (16),
(20),
,
(22),
RF
- (18) RF (19) . 1
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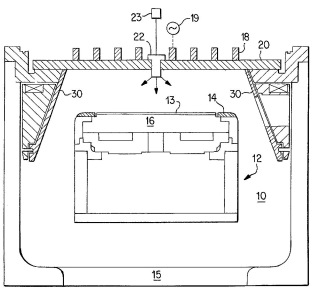

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94709 #321 1709

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RF RF ,

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RF RF ,

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RF RF

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RF RF ,

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16 ,

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31

16 ,

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32

16 ,

, - - (center-to-edge) , .

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16 ,

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16 ,

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, RF RF

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45 ° , .

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45 ° , .

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46

35 ,

2 , 45 ° 8

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47

35 ,

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(seal) , .

48

35 ,

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[0001] . ,

.

[0002] (CVD) ,

(RF) .

(species)

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. , ,

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[0003] Roppel 4,691,662

, (conduit)

. Suzuki 5,522,934

, (

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[0004] . J. Asmussen "Electron Cyclotron Resonance Microwave Discharges for Etching and Thin-film Deposition" [J. Vacuum Science and Technology A, Vol. 7, pp. 883-893 (1989)] . T. V. Herak "Low-temperature Deposition of Silicon Dioxide Films from Electron Cyclotron Resonant Microwave Plasmas" [J. Applied Physics, Vol. 65, pp. 2457-2463 (1989)]

CVD . ,

.

, (drift) .

[0005] T. T. Chau "New Approach to Low Temperature Deposition of High-quality Thin Films by Electron Cyclotron Resonance Microwave Plasma" [J. Vac. Sci. Tech, B, Vol. 10, pp. 2170-2178 (1992)]

CVD

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. .

(batch), 100

. , ,

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.

[0006] Ni 6,230,651 ,

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.

[0007] Hassan 4,270,999
. Hassan
,
. Fairbairn 5,614,055
(elongated) . ,
. Asmussen 4,943,345
CVD . Eres 5,164,040
CVD (pulsed supersonic jets) .
, , , ,
.

[0008] .
McMillin 6,013,155
RF
.
.

[0009] Moslehi 4,996,077 -
(ECR) . -
, -
.

[0010] Miyazaki 5,252,133
- - CVD .
. , Shishiguchi
4,992,301 ,
.

[0011] Singh 6,042,687 .
2 .
.
5,885,358 5,772,771
.

[0012] ,
. .
, ,
.
.
(bottom-pumped) .

[0013] Fairbairn
. . Tokuda
5,134,965 .
.

[0014] , Hegedus 4,614,639
(flared) (port)
(parallel plate) . 5,525,159 (Hama), 5,529,657 (Ishii), 5,580,385
(Paranjpe), 5,540,800 (Qian), 5,531,834 (Ishizuka)

. 6,263,829 ; 6,251,187 ; 6,143,078 ; 5,734,143 ; 5,425,810 .

[0015] ,

.

[0016] , ,

, , , , , RF RF . .

[0017] RF RF .

. , ((on-axis)) ((off-axis)) . . .

[0018] .

, . (flow field) . ( ) . , .

[0019] ( ) (subsonic), . , . , / . / . ,

.

, O- (seal) .

[0020] , , , , , , RF RF , . , . , .

[0029] CVD .
, (, F, Cl, Br), , ,
. / .

[0030] , .
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- (center-to-edge) , (CD), CD ,
/ (microloading) .

[0031]
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[0032] , , ,
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(choked) .
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[0033] , .
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[0034] /
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/ RF
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[0035] 1 (Lam Research Corporation) TCP 9100™
(10) . ,
. (10) (13) RF (16)
(12) He
(14) . (10^{11}-10^{12} ions/cm^3)
, RF RF (19)
(18) (10) RF .
(50 mTorr , 1-20 mTorr) (15)
( ) . (20) (18)
(10) (10) . (22) (20)

(23) (10)
( ) . (30) (2
0) (12) .

[0036] , (12) He
, , . , (22)
(10) . (20) 1
- /
. (18) RF .
, .

[0037] (22) . ,
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, ,
Al_2O_3 Si_3N_4
.

[0038] 2a 2b (22) - .
, (22) 1
(24) 2
(26) . (,
(manifold)) . , (32) T-
(34) . , -
(36a, 36b)
. (36a, 36b) . -
(36a, 36b) (24, 26) .
- / ,
.

[0039] 2a , (bore)/ (24, 25)
(25) . , (25)
6,052,176 , , (29)
(27) . , .
, 1cm 1mm . 2b , (25)
.
. , .

[0040] ,
. ,
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. , 2c , ,
(22) (40) .
, . /
. 2c ,
(40) .
/ (40') .
RF
.

[0041] 3a 3c (20) (22)
(A

B). 3a , ( )
. 3b , ( )
. 3c ,
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/ .
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[0042] , (120 °
3 , 90 ° 4) .
. , 45 °
. , .
10 90 ° , 10 60 ° .

[0043] . ,
.
O-
. , O- (seal)
. , O-
( ) .

[0044] . ,
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. , , ,
( ) /
. , .

[0045] . , 100 500sccm Cl_2 BCl_3 Cl_2 N_2
BCl_3, Cl_2 B_2 .

[0046] . , He / O_2
100 500sccm Cl_2 HBr , Cl_2 , HBr .

[0047] , (10)
.
. (10^9-10^{12} ions/cm^3, 10^{10}-10^{12} ions/cm^3)
. , RF RF
, (18),
RF . , ECR, ,
(helicon), (helical resonator) .
(5 Torr , 1-100 mTorr)
. (20) -
(18) (10) (10)
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[0048] .
Ar . ,

. , 1 Torr
10 mTorr , 100:1 .
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[0049] .
, SiH_4
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[0050] , ,
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(,
(center fast resist etching)) , .
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, , / ,
, , . ,
" "(edge fast etching)
. 5-10 ,
1-4 . 5, 10
(6% 3σ) .
, CF, CF_2, CF_3 $C_xF_yH_z$
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[0051] , .
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[0052] .
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[0053]

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[0054] 1

[0055] (, ,) : . 4a 4c , 4a , 4c . 212.9±4.7nm(±2.2%) 18.3nm(±1.4%) (4a). 212.6±5.3nm(±2.5%) 22.3nm(±1.7%) (4c). , , (4b). , 213.5±2.3nm(±1.1% , 7.7nm(±0.6%) . 420 sccm $Cl_2/HBr/O_2$ 10 mT . RF ( ) 800W -155V . 60° .

[0056] 2

[0057] (, ,) : . 5a 5c , 5a , 5c . 1299 ±27 (±2.1%) 74 (±1.0%) (5a). , 1295 ±23 (±1.8%) 76 (±1.0%) (5b). (5c). , 1272 ±14 (±1.1%) 41 (±0.53%) . HBr/O_2 40 mT , 60° . RF ( ) 1200W -320V . 45° .

[0058] 3

[0059] 6a 6b (CD) . , 6a , 6b . CD . , 6a -3.9nm CD , 2.1nm , 7.5nm , 6b -3.4nm CD , 1.6nm , 5.9nm .

[0060] 4

[0061] 7a 7b CD . CD . 5 mT 100 sccm Cl_2/O_2 60° . RF ( ) 385W -34V . 45° . , 7a -49.3nm CD , 2.5nm , 9.1nm , 7b -47.6nm CD , 2.0nm , 7.5nm .

[0062] 5

[0063] 8a 8b (CD) . 8a CD . $Cl_2/HBr/He/O_2$. 1 15 mT, 400sccm, (/) 575W , -138V 2 30 mT, 575sccm, 750W , -80V . , 8a 0.1nm CD , 2.4nm , 9.5nm

, 8b 13.3nm CD , 2.4nm , 8.9nm .

[0064] . , . , , .

[0065] , .

[0021] 1 .

[0022] 2a 2b 2- (two-zone) , .

[0023] 2c (outer jacket) 2- .

[0024] 3a 3c .

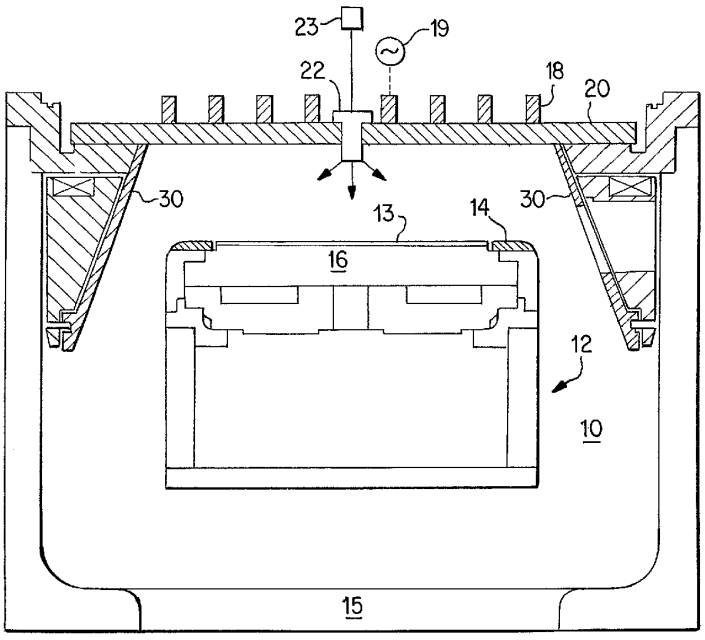
[0025] 4a 4c (blanket) .

[0026] 5a 5c .

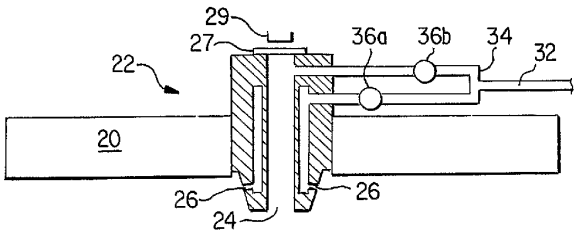
[0027] 6a 6b 7a 7b (trimmed) .

[0028] 8a 8b .

1



2a


29
27
22
36a
36b
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32
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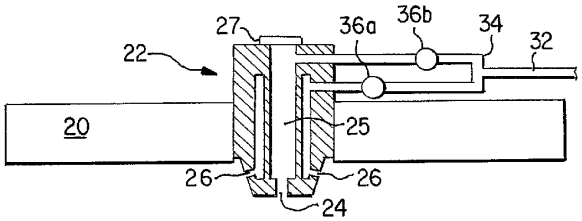
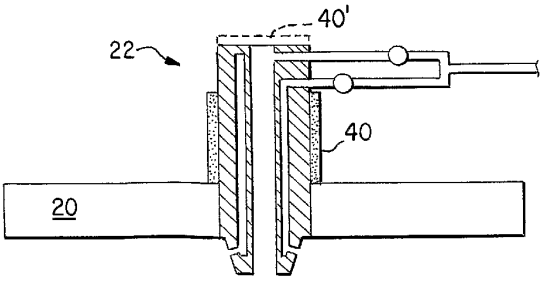
2b


27
36a
36b
34
32
22
20
25
26
26
24

2c


40'
22
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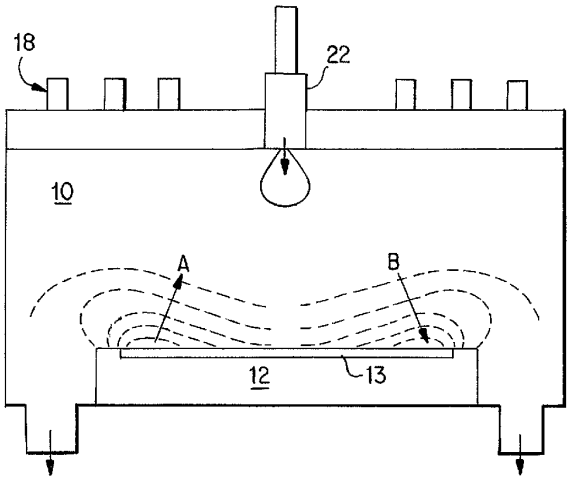
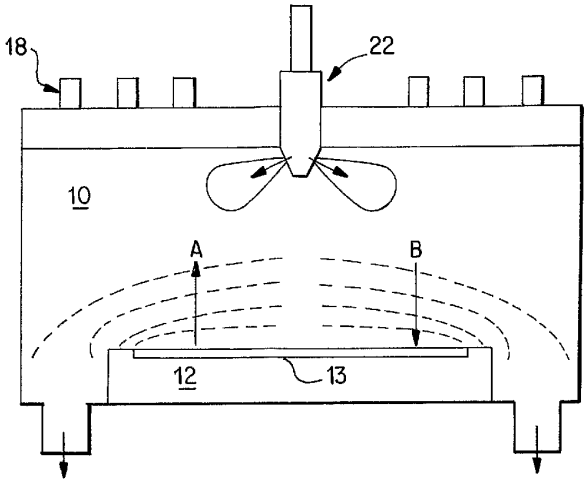
20

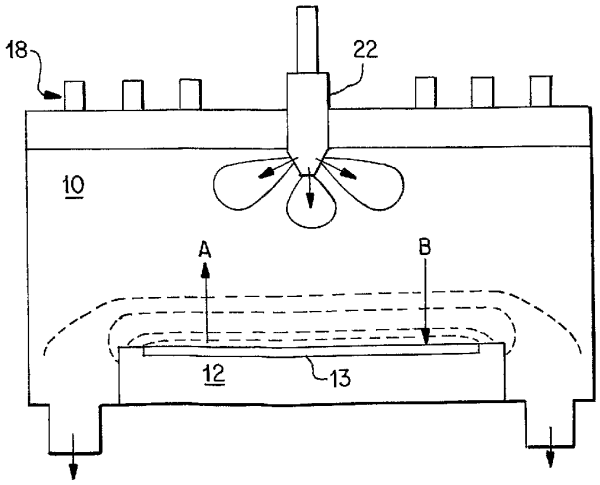
3a



3b



3c


18
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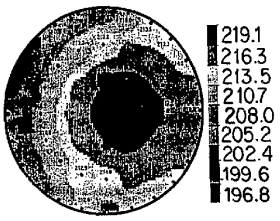
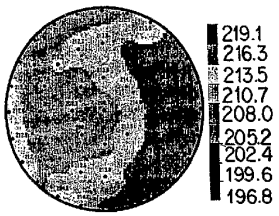
A
B
12
13

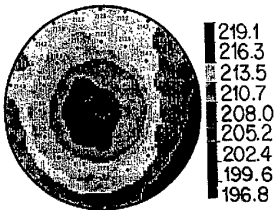
4a


219.1
216.3
213.5
210.7
208.0
205.2
202.4
199.6
196.8

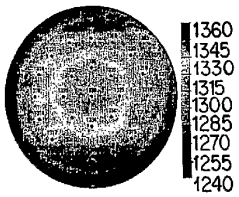
4b


219.1
216.3
213.5
210.7
208.0
205.2
202.4
199.6
196.8

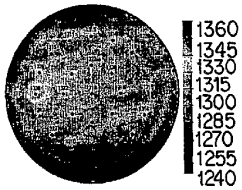
4c


219.1
216.3
213.5
210.7
208.0
205.2
202.4
199.6
196.8

5a


1360
1345
1330
1315
1300
1285
1270
1255
1240

5b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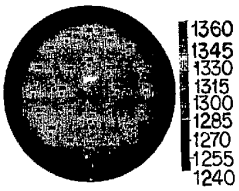
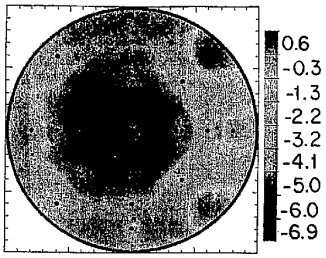
1285
1270
1255
1240

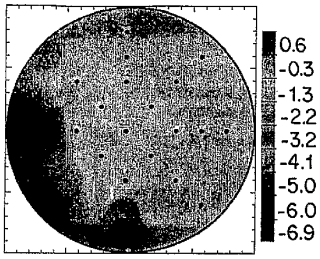
5c


1360
1345
1330
1315
1300
1285
1270
1255
1240

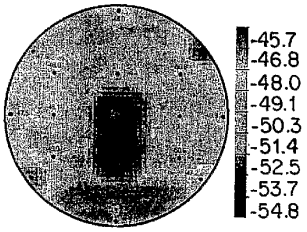
6a


0.6
-0.3
-1.3
-2.2
-3.2
-4.1
-5.0
-6.0
-6.9

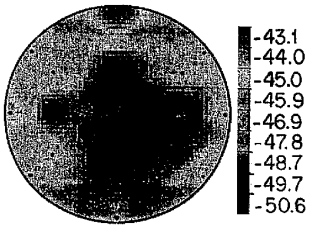
6b


0.6
-0.3
-1.3
-2.2
-3.2
-4.1
-5.0
-6.0
-6.9

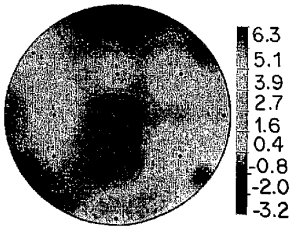
7a


-45.7
-46.8
-48.0
-49.1
-50.3
-51.4
-52.5
-53.7
-54.8

7b


-43.1
-44.0
-45.0
-45.9
-46.9
-47.8
-48.7
-49.7
-50.6

8a


6.3
5.1
3.9
2.7
1.6
0.4
-0.8
-2.0
-3.2

8b