FIG. 1A

FIG. 1B

FIG. 1C

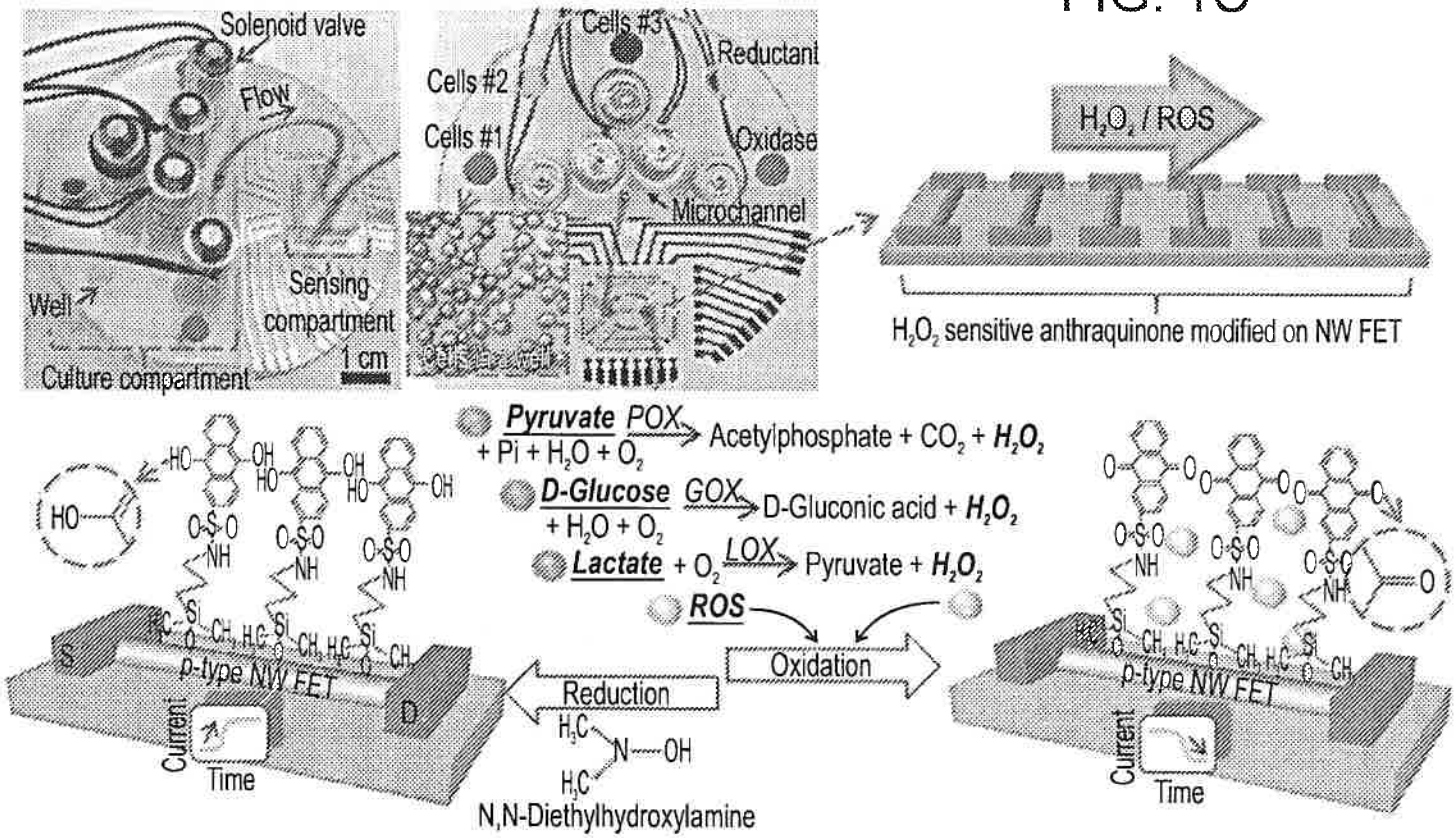


FIG. 1D

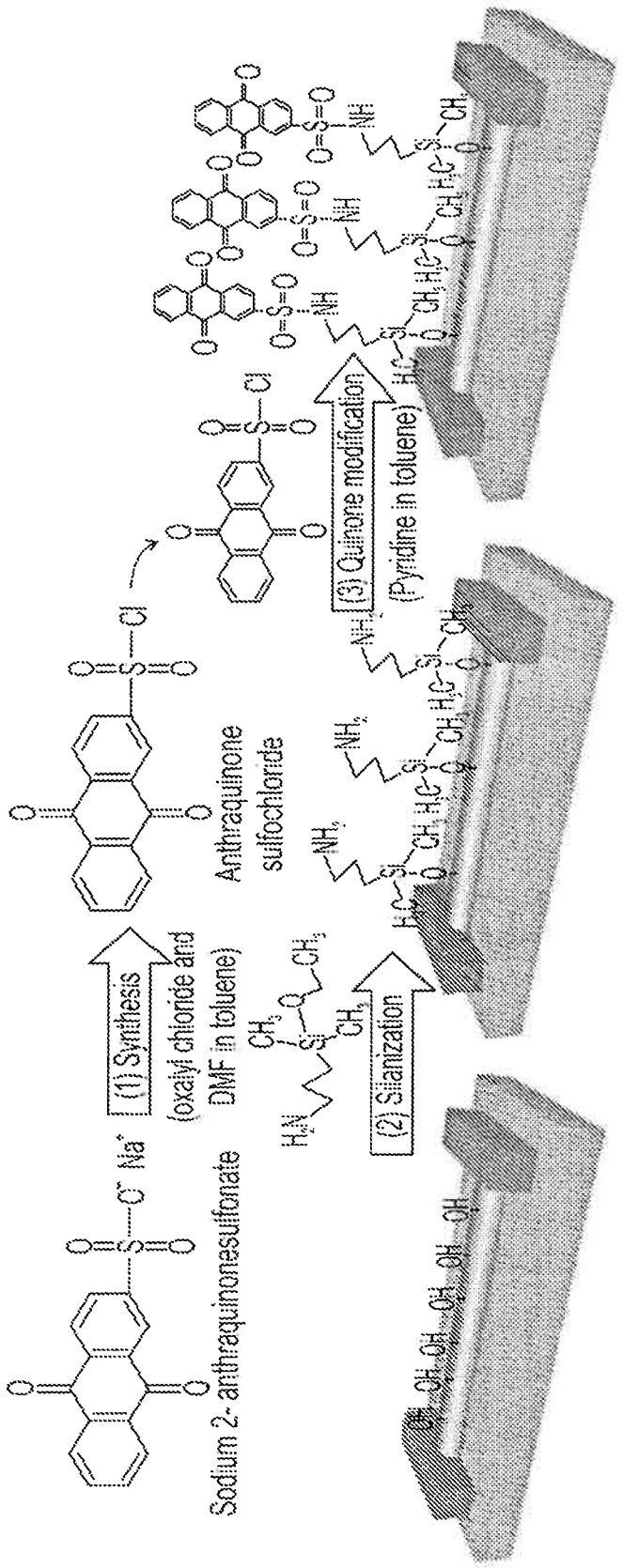


FIG. 2A

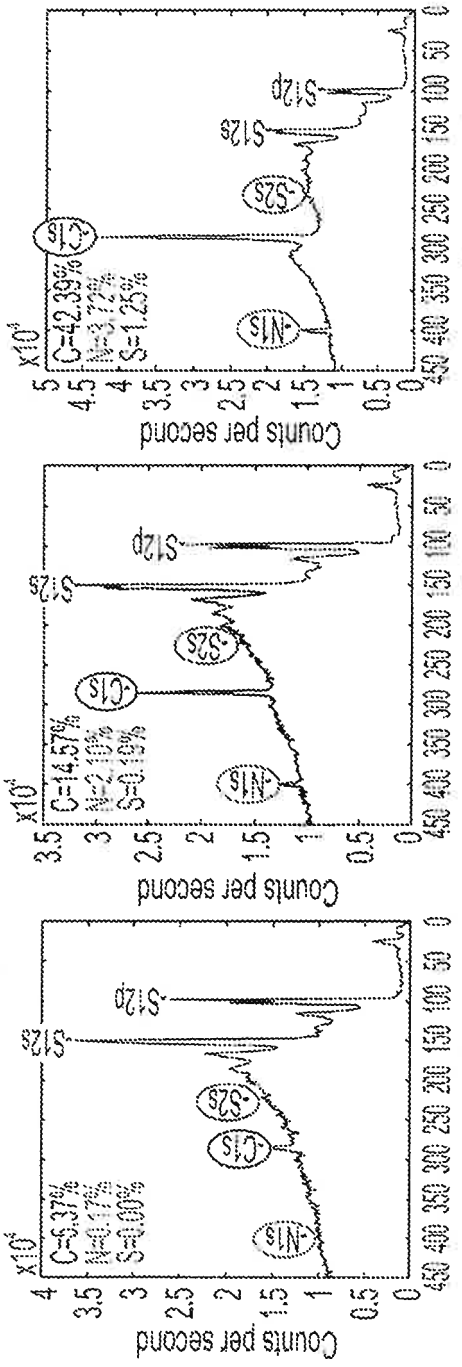


FIG. 2B

FIG. 2C

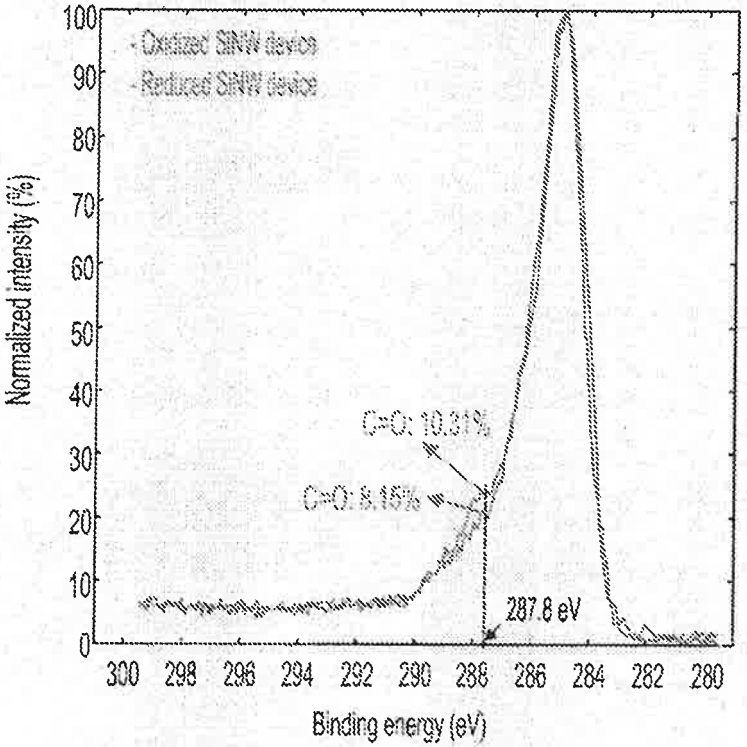

- Oxidized SiNW device
- Reduced SiNW device
C=O: 10.31%
C-O: 8.15%
287.8 eV
Normalized intensity (%)
Binding energy (eV)
100
90
80
70
60
50
40
30
20
10
0
300
298
296
294
292
290
288
286
284
282
280

FIG. 2D

SUBSTITUTE SHEET (RULE 26)

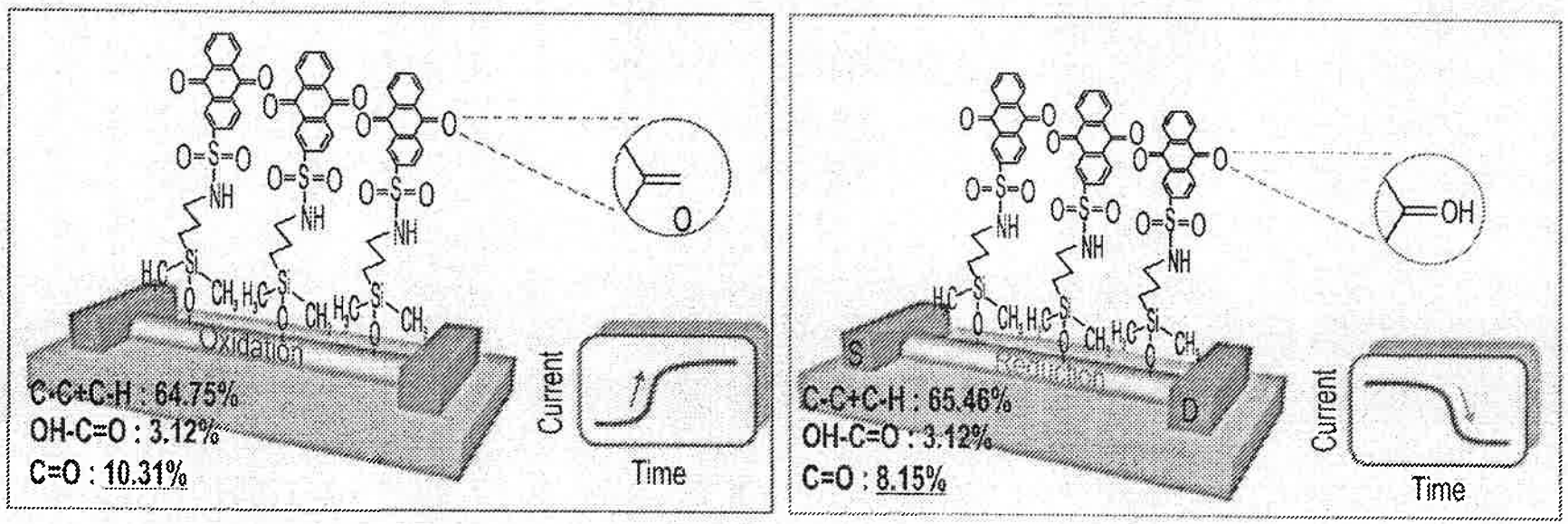
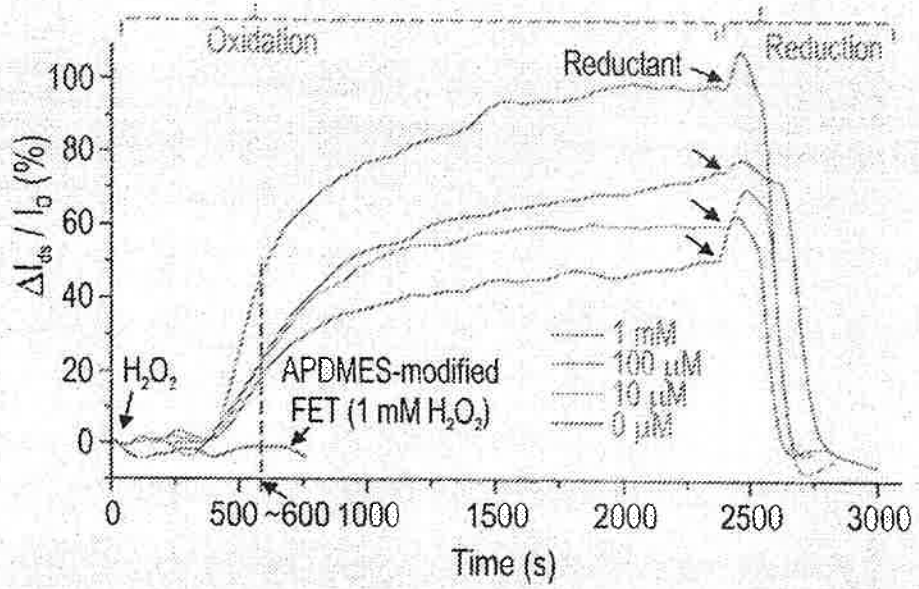


FIG. 3A



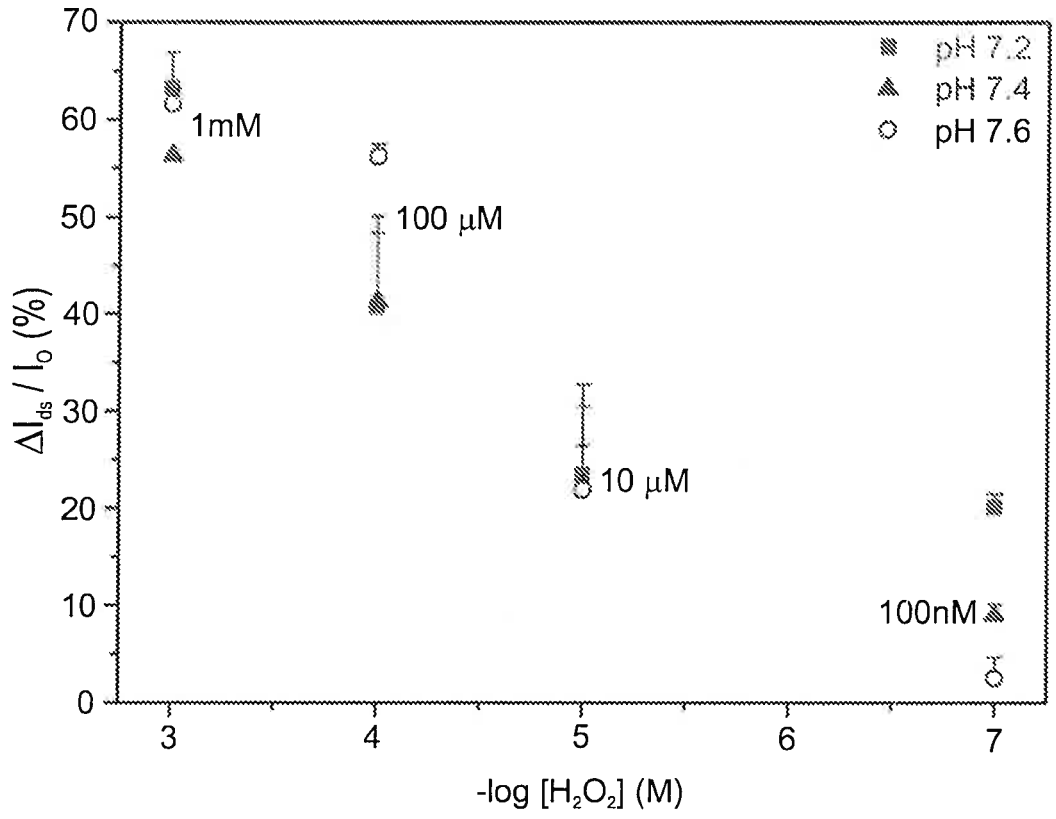

70
60
50
40
30
20
10
0
3
4
5
6
7
$\Delta I_{ds} / I_o$ (%)
-log [H_2O_2] (M)
pH 7.2
pH 7.4
pH 7.6
1mM
100 μM
10 μM
100nM

FIG. 3B

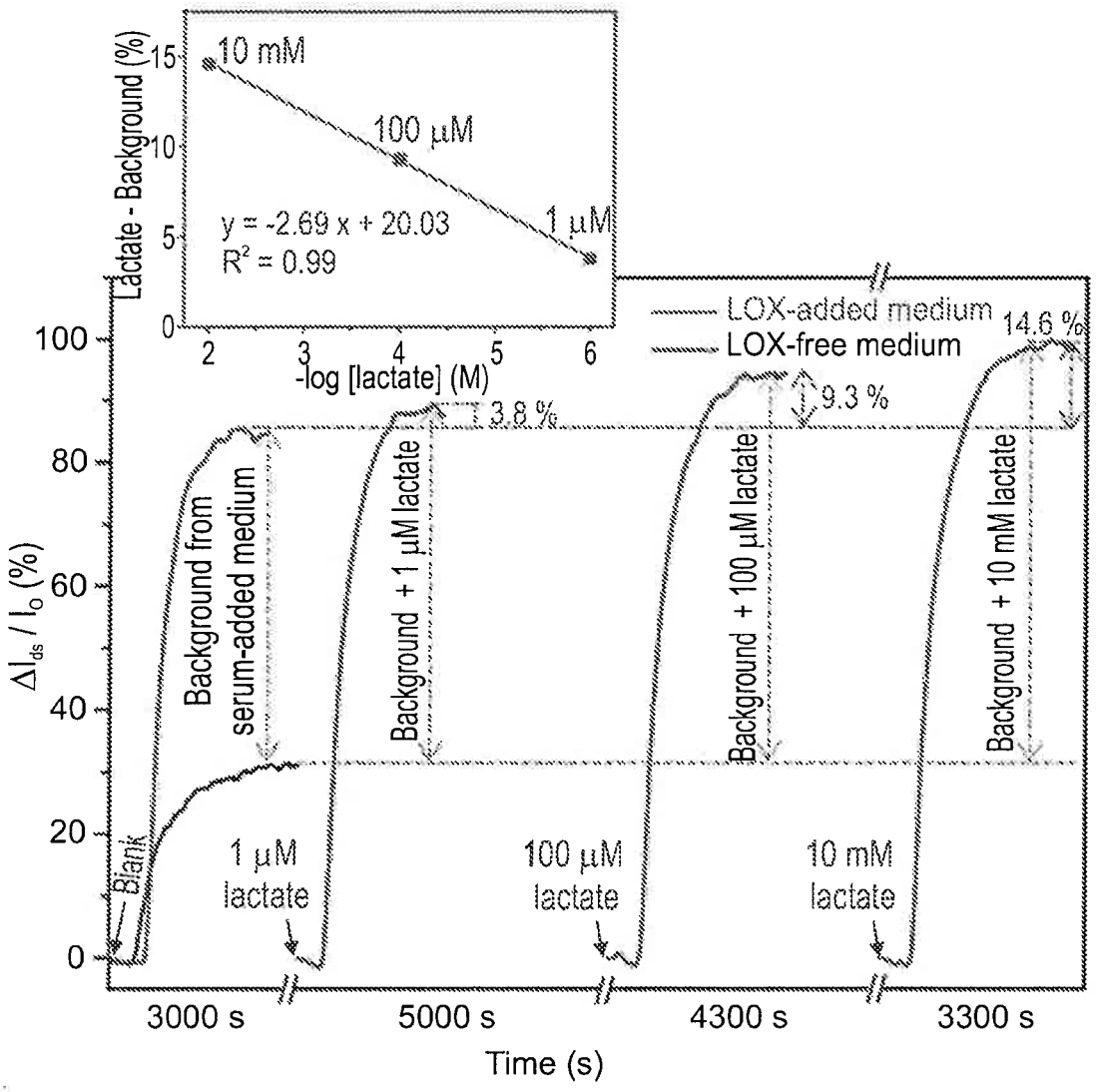

Lactate - Background (%)
10 mM
100 µM
1 µM
y = -2.69 x + 20.03
R² = 0.99
-log [lactate] (M)
LOX-added medium
LOX-free medium
14.6 %
9.3 %
3.8 %
ΔIds / Io (%)
Background from serum-added medium
Background + 1 µM lactate
Background + 100 µM lactate
Background + 10 mM lactate
Blank
1 µM lactate
100 µM lactate
10 mM lactate
3000 s
5000 s
4300 s
3300 s
Time (s)

FIG. 4A

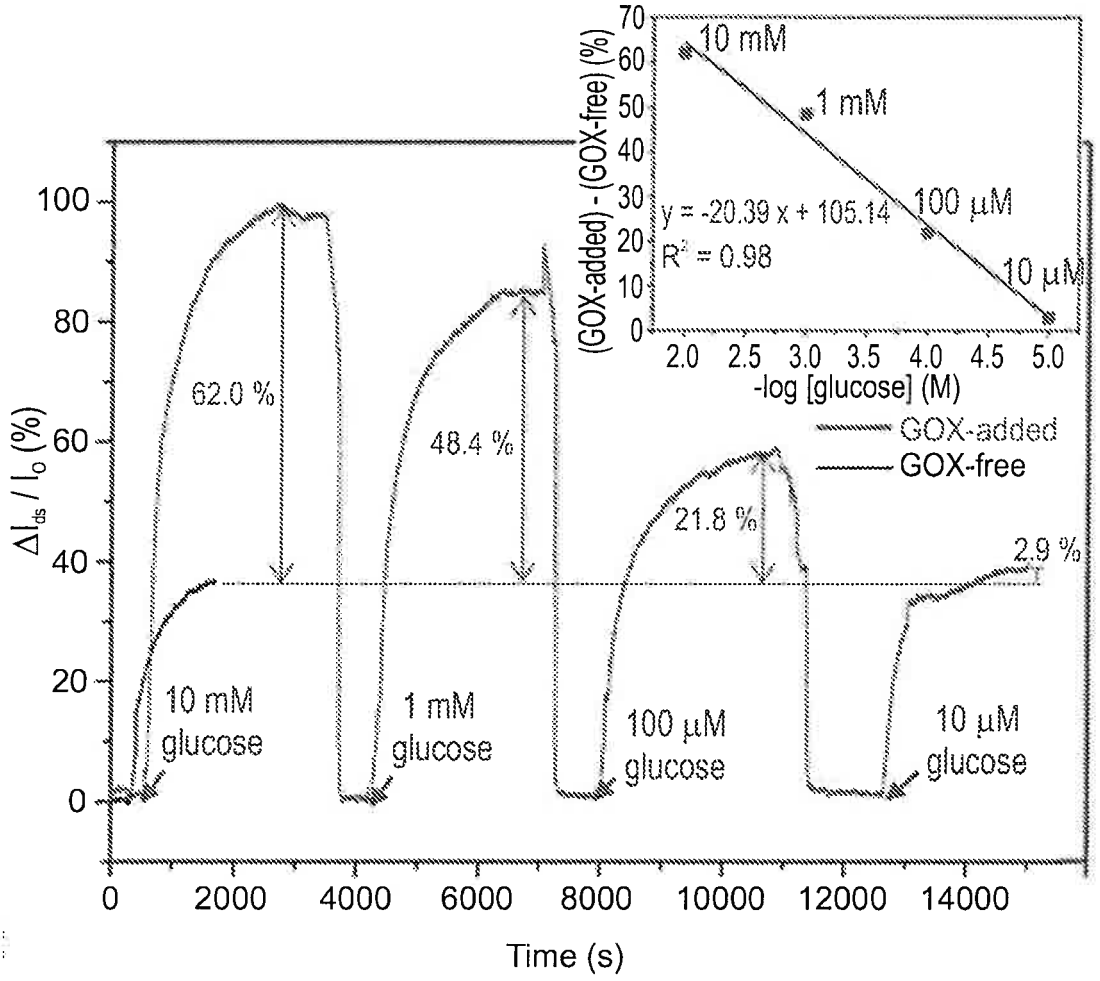

10 mM
1 mM
100 µM
10 µM
y = -20.39 x + 105.14
R² = 0.98
(GOX-added) - (GOX-free) (%)
-log [glucose] (M)
GOX-added
GOX-free
62.0 %
48.4 %
21.8 %
2.9 %
10 mM glucose
1 mM glucose
100 µM glucose
10 µM glucose
ΔIds / Io (%)
Time (s)

FIG. 4B

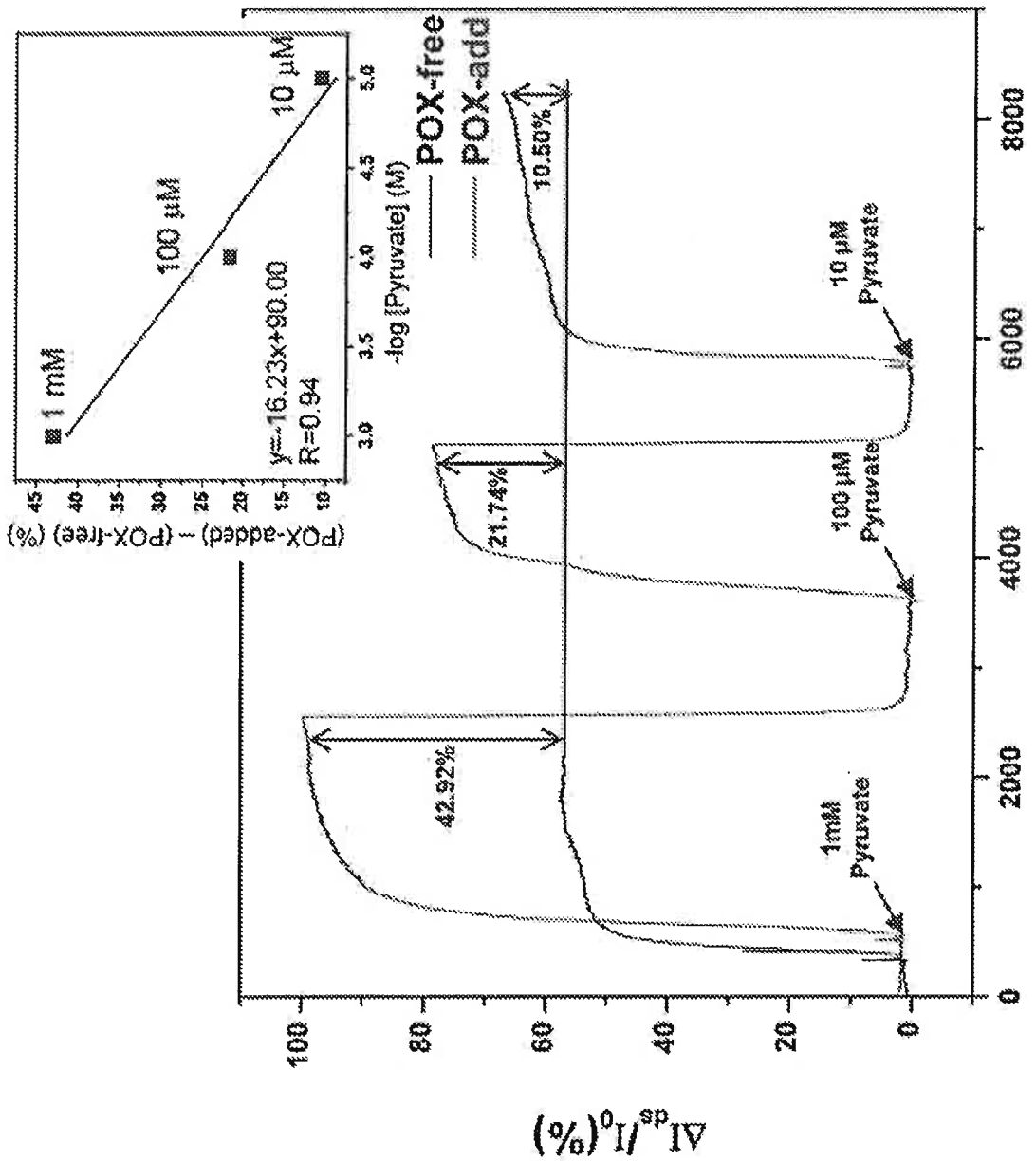

ΔI_ds/I_0(%)
Time (Sec)
POX-free
POX-add
42.92%
21.74%
10.50%
1mM Pyruvate
100 μM Pyruvate
10 μM Pyruvate
(POX-added) – (POX-free) (%)
-log [Pyruvate] (M)
1 mM
100 μM
10 μM
y=-16.23x+90.00
R=0.94

FIG. 4C

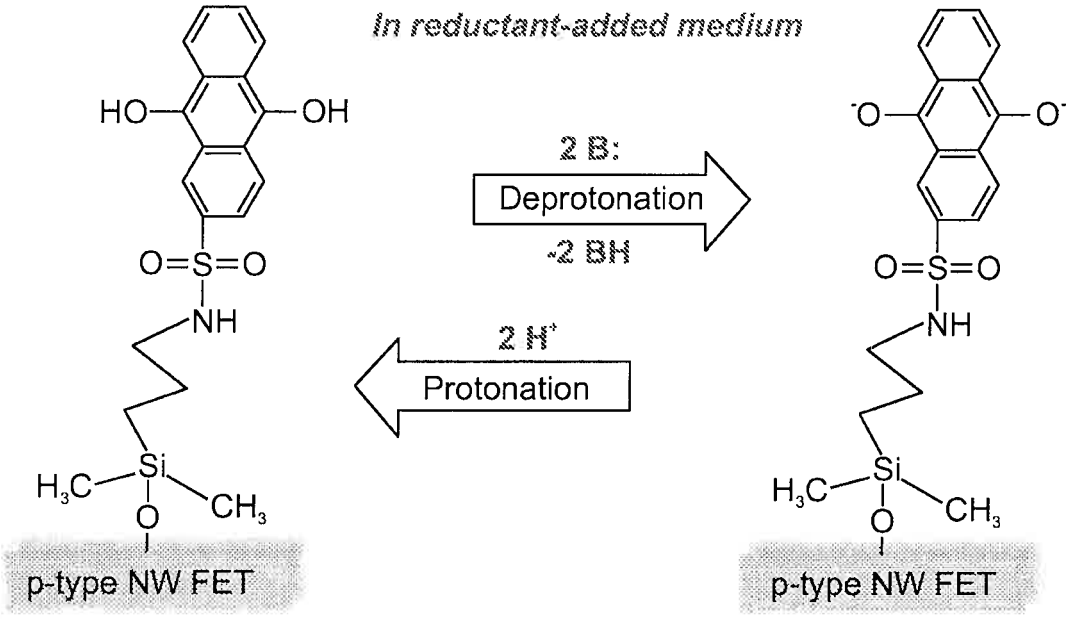

In reductant-added medium
HO
OH
O=S=O
NH
H3C
Si
CH3
O
p-type NW FET
2 B:
Deprotonation
-2 BH
2 H+
Protonation
-O
O-
O=S=O
NH
H3C
Si
CH3
O
p-type NW FET

FIG. 5A

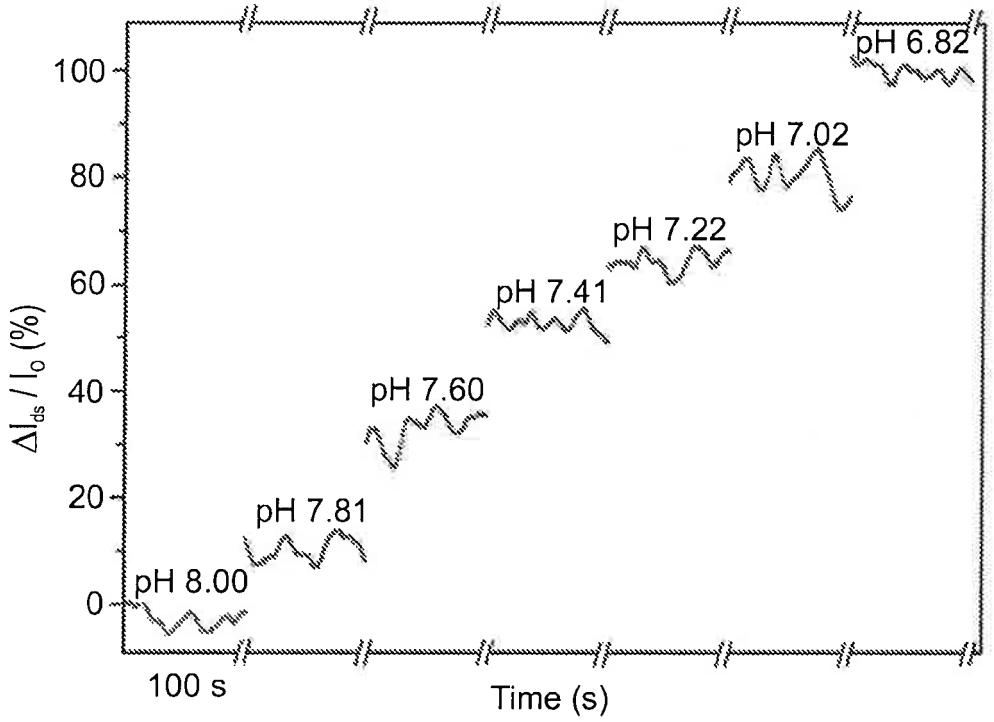

pH 6.82
pH 7.02
pH 7.22
pH 7.41
pH 7.60
pH 7.81
pH 8.00
100
80
60
40
20
0
ΔIds / I0 (%)
100 s
Time (s)

FIG. 5B

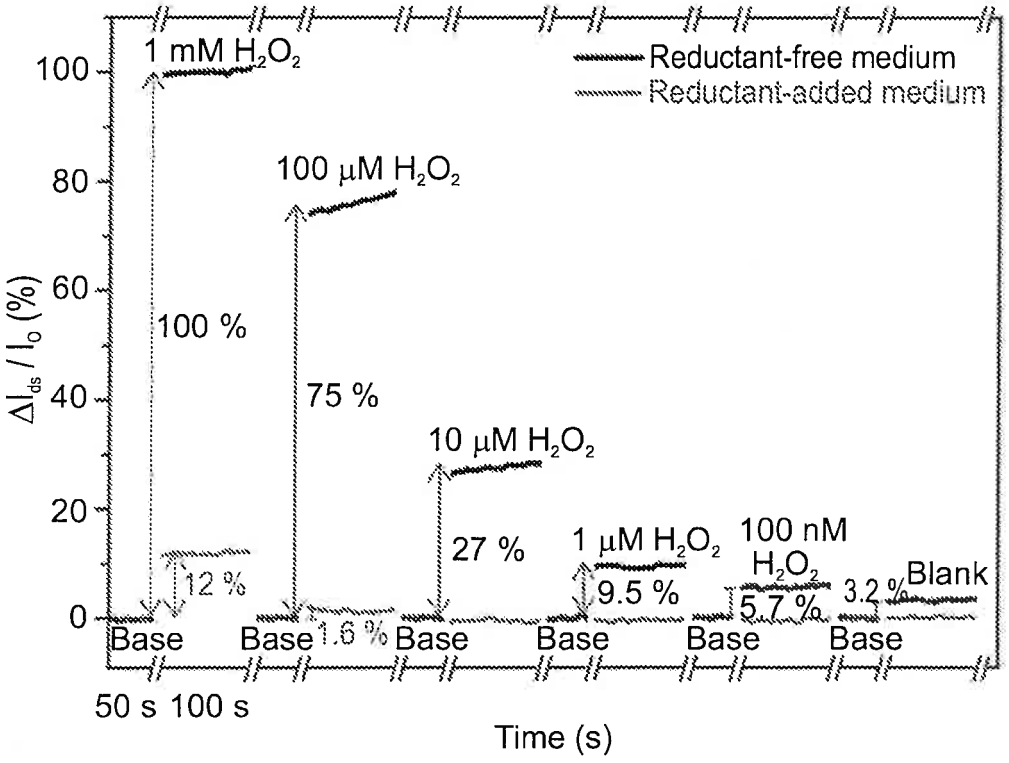
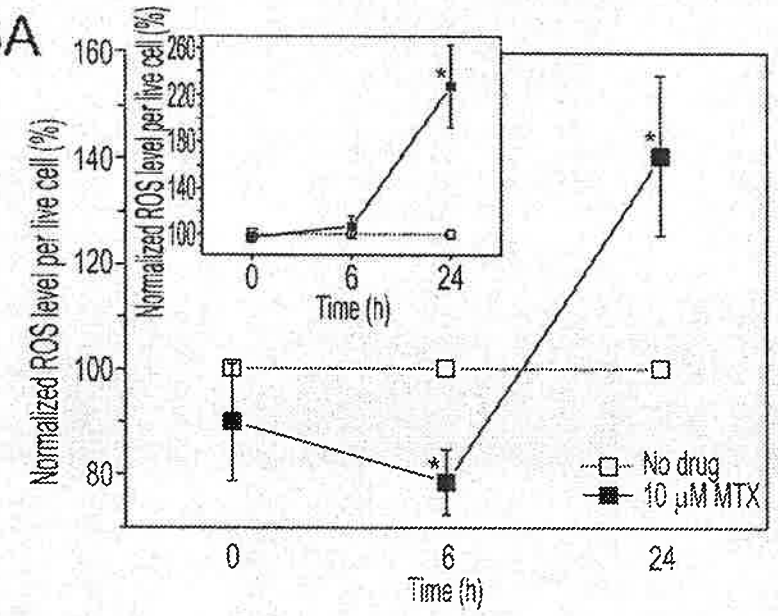

1 mM H2O2
Reductant-free medium
Reductant-added medium
100 μM H2O2
100 %
75 %
10 μM H2O2
27 %
1 μM H2O2
100 nM H2O2
12 %
9.5 %
5.7 %
3.2 %
Blank
1.6 %
Base
Base
Base
Base
Base
Base
100
80
60
40
20
0
ΔIds / I0 (%)
50 s 100 s
Time (s)

FIG. 5C

SUBSTITUTE SHEET (RULE 26)

FIG. 6A



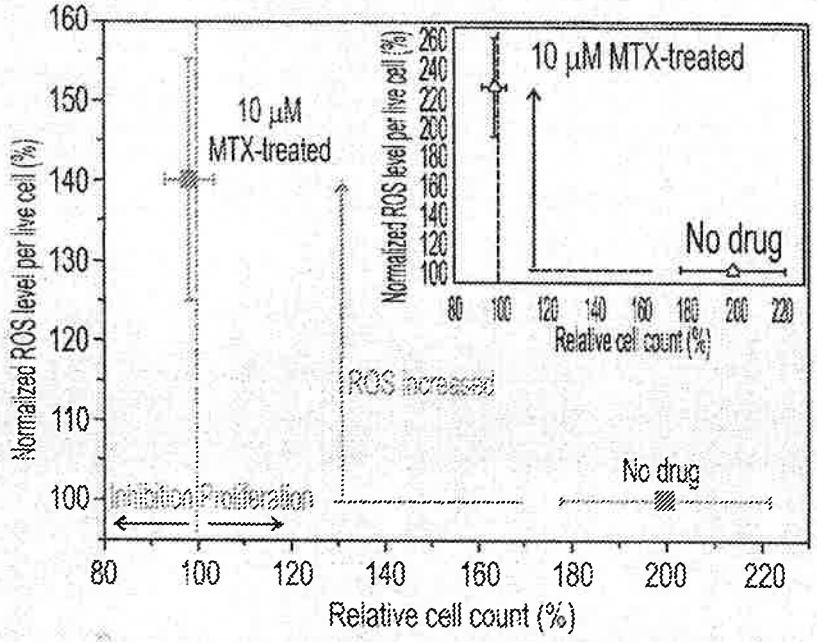


FIG. 6B

FIG. 6C

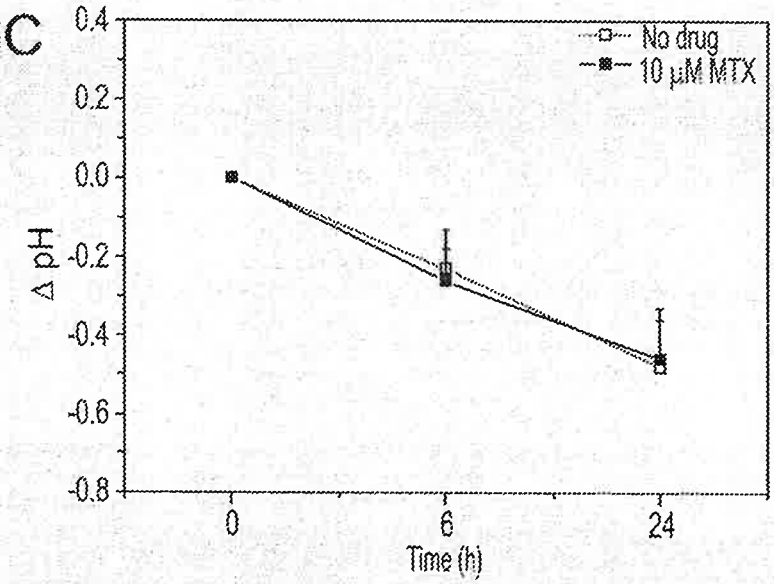


FIG. 6D

FIG. 6E

FIG. 6G

FIG. 6F

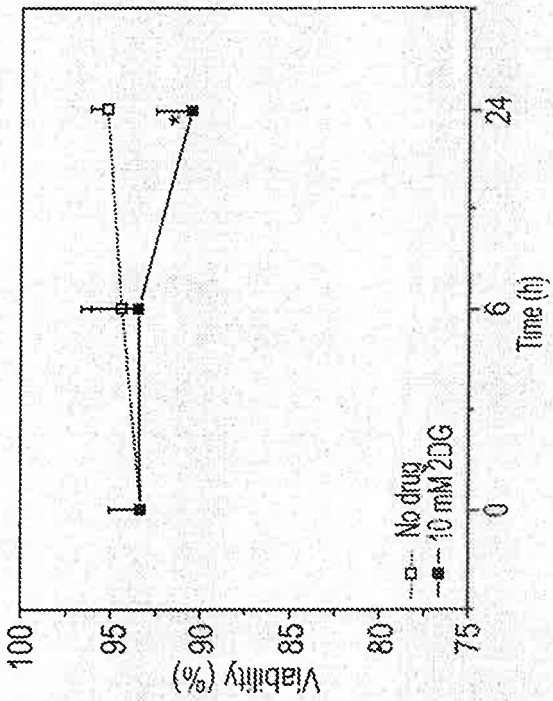

Viability (%)
100
95
90
85
80
75
0
6
24
Time (h)
No drug
10 mM 2DG
*

FIG. 6I

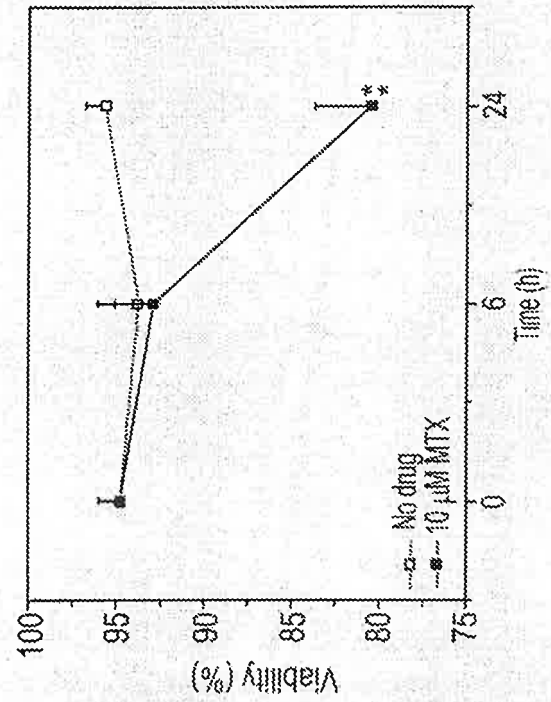

Viability (%)
100
95
90
85
80
75
0
6
24
Time (h)
No drug
10 μM MTX
**

FIG. 6H

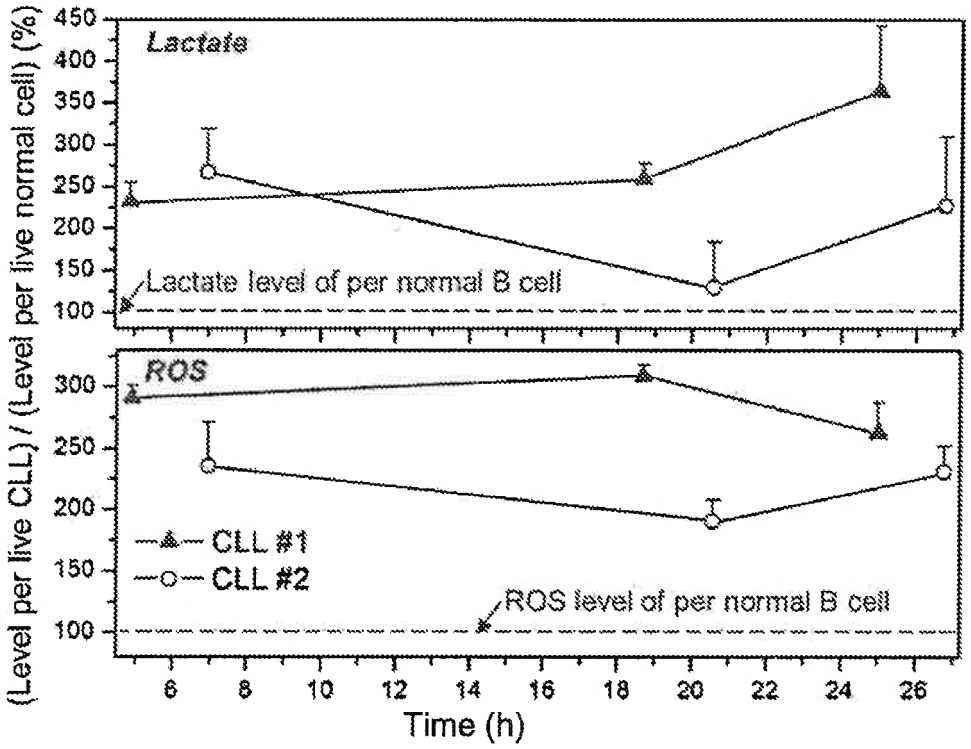

Lactate
Lactate level of per normal B cell
ROS
ROS level of per normal B cell
CLL #1
CLL #2
(Level per live CLL) / (Level per live normal cell) (%)
Time (h)

FIG. 7A

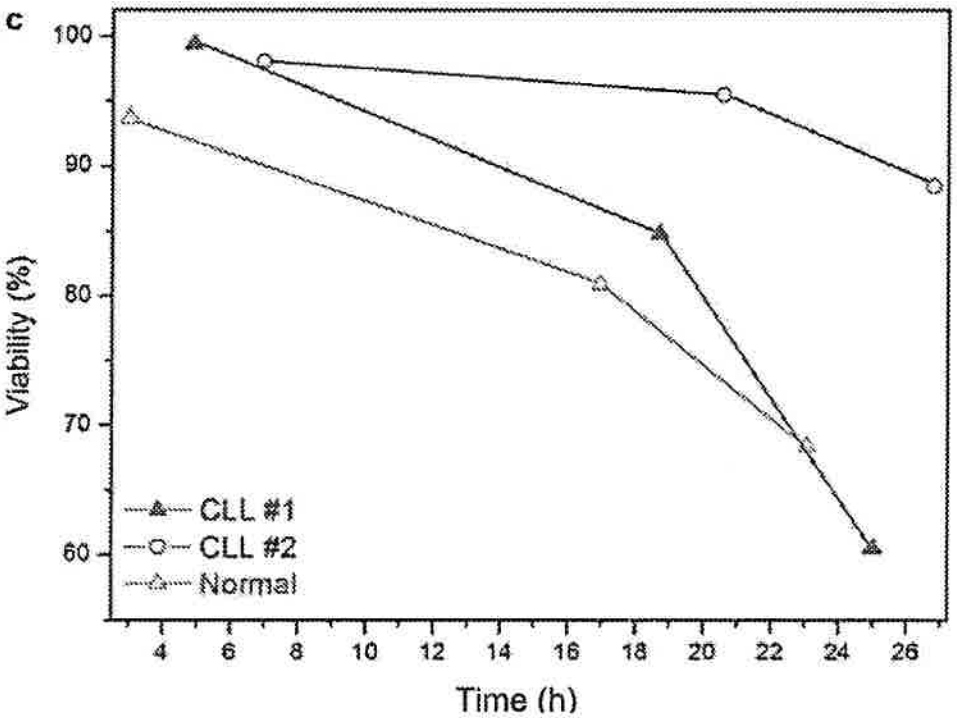

c
Viability (%)
CLL #1
CLL #2
Normal
Time (h)

FIG. 7B

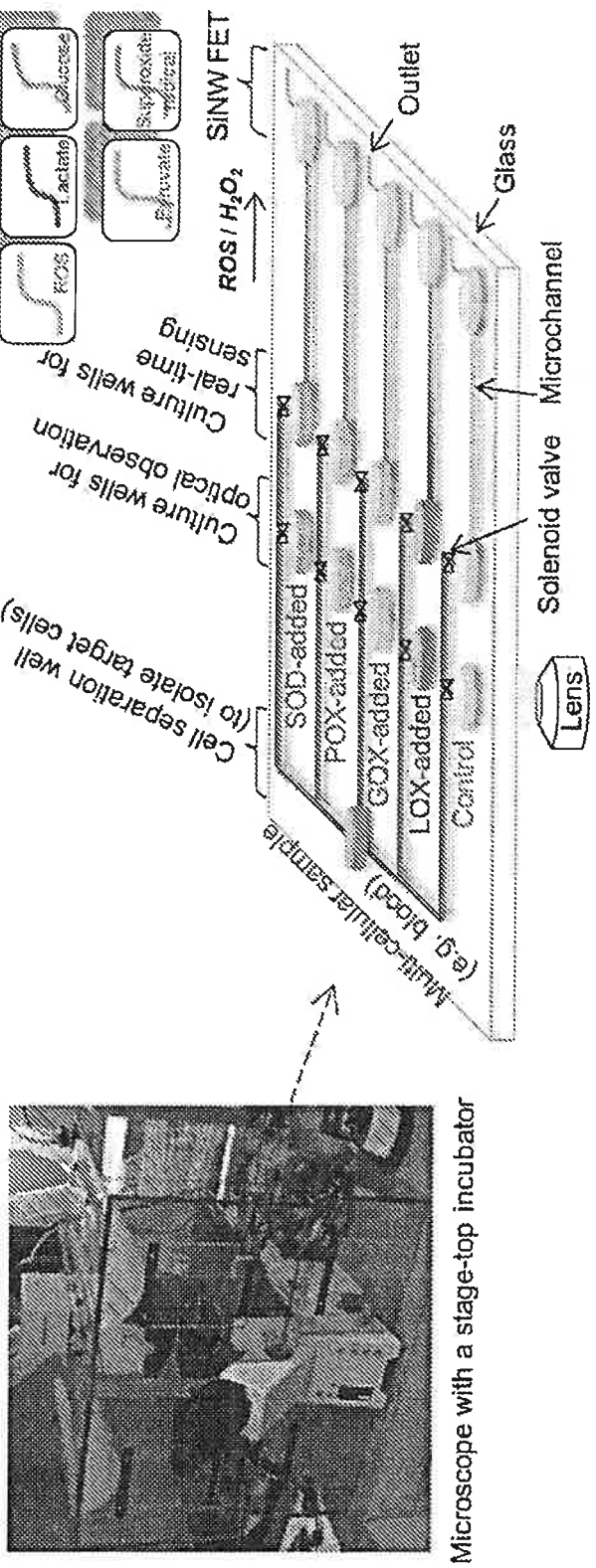

Microscope with a stage-top incubator
Multi-cellular sample
(e.g. blood)
Cell separation well
(to isolate target cells)
Culture wells for
optical observation
Culture wells for
real-time
sensing
ROS / H_2O_2
SiNW FET
Outlet
Glass
Microchannel
Solenoid valve
Lens
SOD-added
POX-added
GOX-added
LOX-added
Control
ROS
Lactate
Glucose
Pyruvate
Superoxide radical

FIG. 8

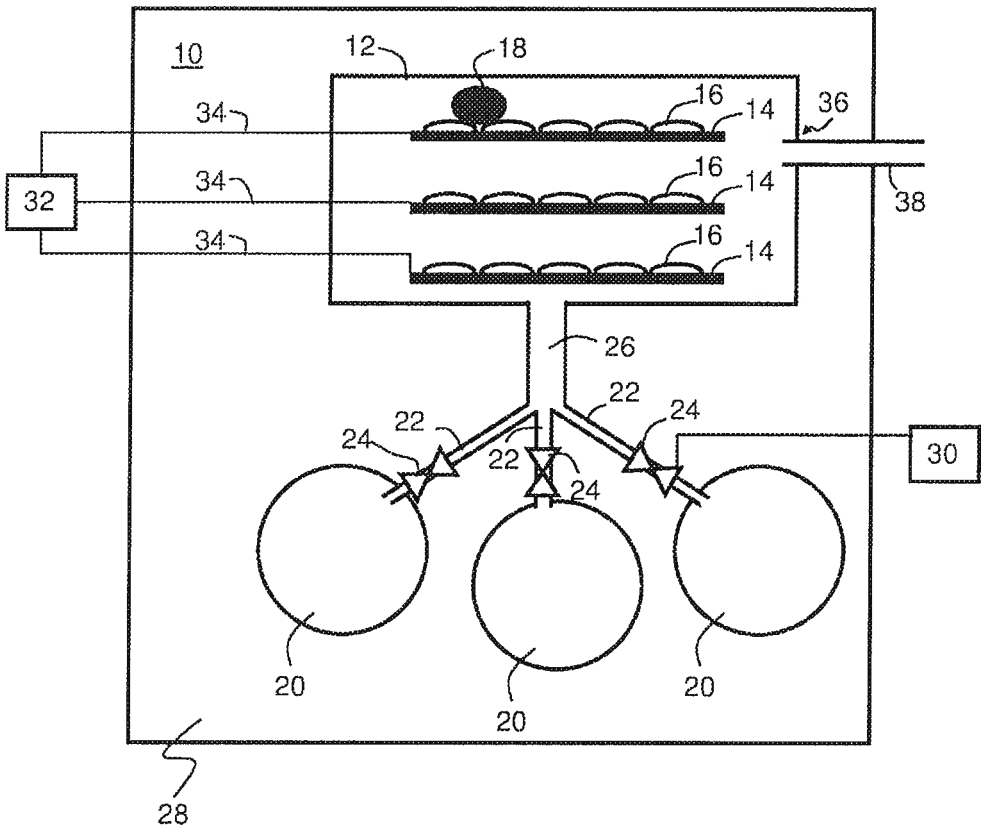


FIG. 9A

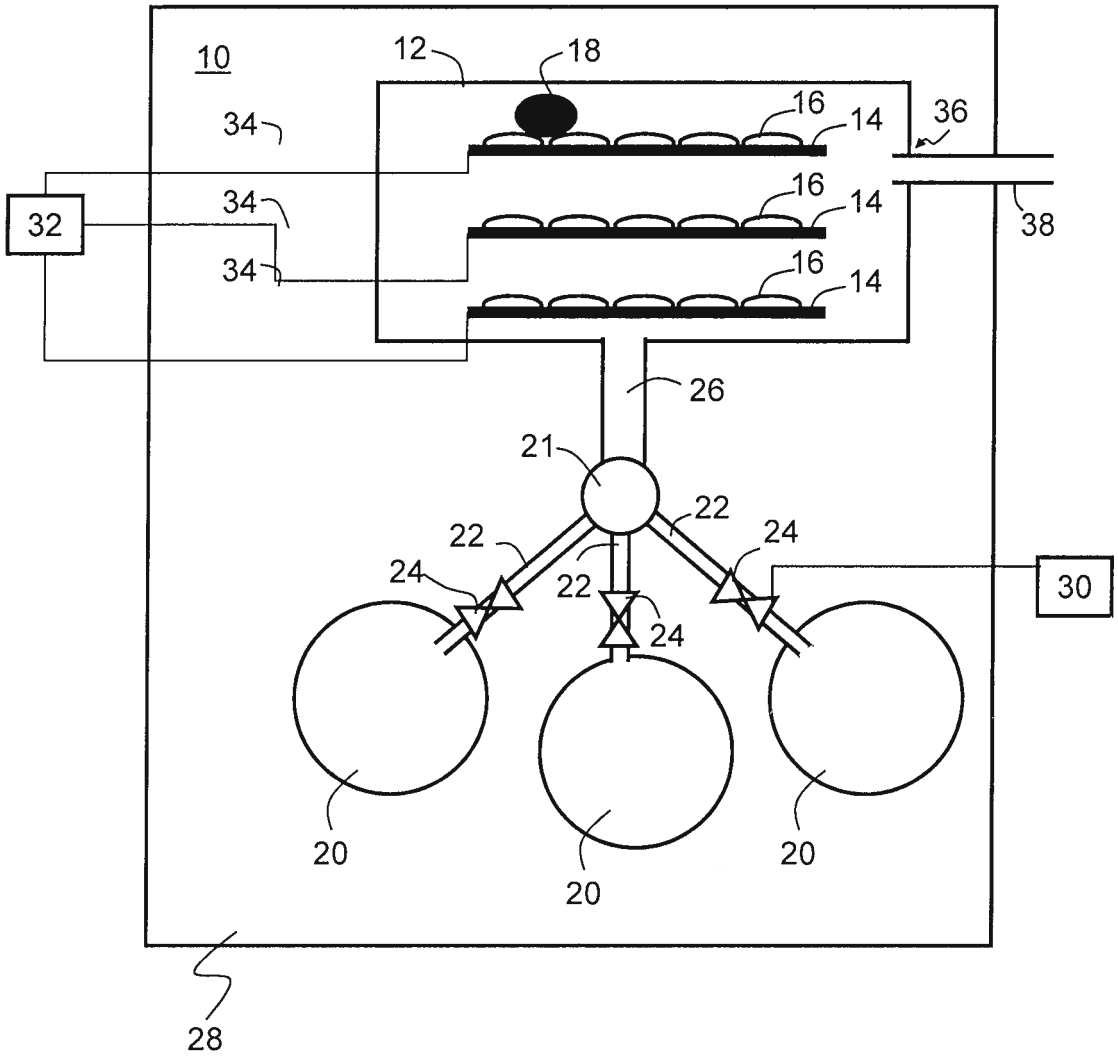

10
12
18
16
14
36
34
32
34
34
16
14
16
14
38
26
21
22
22
24
24
22
24
30
20
20
20
28

FIG. 9B

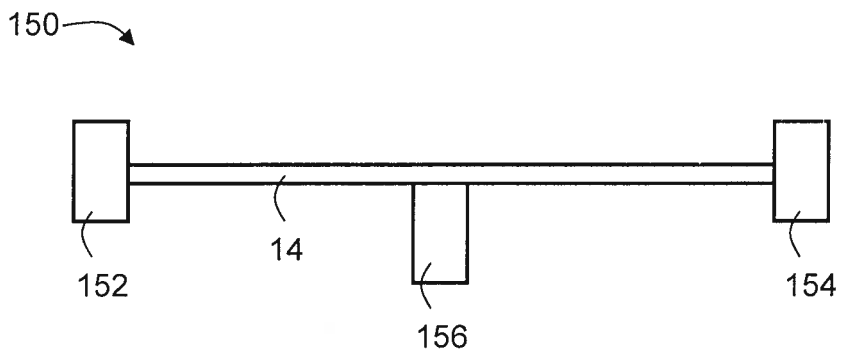

150
14
152
154
156

FIG. 10

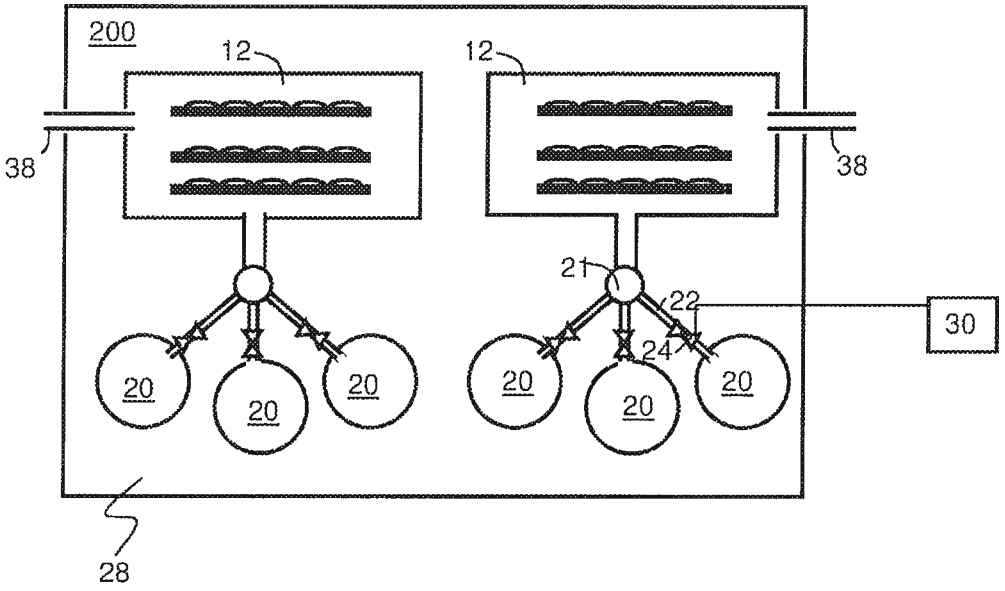


FIG. 11A

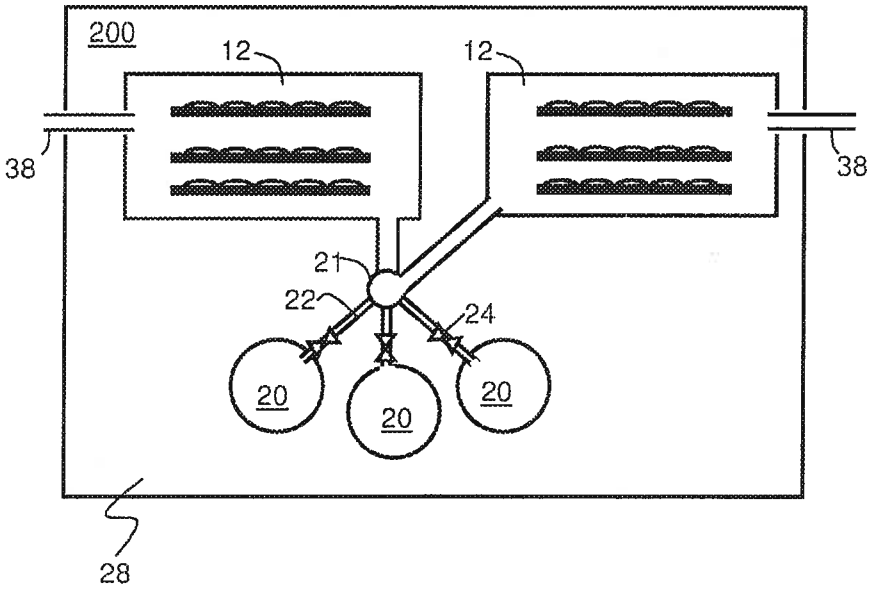


FIG. 11B

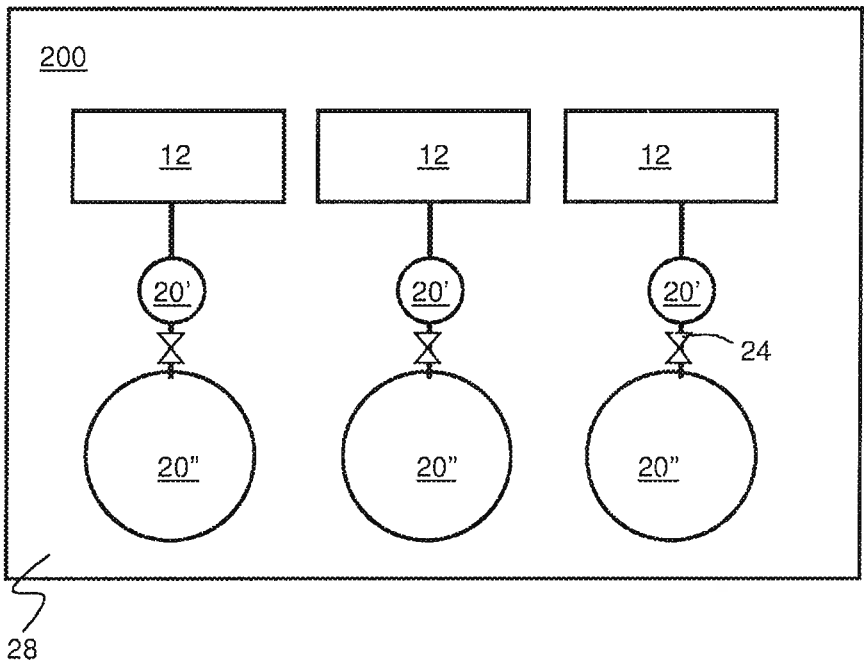


FIG. 11C

FIG. 1A

FIG. 1B

FIG. 1C

FIG. 1D

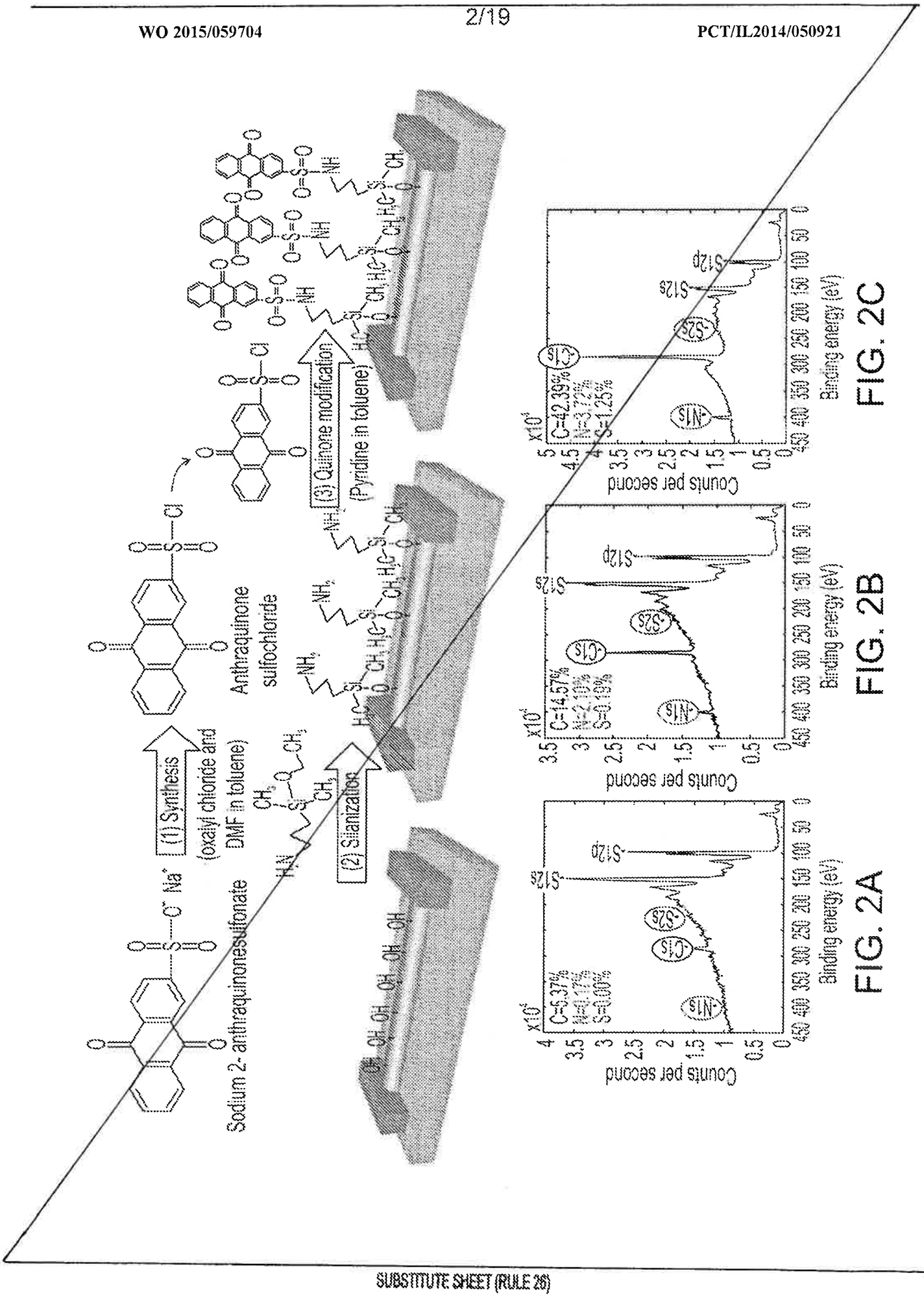


FIG. 2A

FIG. 2B

FIG. 2C

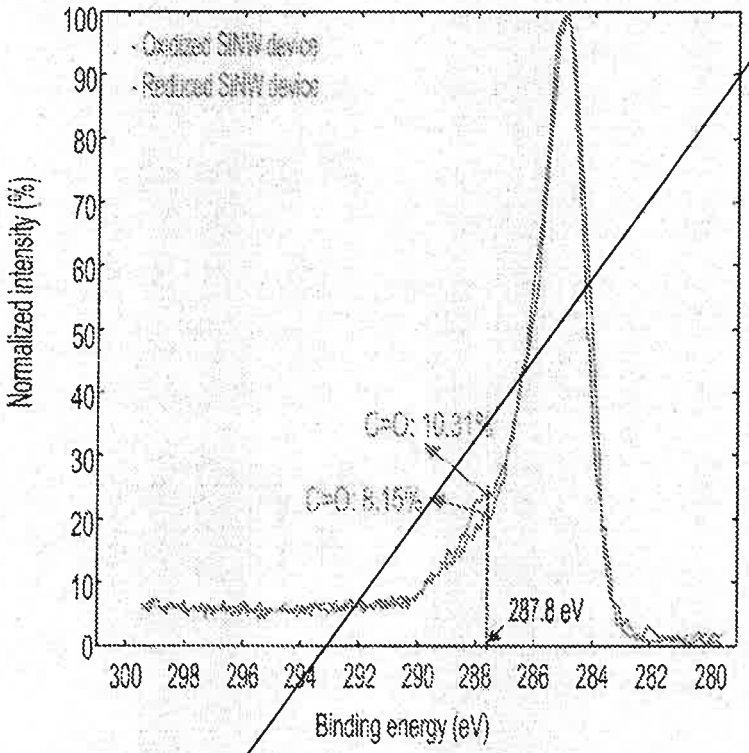

Oxidized SiNW device
Reduced SiNW device
C=O: 10.31%
C=O: 5.15%
287.8 eV
Normalized intensity (%)
Binding energy (eV)
100
90
80
70
60
50
40
30
20
10
0
300
298
296
294
292
290
288
286
284
282
280

FIG. 2D

Oxidation
Reduction
Reductant
APDMES-modified FET (1 mM H_2O_2)
1 mM
100 µM
10 µM
0 µM
H_2O_2
500~600
Time (s)
$\Delta I_{ds} / I_0$ (%)
C-C+C-H : 64.75%
OH-C=O : 3.12%
C=O : 10.31%
C-C+C-H : 65.46%
OH-C=O : 3.12%
C=O : 8.15%
Current
Time

FIG. 3A

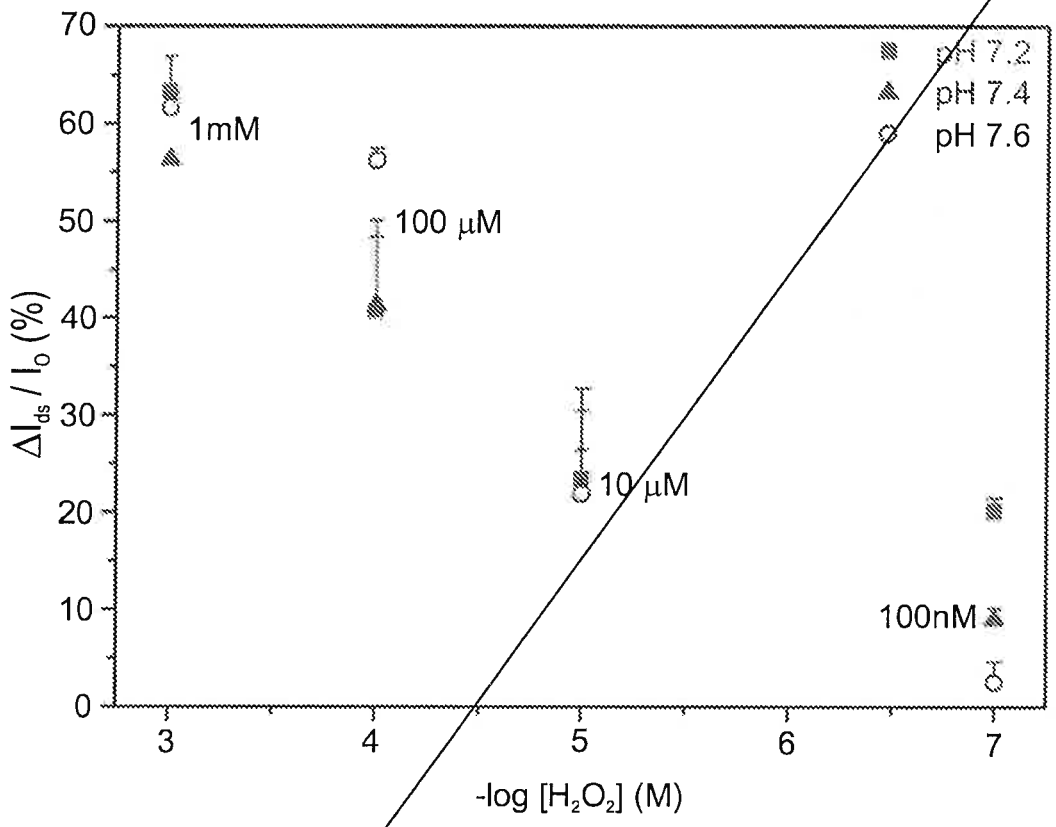

70
60
50
40
30
20
10
0
3
4
5
6
7
$\Delta I_{ds} / I_O$ (%)
-log [H_2O_2] (M)
pH 7.2
pH 7.4
pH 7.6
1mM
100 μM
10 μM
100nM

FIG. 3B

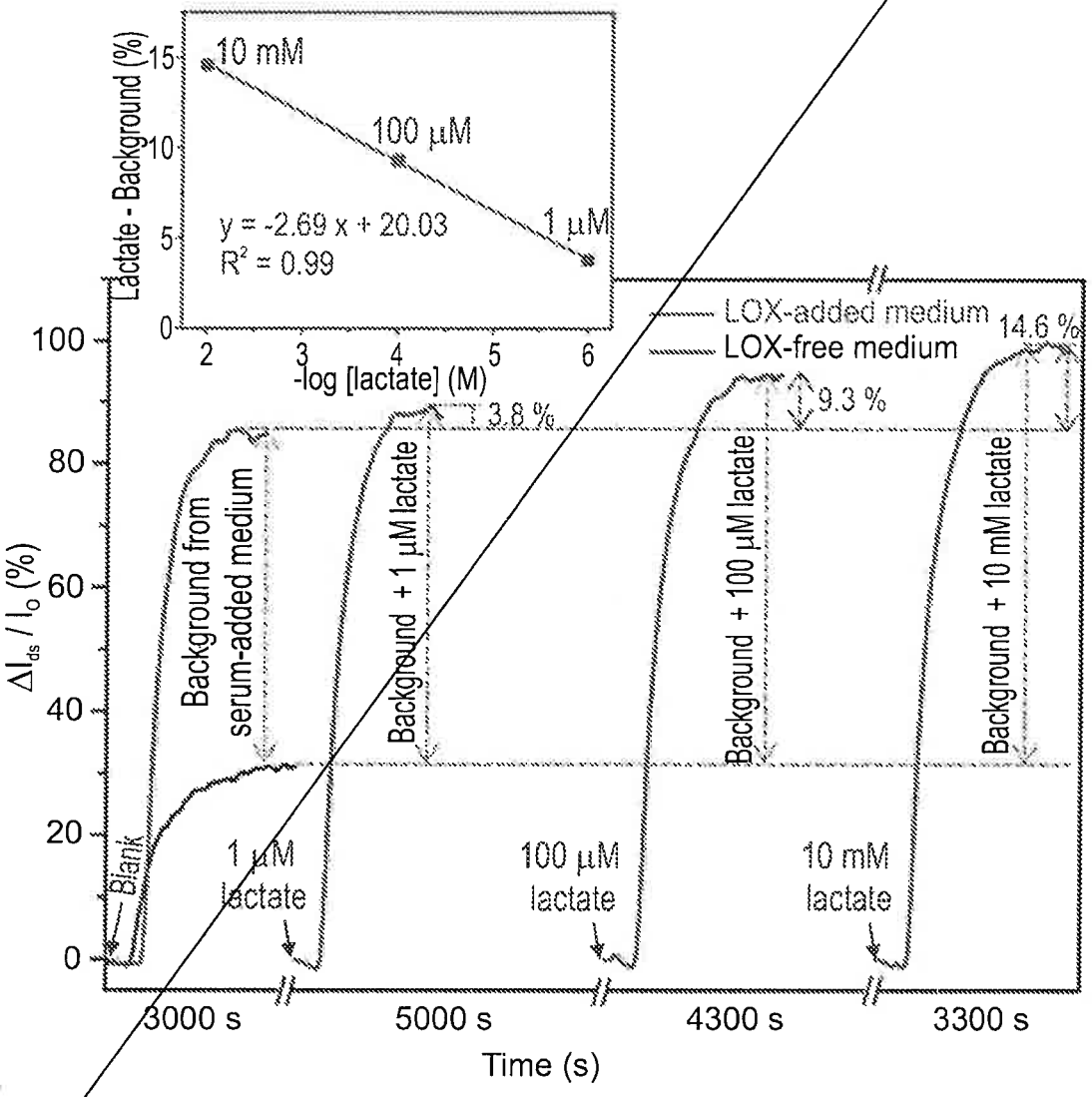

Lactate - Background (%)
15
10
5
0
10 mM
100 µM
1 µM
y = -2.69 x + 20.03
R² = 0.99
2
3
4
5
6
-log [lactate] (M)
LOX-added medium
LOX-free medium
14.6 %
9.3 %
3.8 %
100
80
60
40
20
0
ΔIds / Io (%)
Background from serum-added medium
Background + 1 µM lactate
Background + 100 µM lactate
Background + 10 mM lactate
Blank
1 µM lactate
100 µM lactate
10 mM lactate
3000 s
5000 s
4300 s
3300 s
Time (s)

FIG. 4A

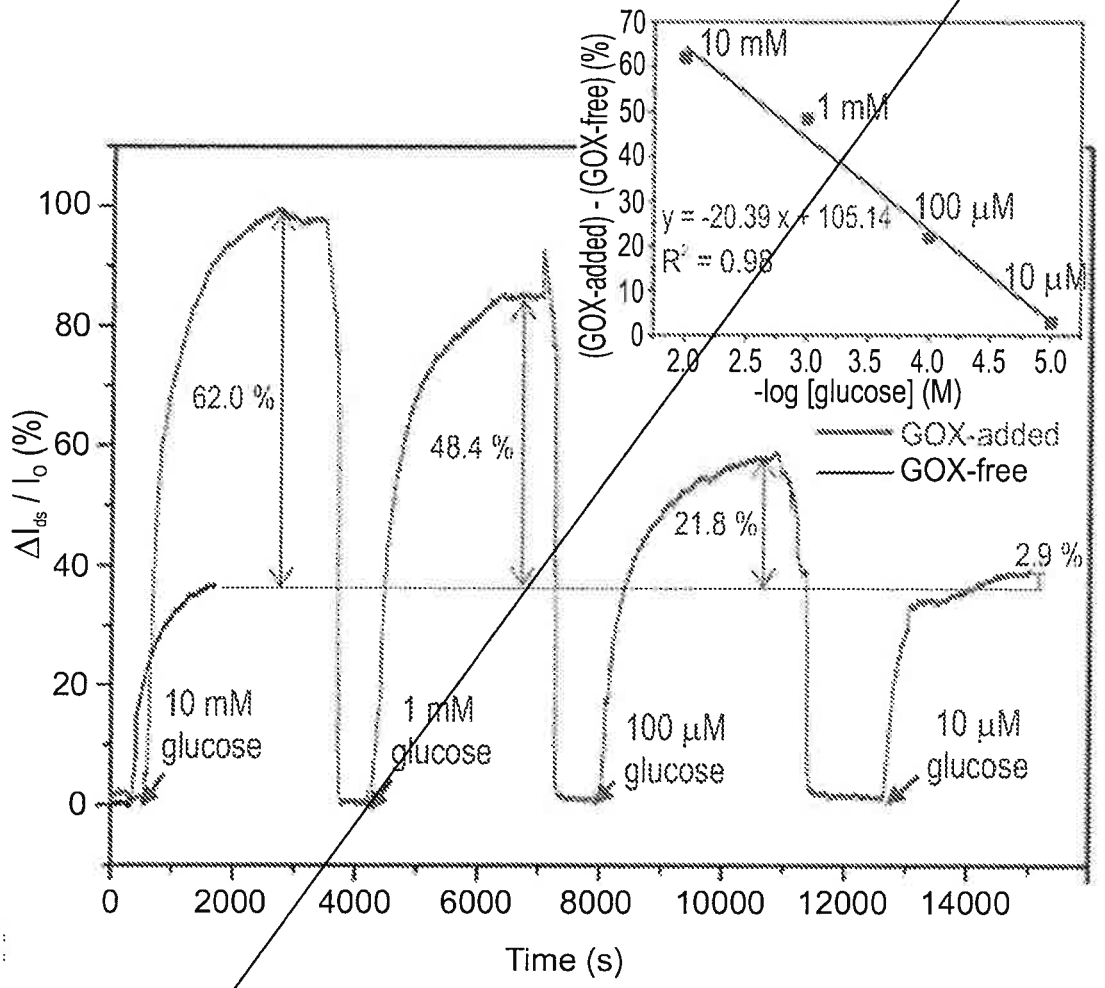

100
80
60
40
20
0
$\Delta I_{ds} / I_o$ (%)
62.0 %
48.4 %
21.8 %
2.9 %
10 mM glucose
1 mM glucose
100 µM glucose
10 µM glucose
0
2000
4000
6000
8000
10000
12000
14000
Time (s)
(GOX-added) - (GOX-free) (%)
70
60
50
40
30
20
10
0
10 mM
1 mM
100 µM
10 µM
y = -20.39 x + 105.14
R^2 = 0.98
2.0
2.5
3.0
3.5
4.0
4.5
5.0
-log [glucose] (M)
GOX-added
GOX-free

FIG. 4B

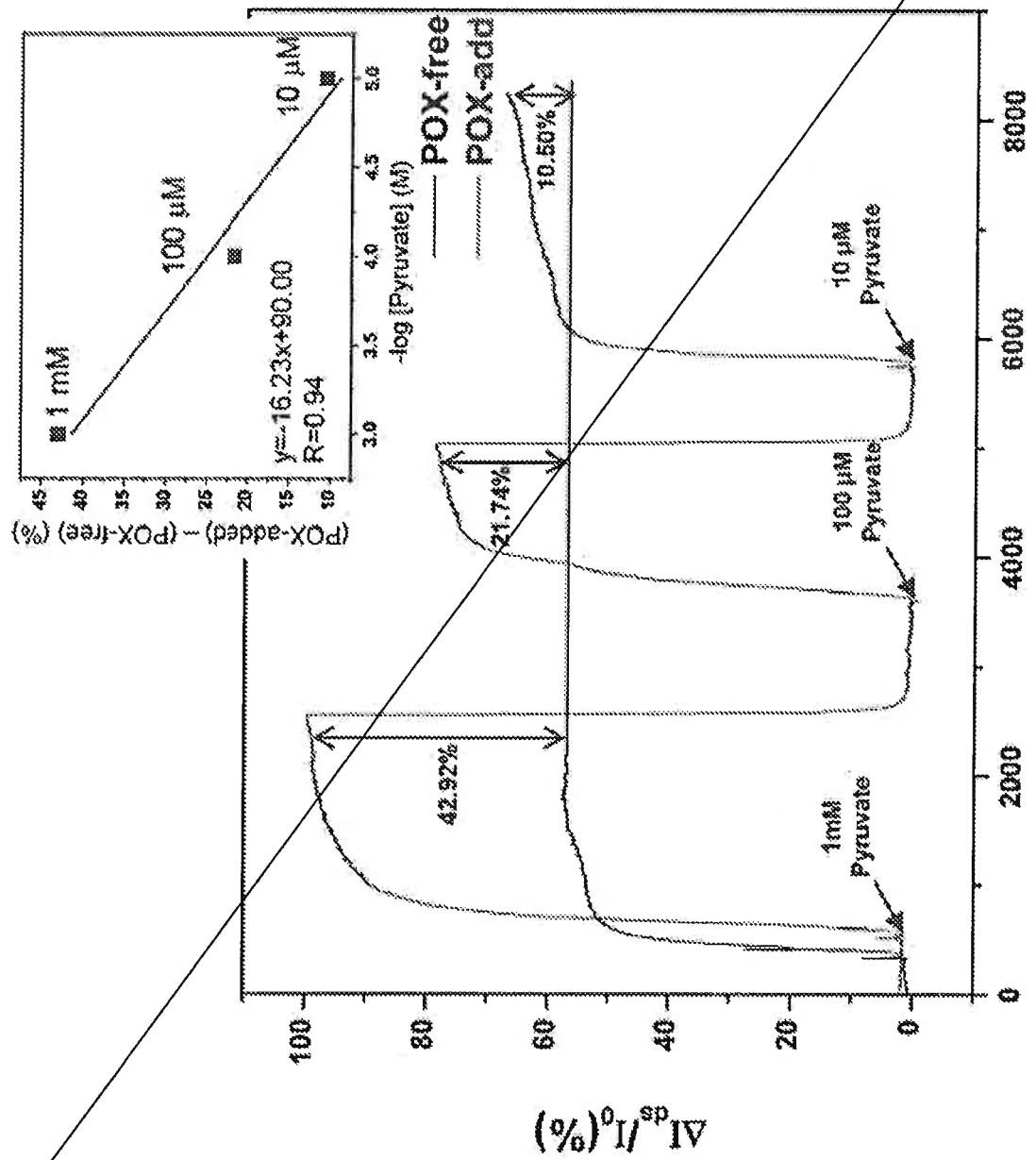

ΔI_ds/I_0(%)
Time (Sec)
POX-free
POX-add
1mM Pyruvate
100 µM Pyruvate
10 µM Pyruvate
42.92%
21.74%
10.50%
1 mM
100 µM
10 µM
y=-16.23x+90.00
R=0.94
-log [Pyruvate] (M)
(POX-added) – (POX-free) (%)

FIG. 4C

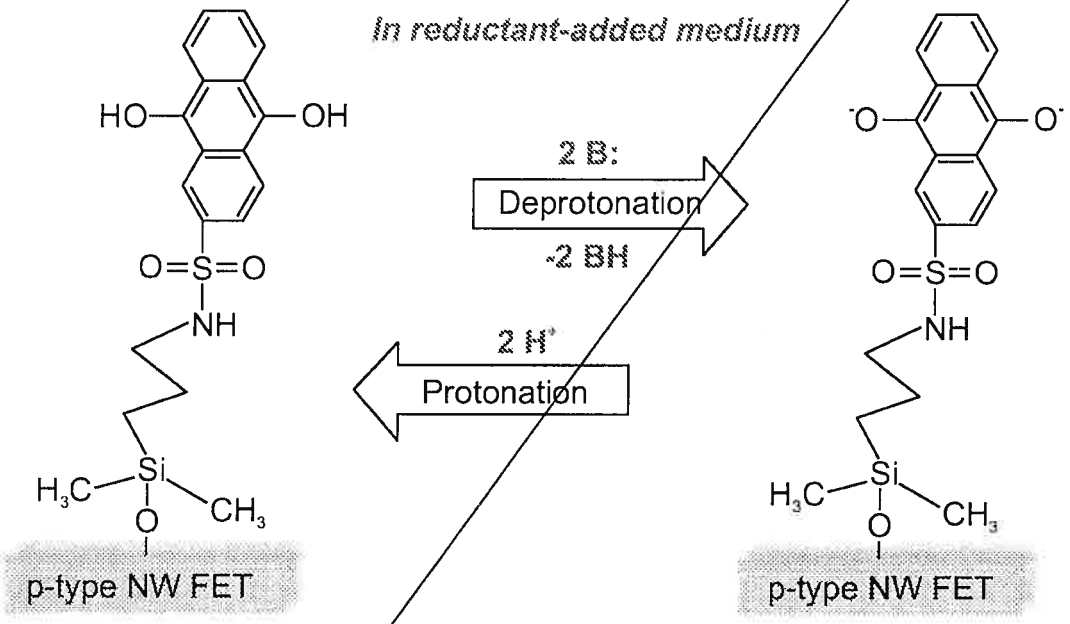

In reductant-added medium
HO
OH
O=S=O
NH
H3C
Si
CH3
O
p-type NW FET
2 B:
Deprotonation
-2 BH
2 H+
Protonation
-O
O-
O=S=O
NH
H3C
Si
CH3
O
p-type NW FET

FIG. 5A

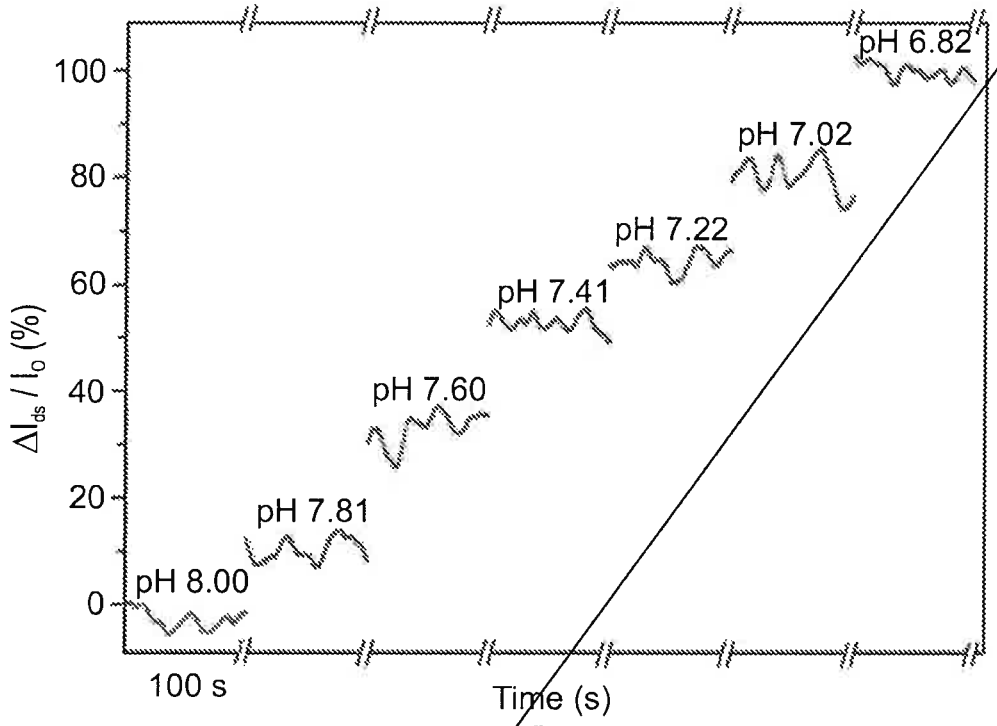

pH 6.82
pH 7.02
pH 7.22
pH 7.41
pH 7.60
pH 7.81
pH 8.00
100
80
60
40
20
0
$\Delta I_{ds} / I_O$ (%)
100 s
Time (s)

FIG. 5B

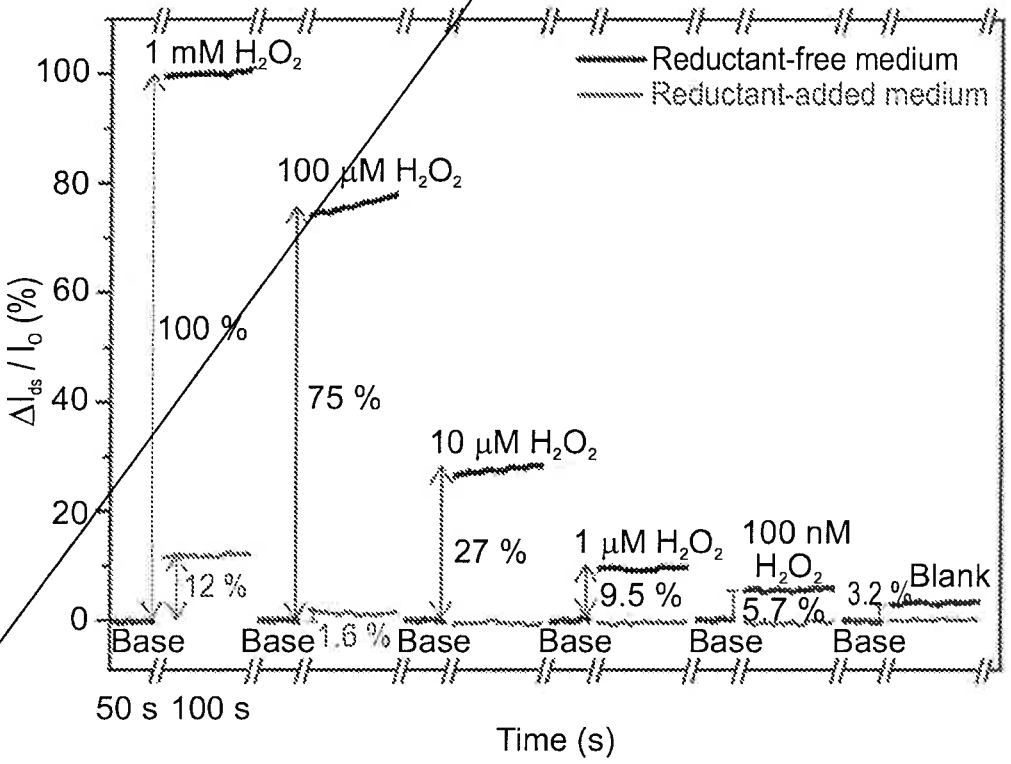

1 mM H_2O_2
Reductant-free medium
Reductant-added medium
100 µM H_2O_2
10 µM H_2O_2
1 µM H_2O_2
100 nM H_2O_2
Blank
100 %
75 %
27 %
12 %
9.5 %
5.7 %
3.2 %
1.6 %
Base
100
80
60
40
20
0
$\Delta I_{ds} / I_O$ (%)
50 s 100 s
Time (s)

FIG. 5C

FIG. 6A

FIG. 6B

FIG. 6C

FIG. 6D

FIG. 6E

FIG. 6F

FIG. 6G

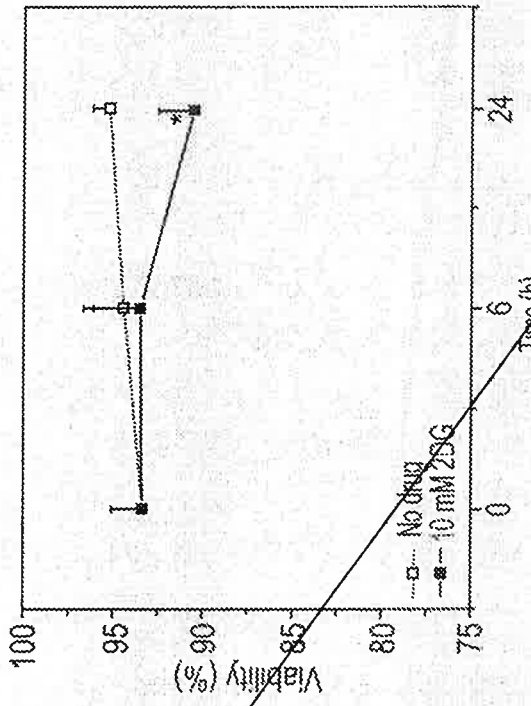

Viability (%)
100
95
90
85
80
75
0
6
24
Time (h)
No drug
10 mM 2DG
*
*

FIG. 6I

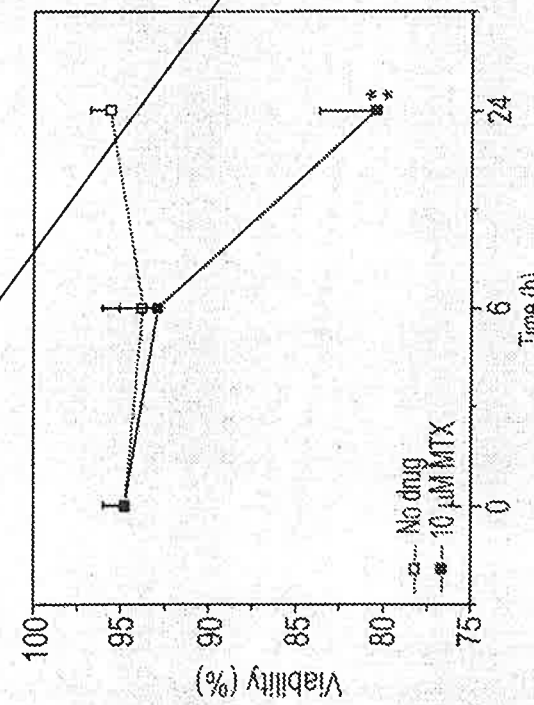

Viability (%)
100
95
90
85
80
75
0
6
24
Time (h)
No drug
10 μM MTX
**
**

FIG. 6H

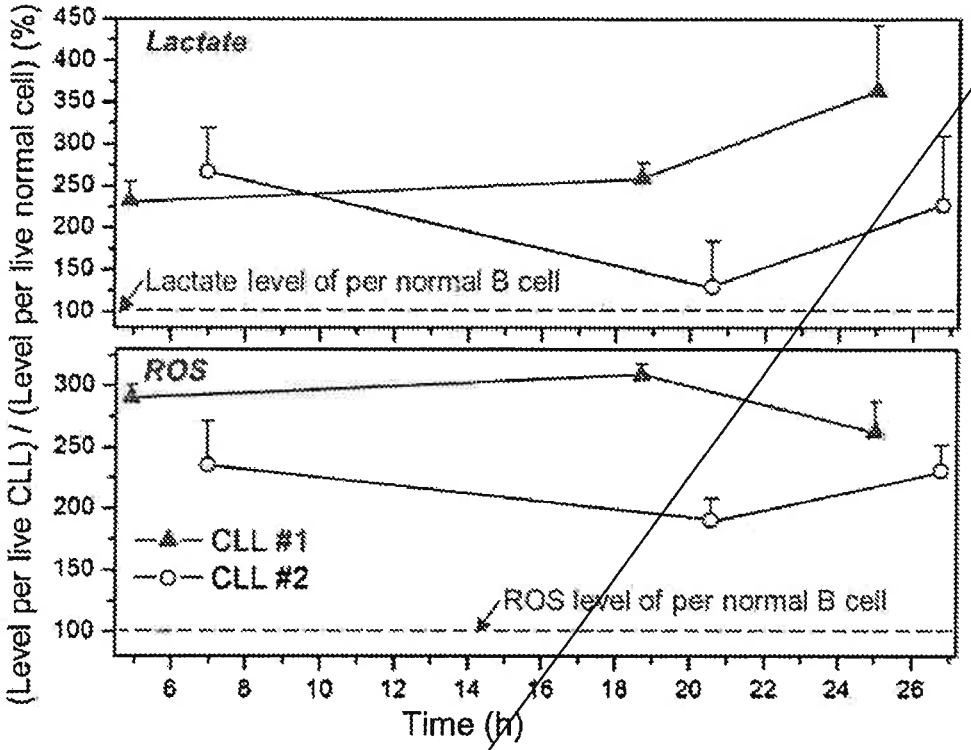

Lactate
Lactate level of per normal B cell
ROS
ROS level of per normal B cell
CLL #1
CLL #2
(Level per live CLL) / (Level per live normal cell) (%)
Time (h)

FIG. 7A

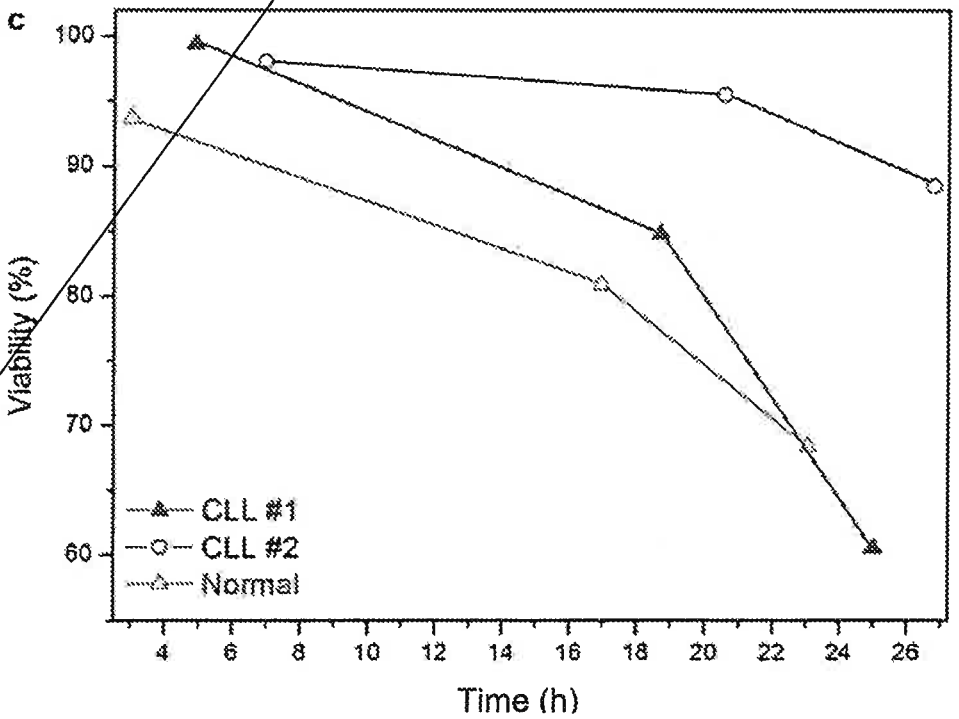

c
Viability (%)
CLL #1
CLL #2
Normal
Time (h)

FIG. 7B

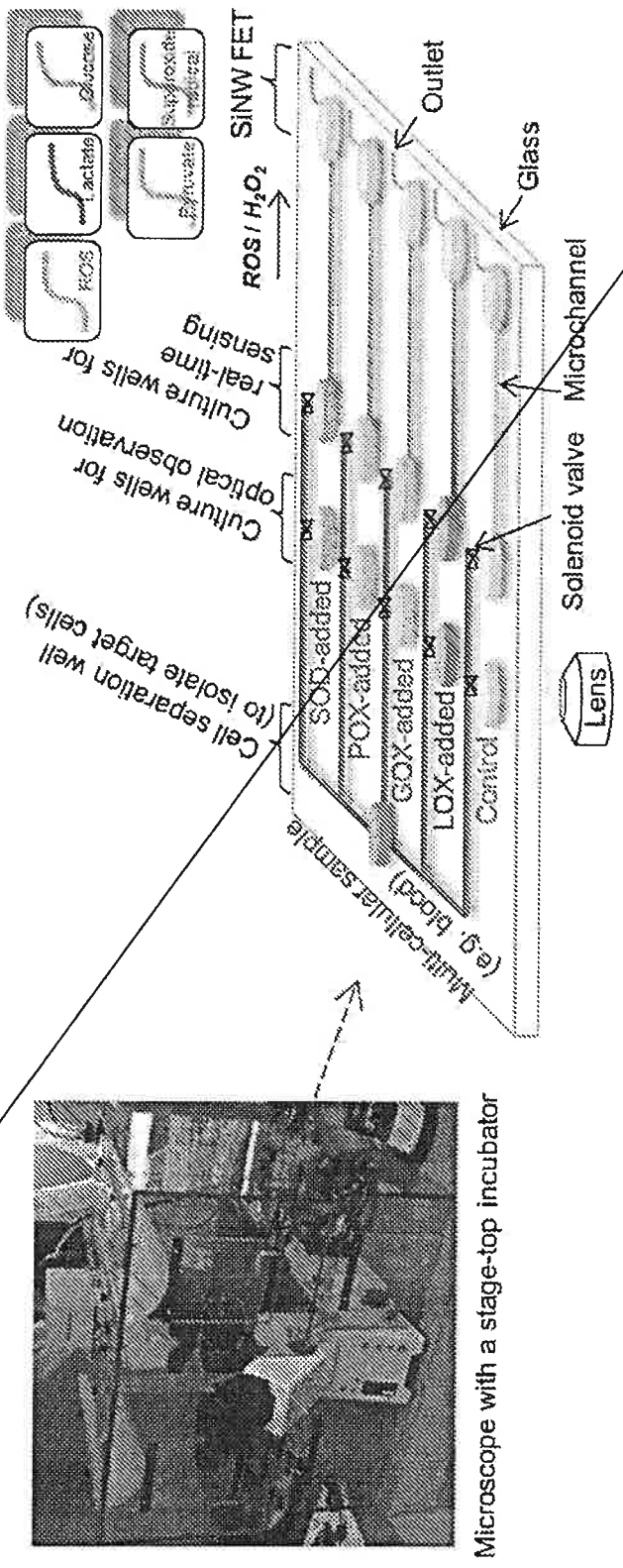

Microscope with a stage-top incubator
Multi-cellular sample
(e.g. blood)
Control
LOX-added
COX-added
POX-added
SOD-added
Cell separation well
(to isolate target cells)
Culture wells for
optical observation
Culture wells for
real-time
sensing
ROS / H_2O_2
SiNW FET
Outlet
Glass
Microchannel
Solenoid valve
Lens
ROS
Lactate
Glucose
Pyruvate
Superoxide

FIG. 8

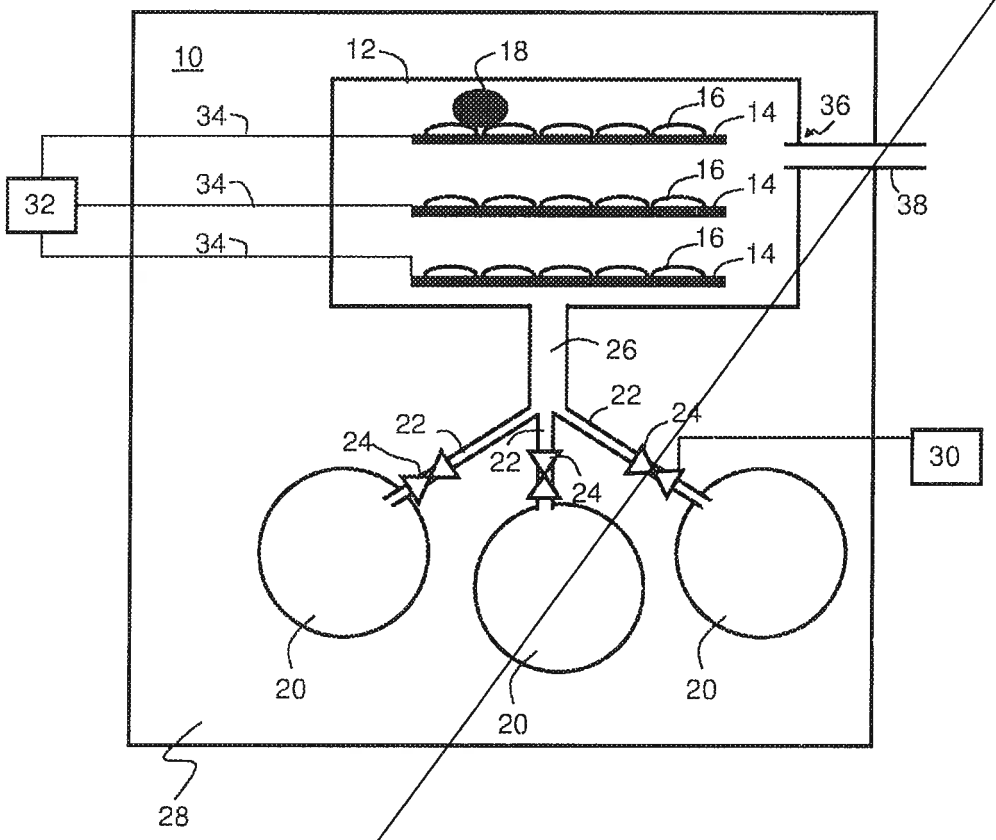


FIG. 9A

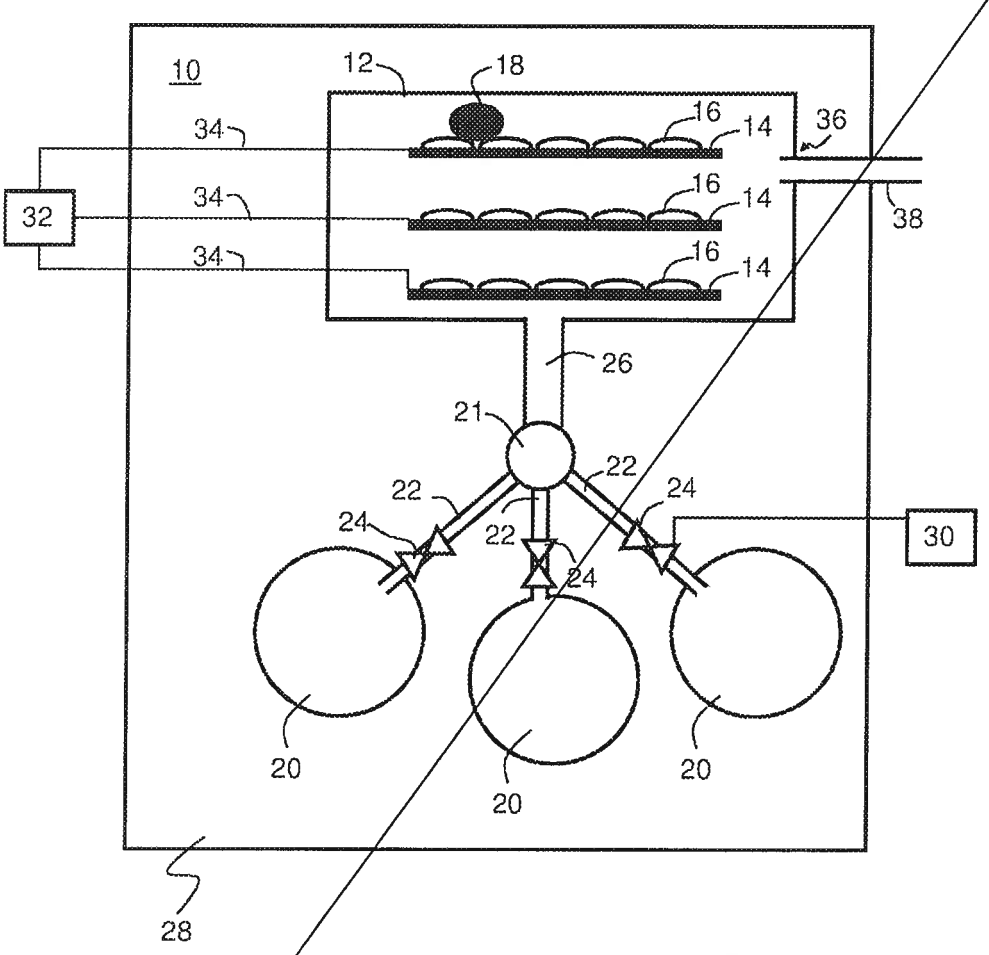


FIG. 9B

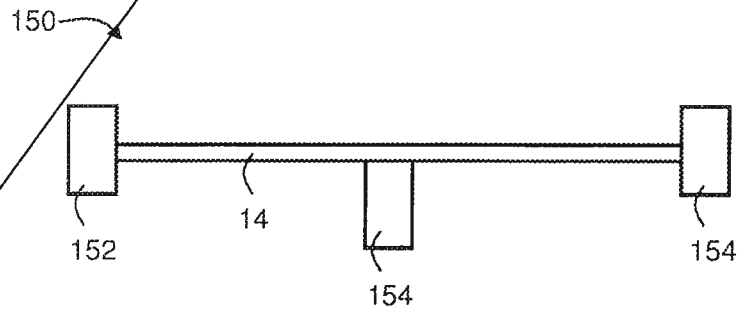


FIG. 10

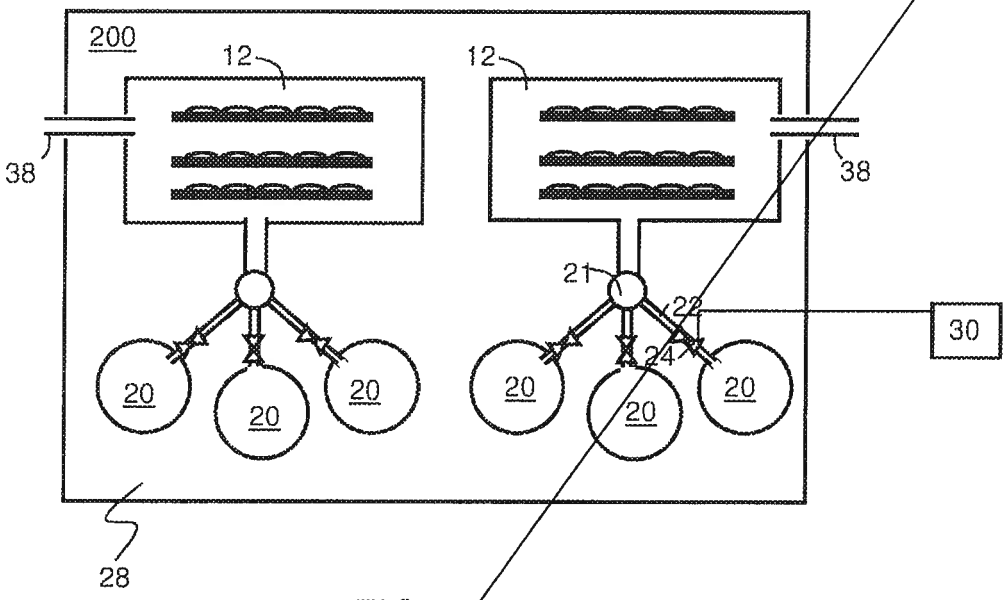


FIG. 11A

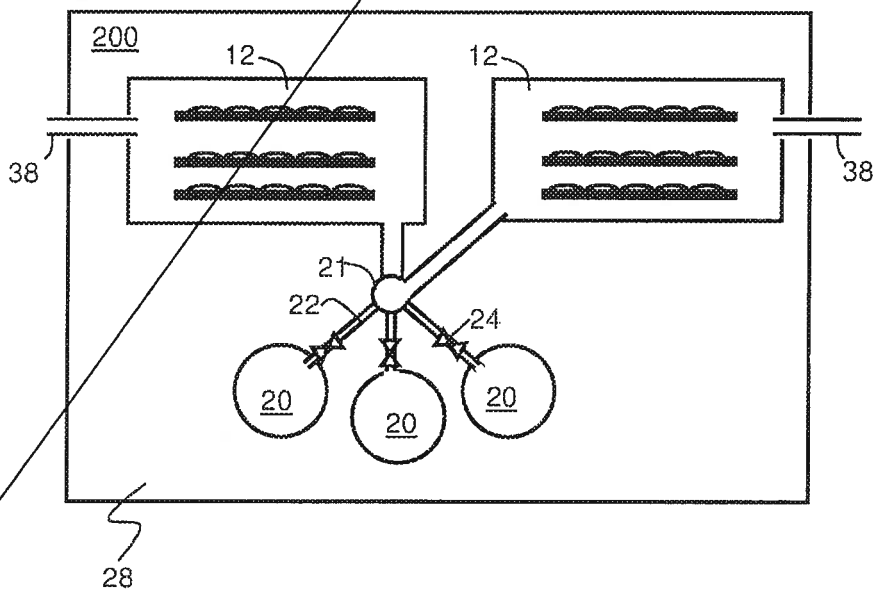


FIG. 11B

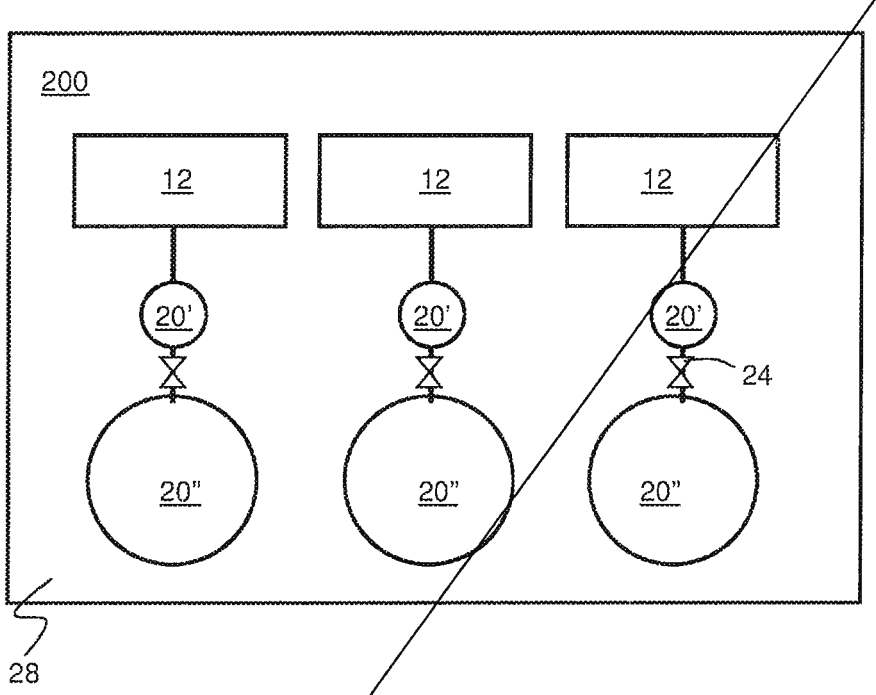


FIG. 11C