FIG. 1

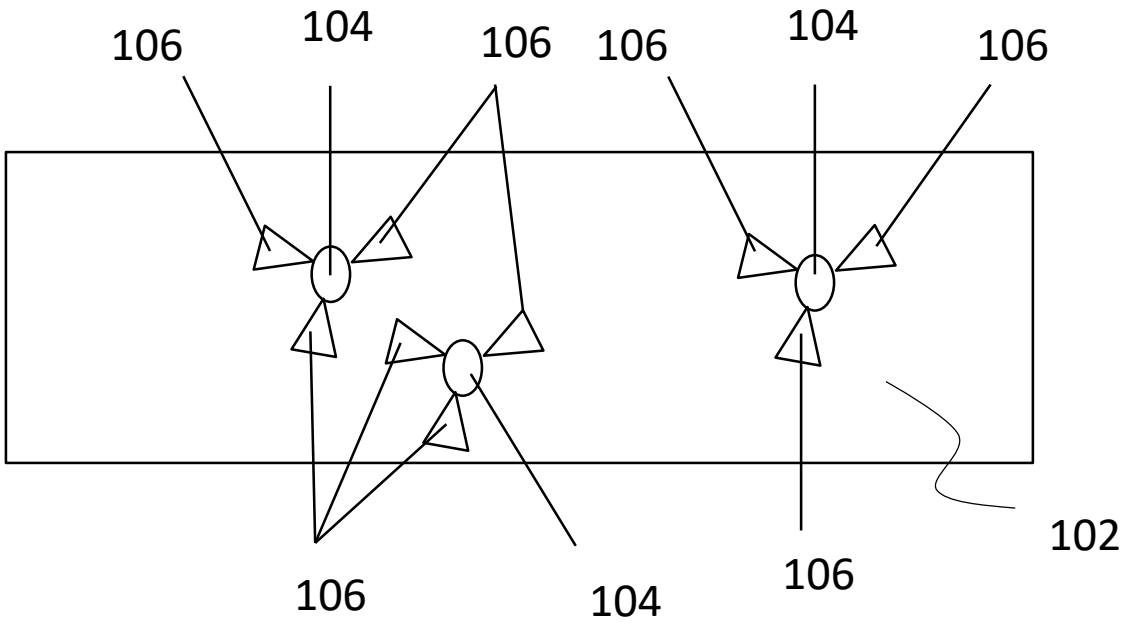


FIG. 2

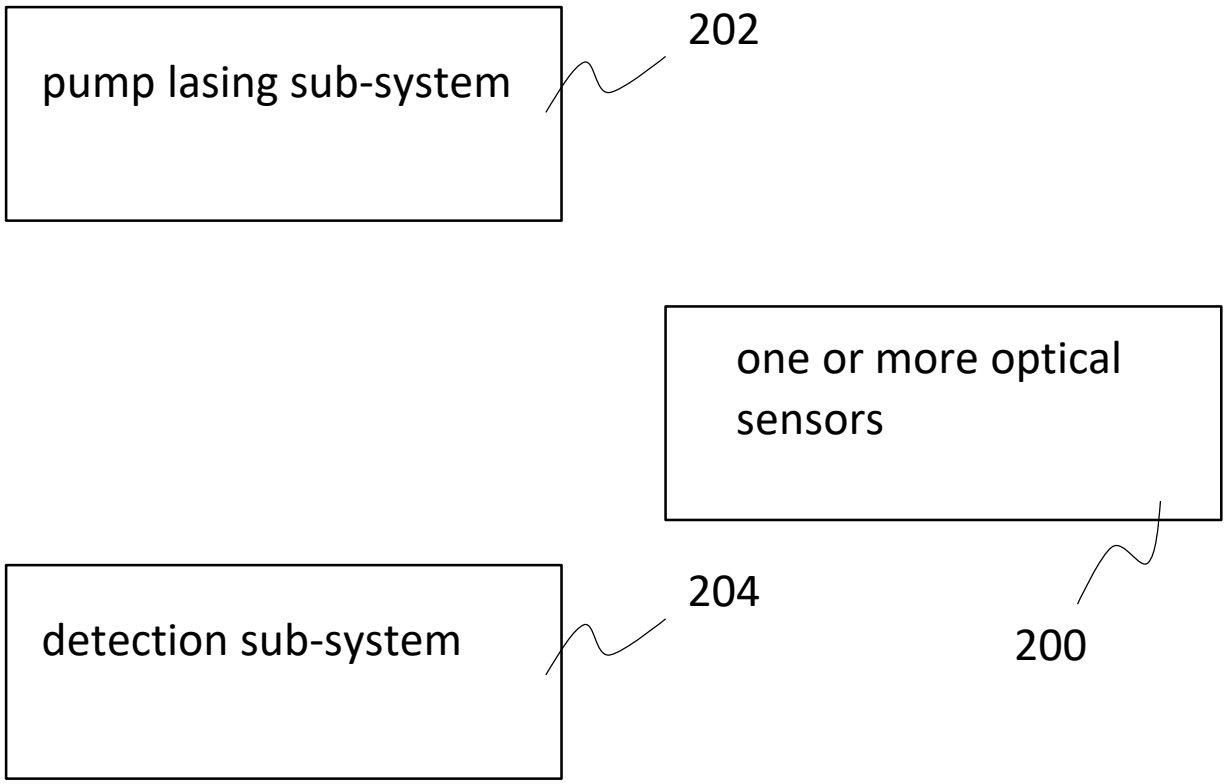

pump lasing sub-system
202
one or more optical sensors
detection sub-system
204
200

FIG. 3

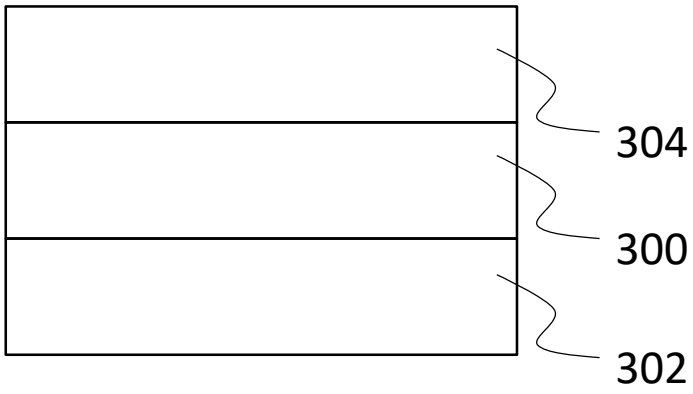


FIG. 4

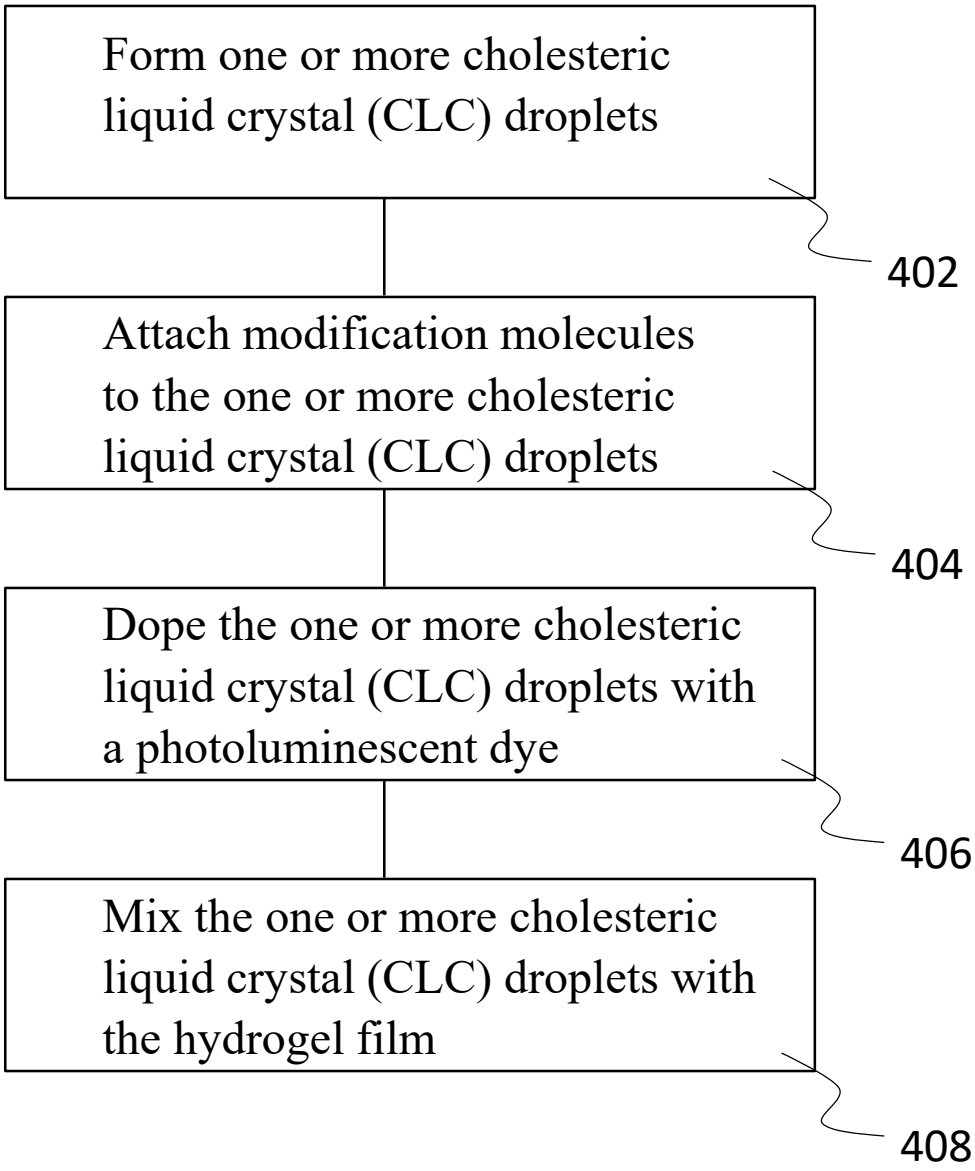

Form one or more cholesteric liquid crystal (CLC) droplets
402
Attach modification molecules to the one or more cholesteric liquid crystal (CLC) droplets
404
Dope the one or more cholesteric liquid crystal (CLC) droplets with a photoluminescent dye
406
Mix the one or more cholesteric liquid crystal (CLC) droplets with the hydrogel film
408

FIG. 5

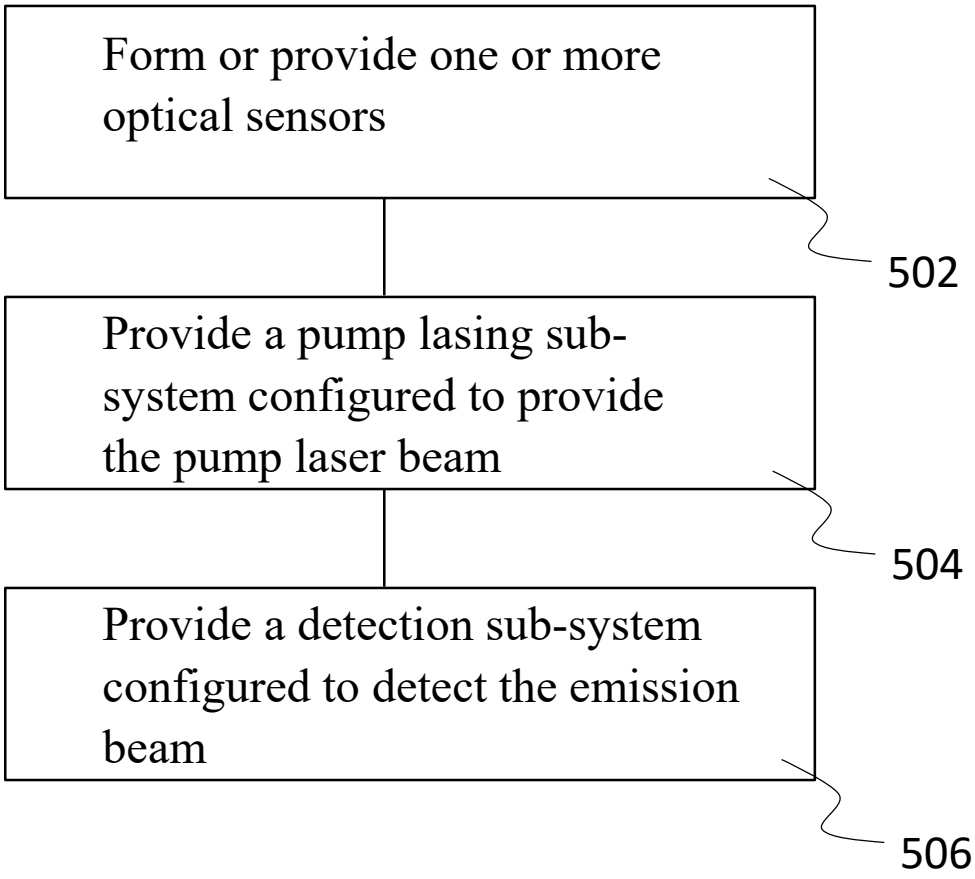

Form or provide one or more optical sensors
502
Provide a pump lasing sub-system configured to provide the pump laser beam
504
Provide a detection sub-system configured to detect the emission beam
506

FIG. 6

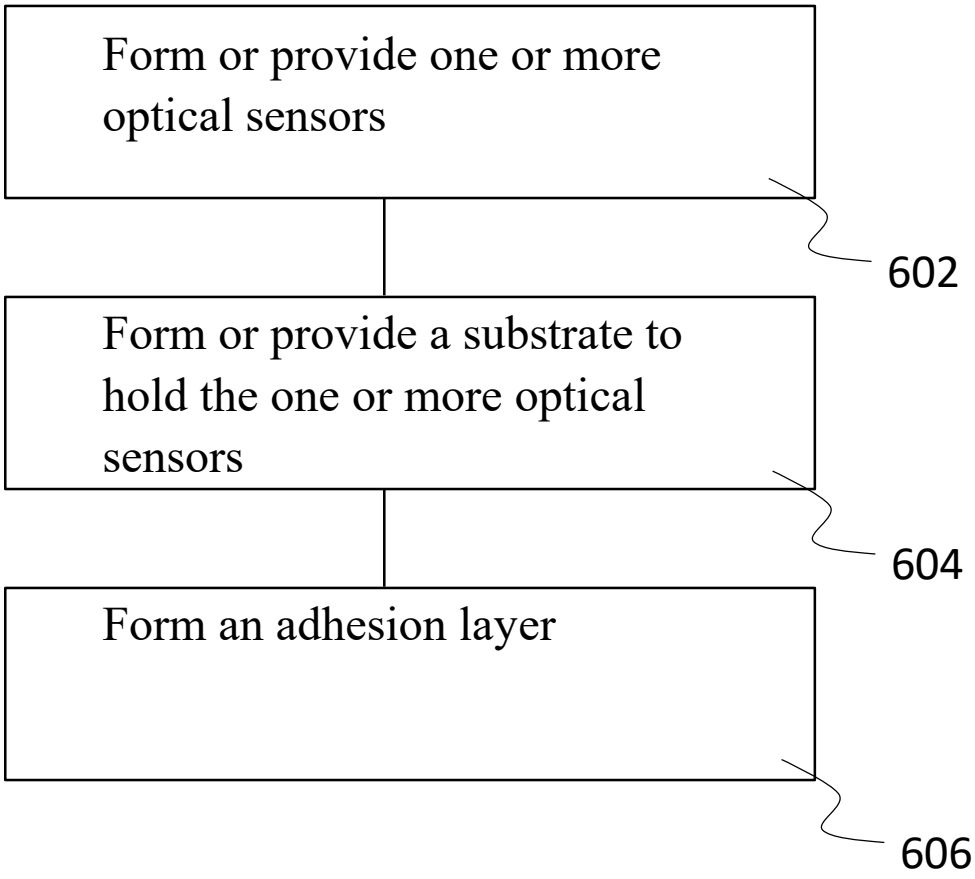

Form or provide one or more optical sensors
602
Form or provide a substrate to hold the one or more optical sensors
604
Form an adhesion layer
606

FIG. 7A

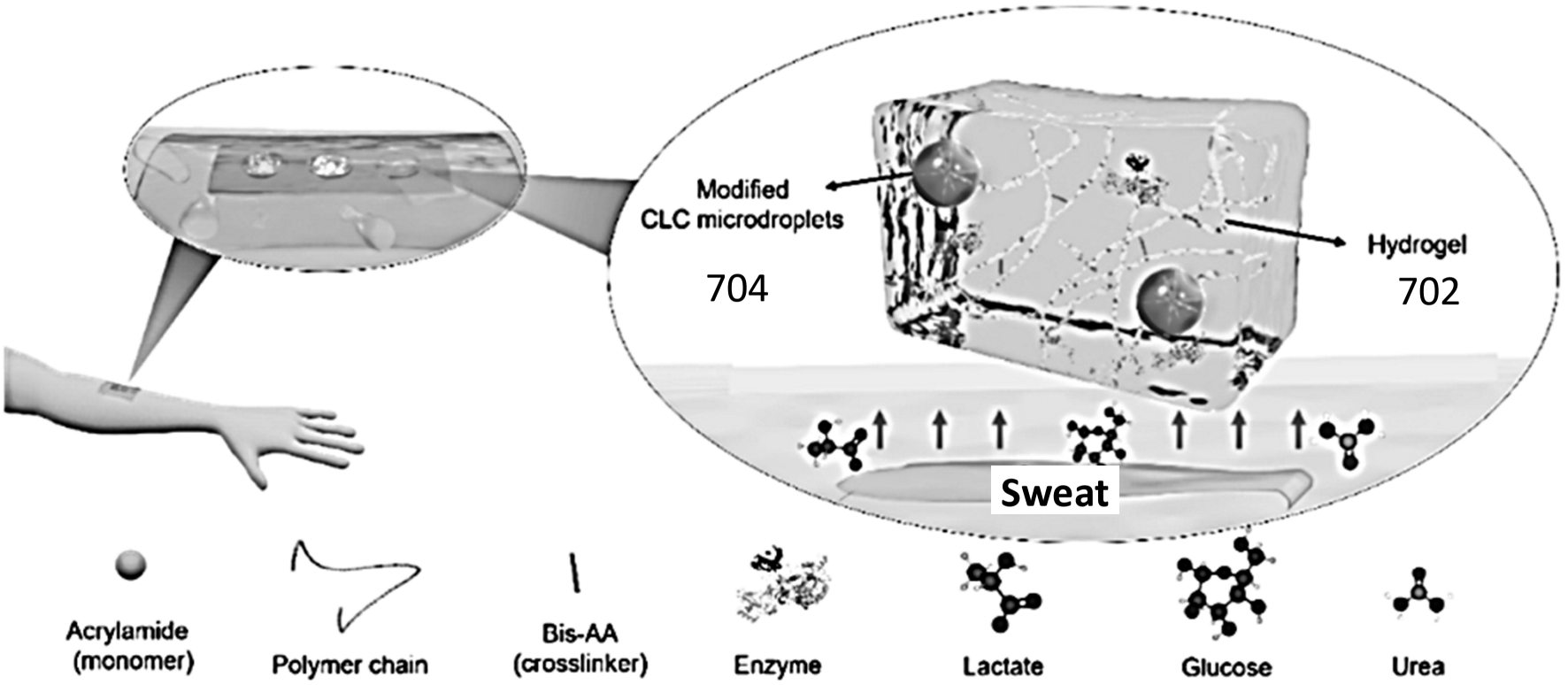

Modified
CLC microdroplets
704
Hydrogel
702
Sweat
Acrylamide
(monomer)
Polymer chain
Bis-AA
(crosslinker)
Enzyme
Lactate
Glucose
Urea

FIG. 7B

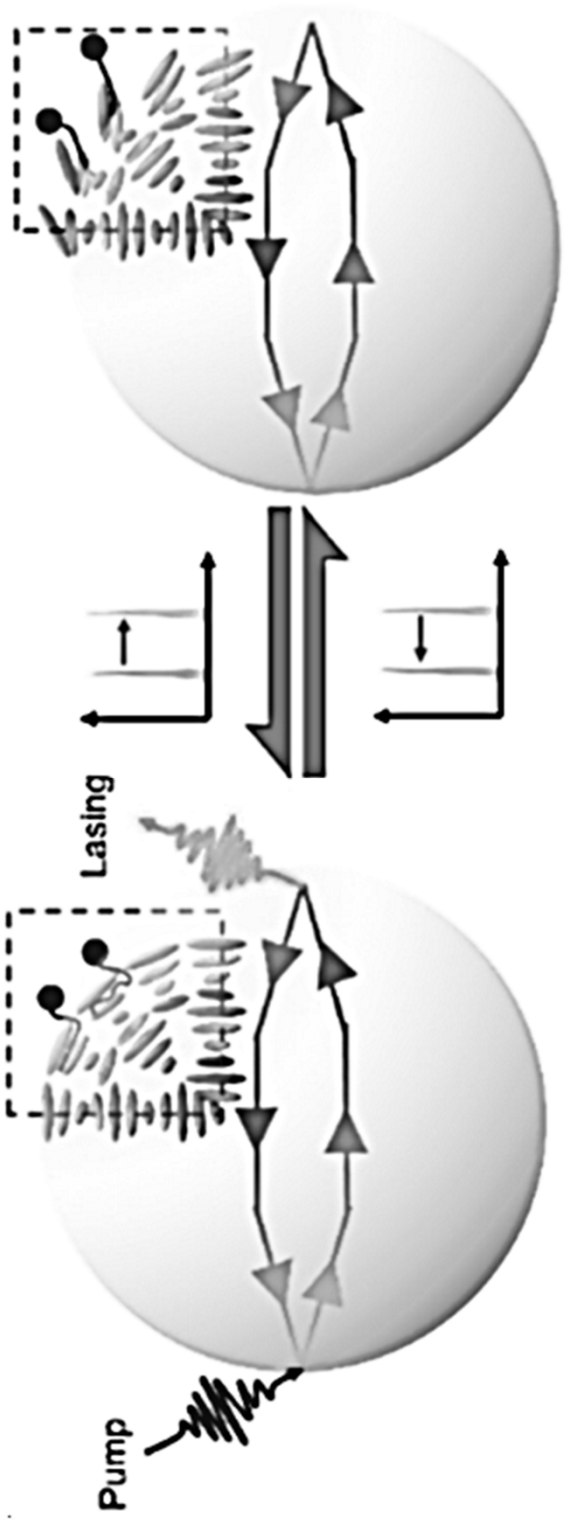


FIG. 7C

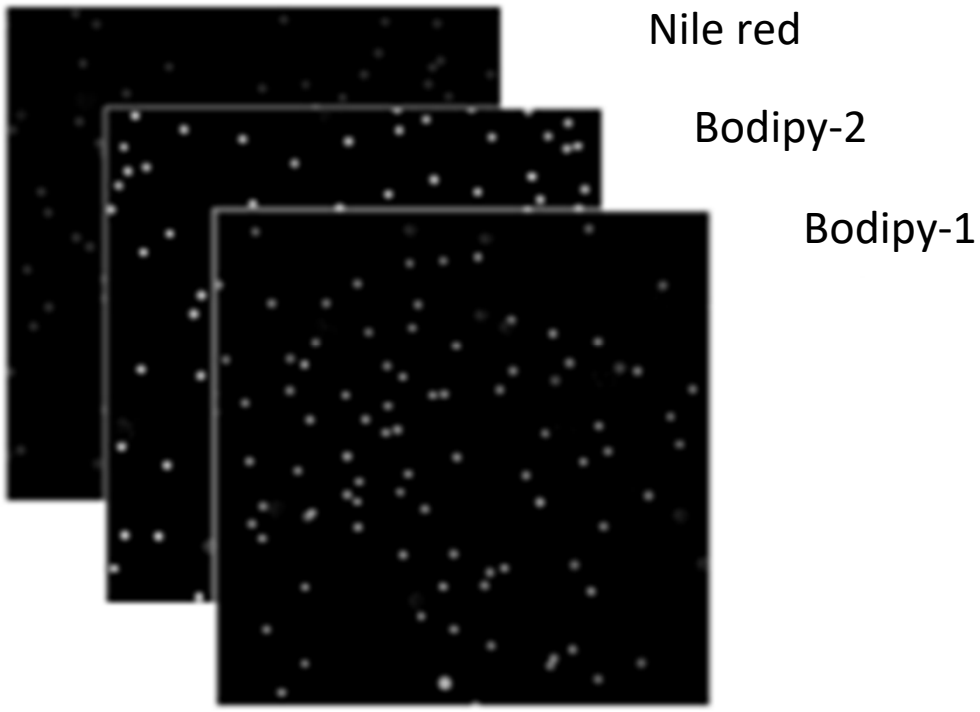
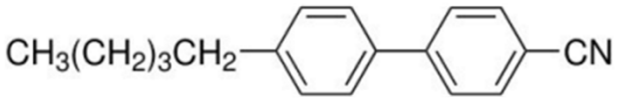
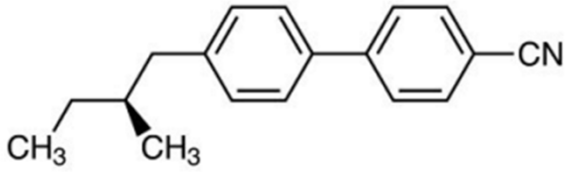


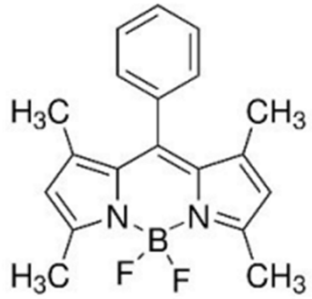
FIG. 7D



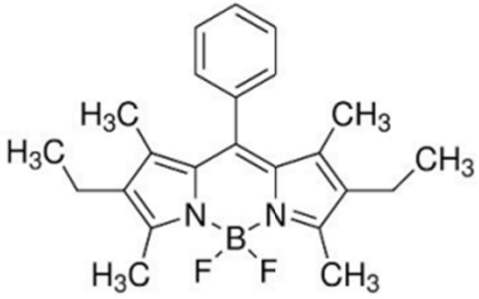
4'-Pentyl-4-biphenylcarbonitrile (5CB)



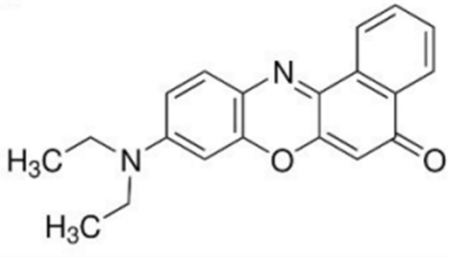
(S)-4-Cyano-4'-(2-methylbutyl)biphenyl (Chiral dopant)



1,3,5,7-Tetramethyl-8-phenyl-4,4-difluoroboradiazaindacene (Bodipy-1)



2,8-Diethyl-1,3,5,7-tetramethyl-9-phenylbipyrromethene difluoroborate (Bodipy-2)



Nile red

FIG. 7E

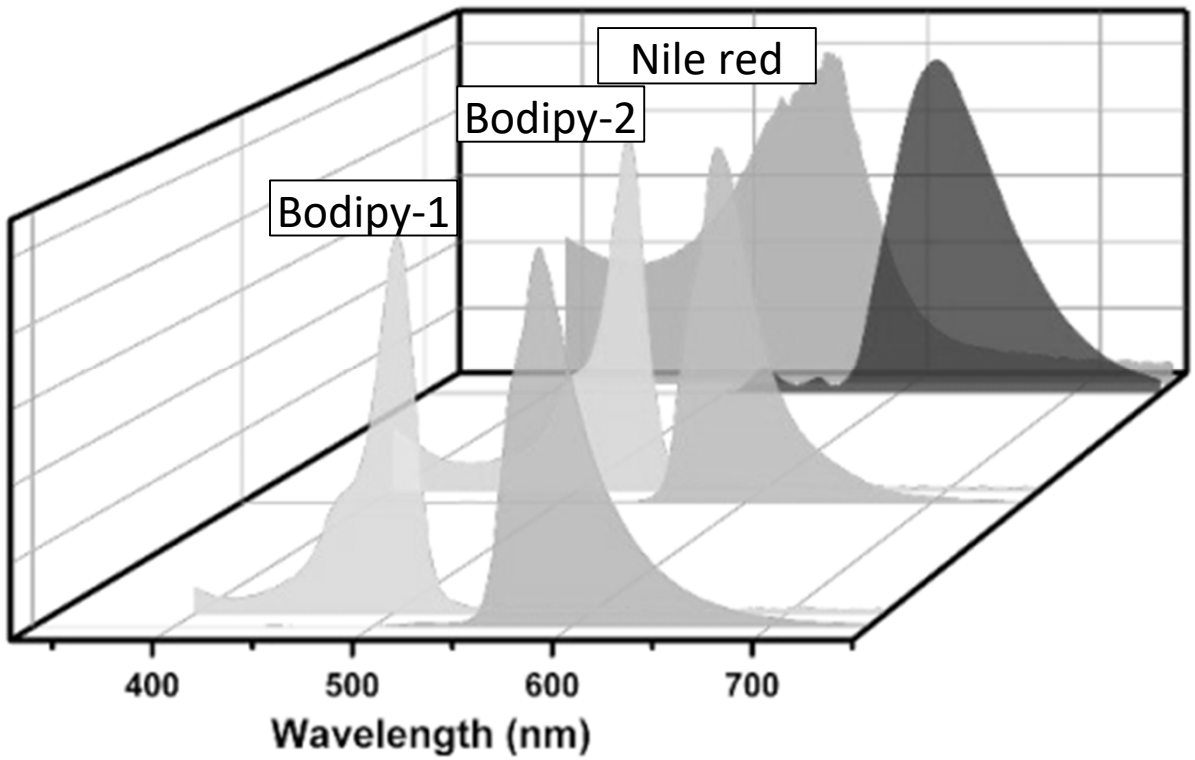


FIG. 8A

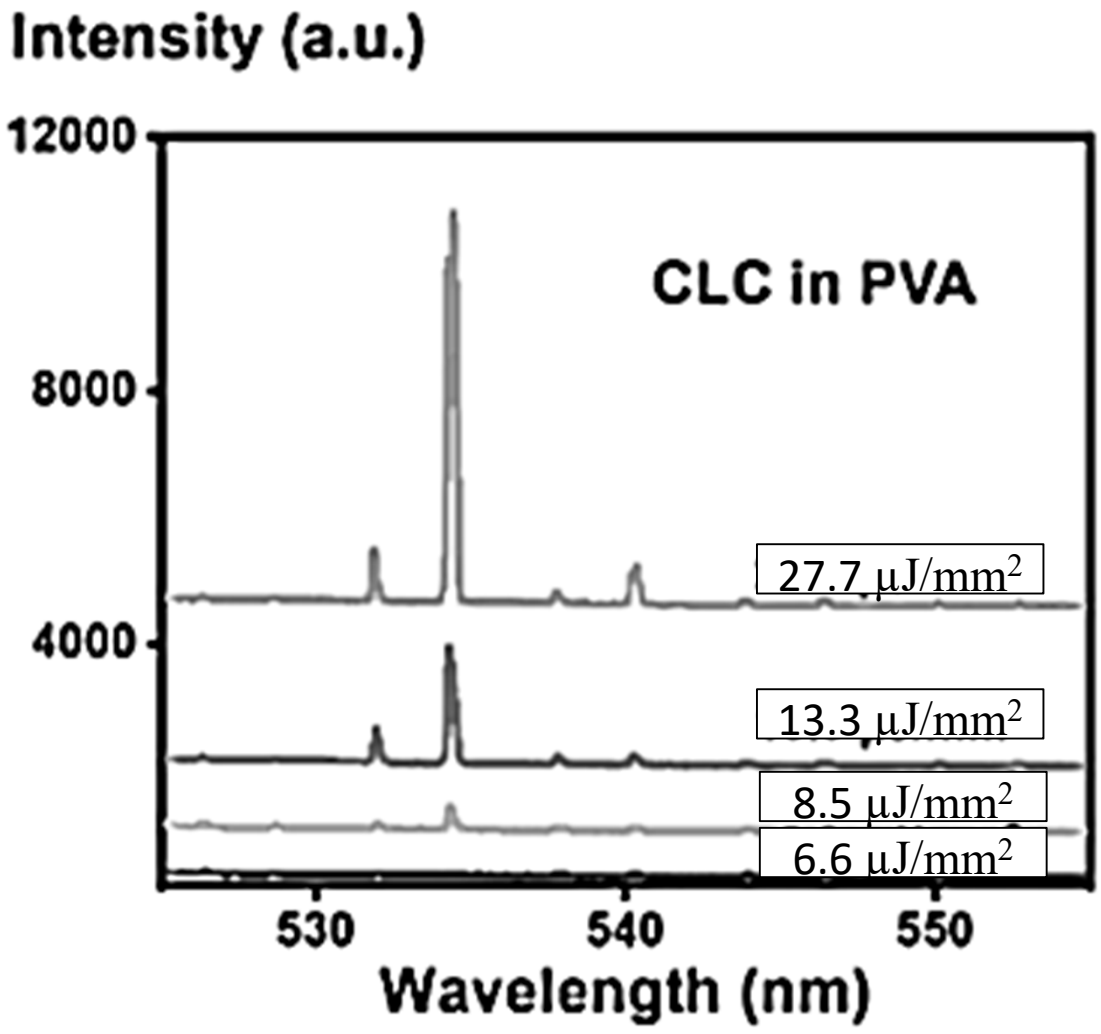

Intensity (a.u.)
12000
8000
4000
CLC in PVA
27.7 μJ/mm2
13.3 μJ/mm2
8.5 μJ/mm2
6.6 μJ/mm2
530
540
550
Wavelength (nm)

FIG. 8B

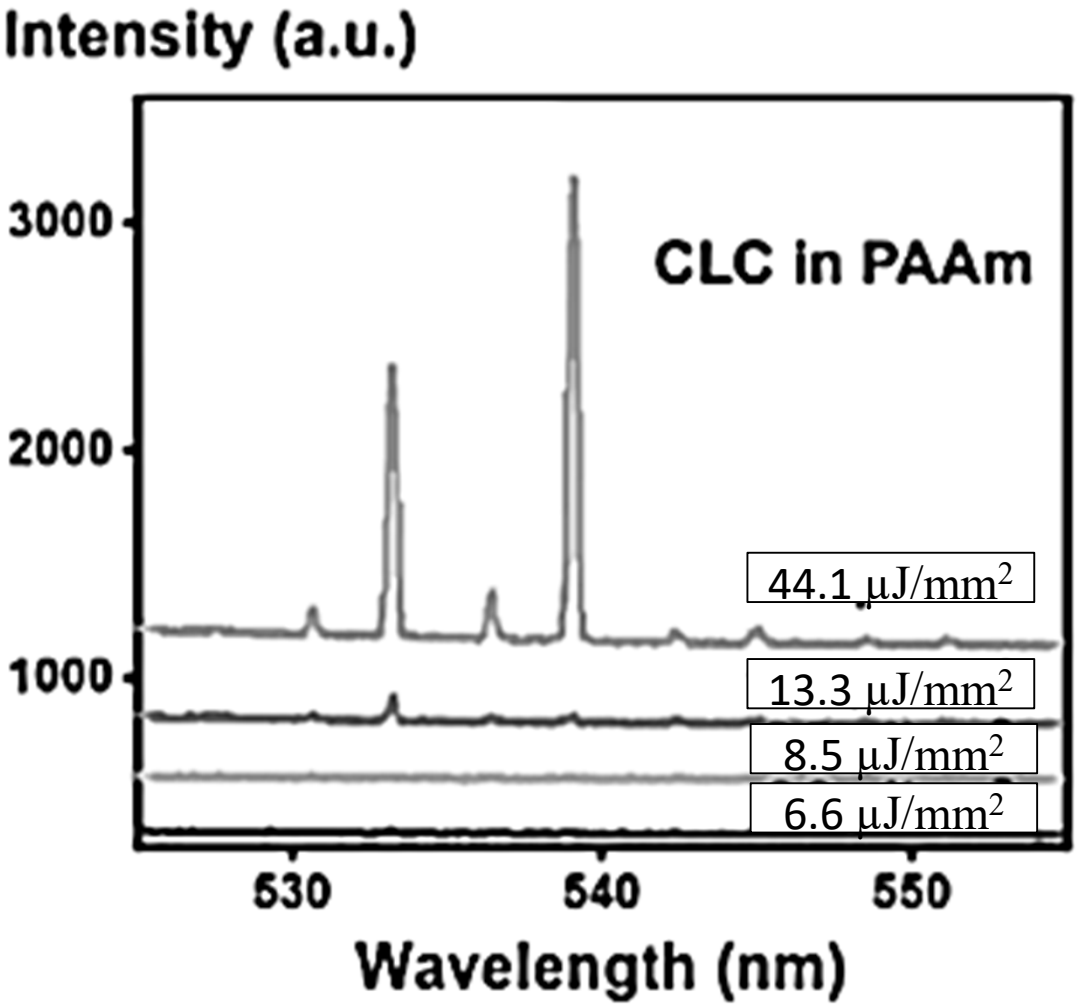

Intensity (a.u.)
3000
2000
1000
CLC in PAAm
44.1 μJ/mm2
13.3 μJ/mm2
8.5 μJ/mm2
6.6 μJ/mm2
530
540
550
Wavelength (nm)

FIG. 8C

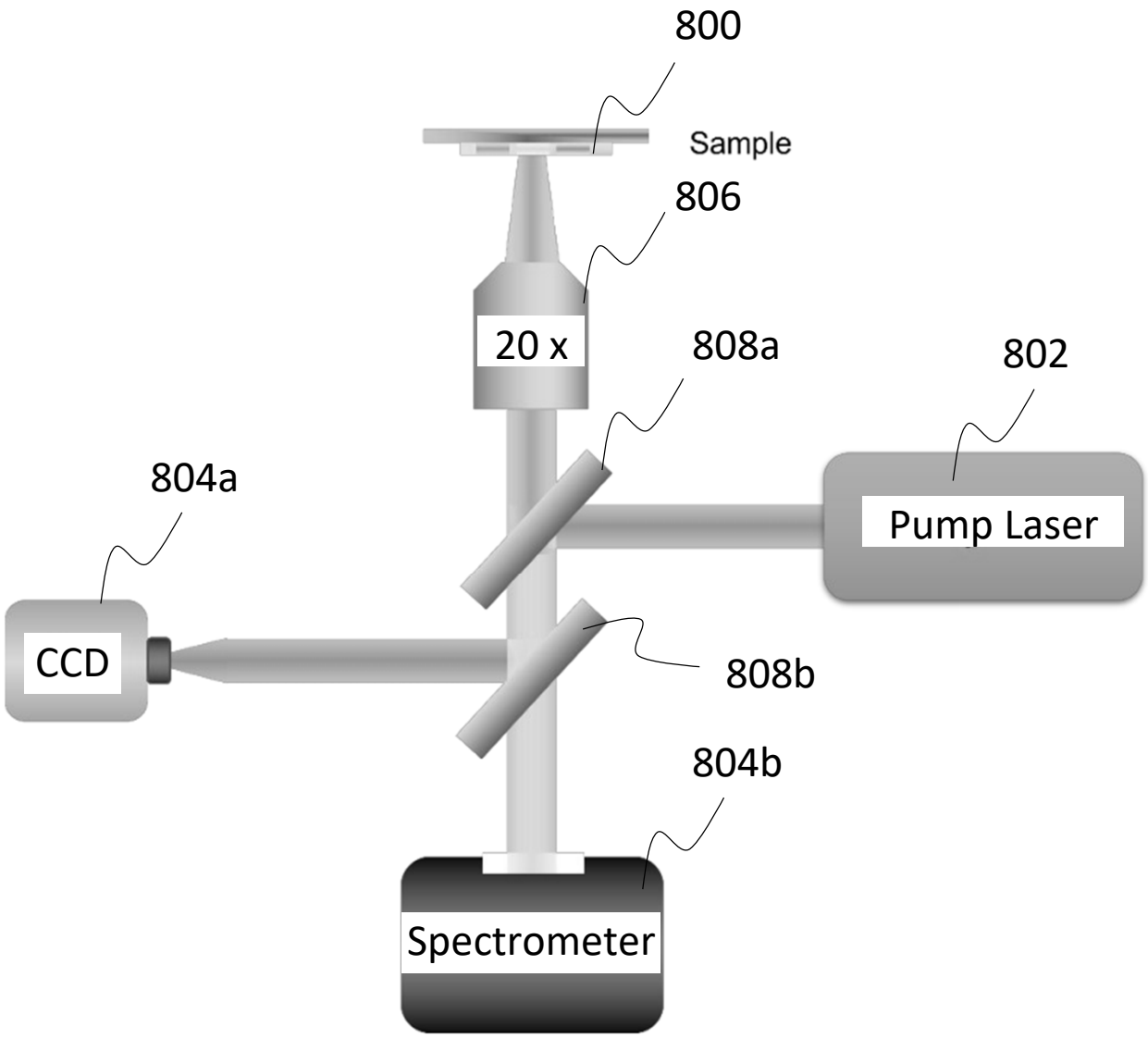

800
Sample
806
20 x
808a
802
804a
Pump Laser
CCD
808b
804b
Spectrometer

FIG. 8D

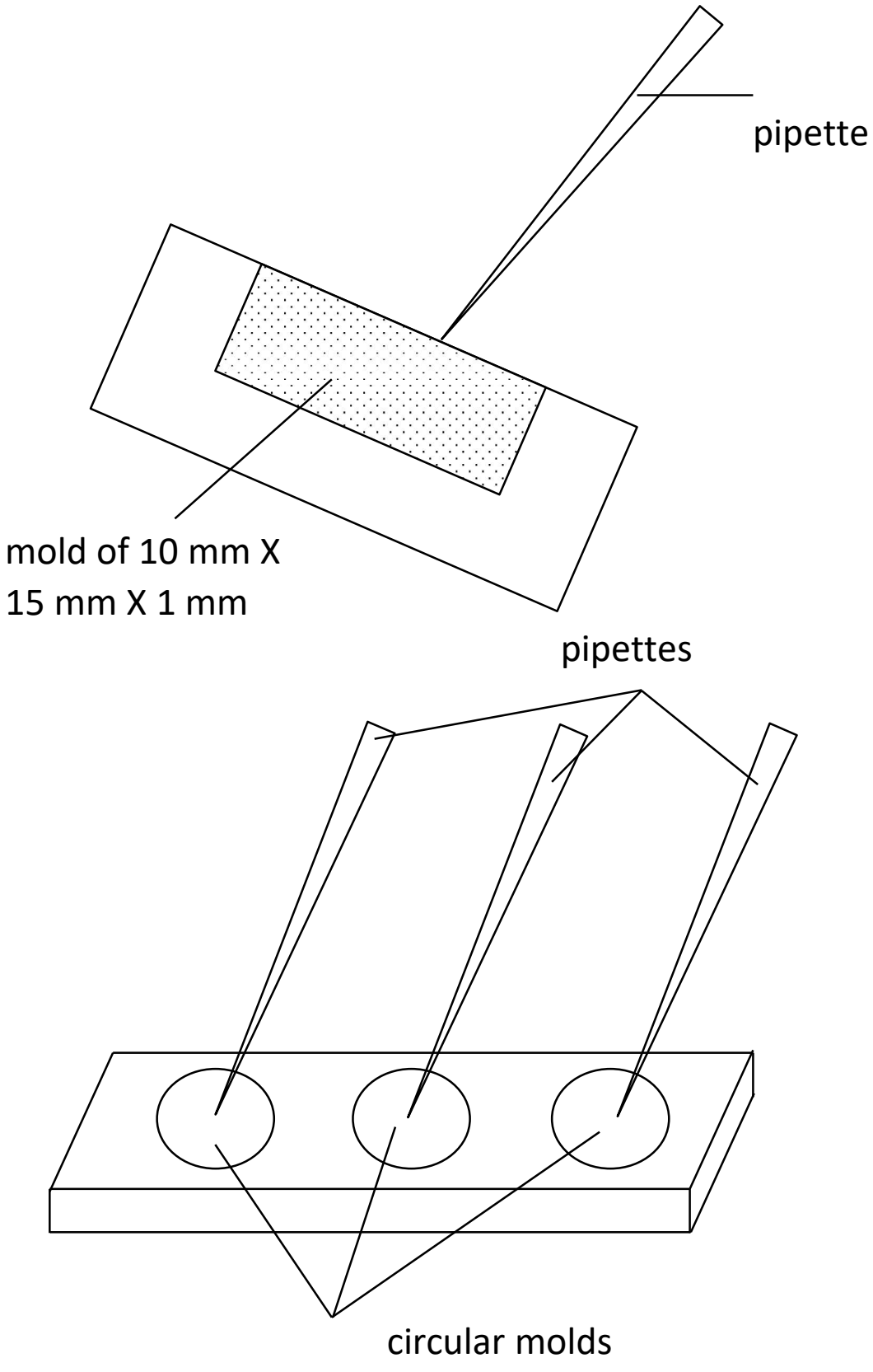


FIG. 8E

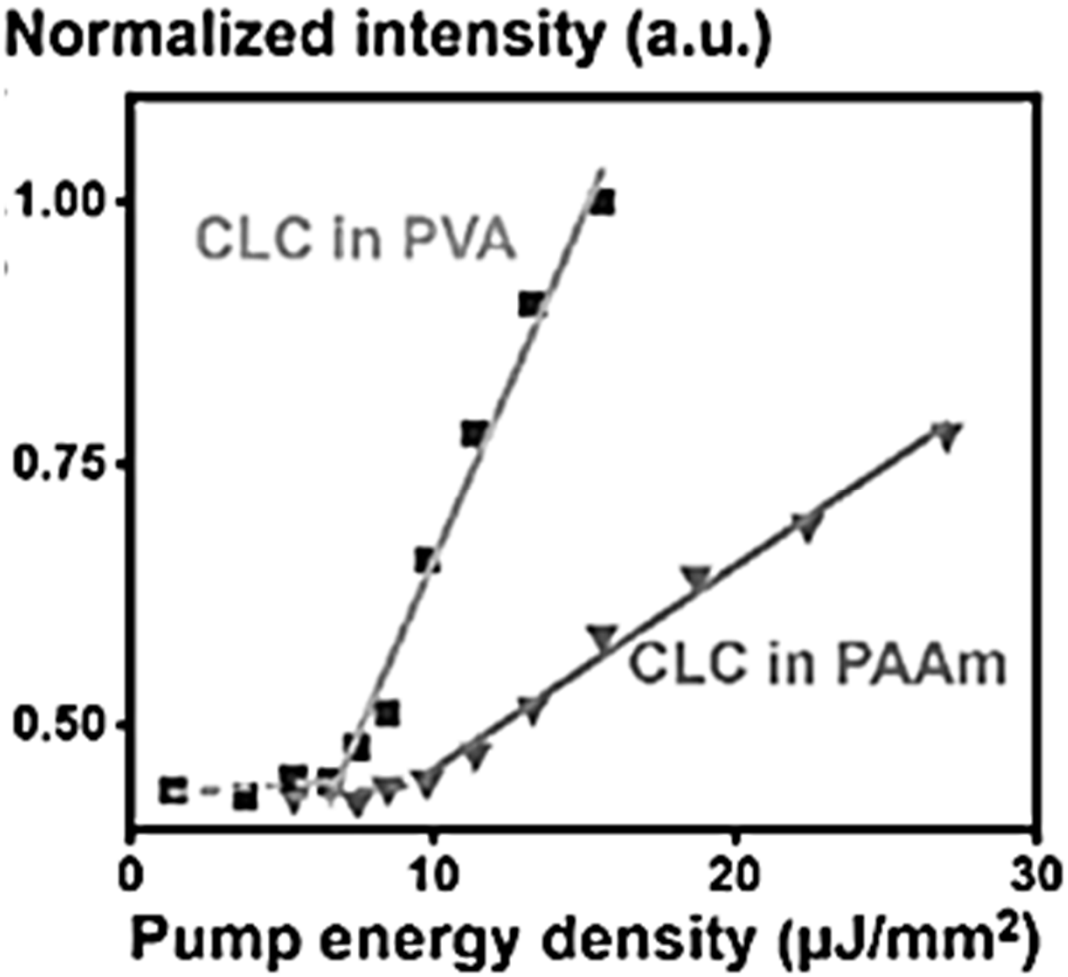

Normalized intensity (a.u.)
1.00
0.75
0.50
CLC in PVA
CLC in PAAm
0
10
20
30
Pump energy density (μJ/mm²)

FIG. 8F

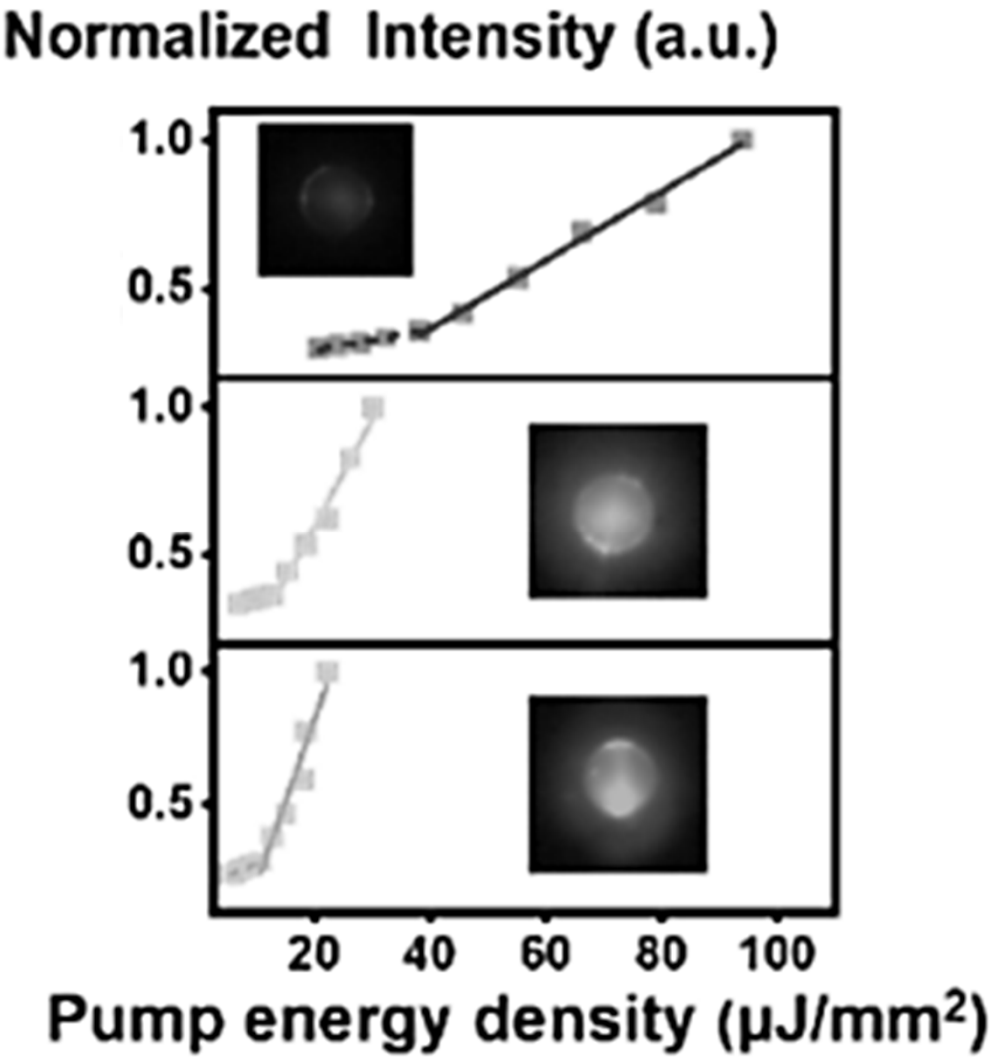
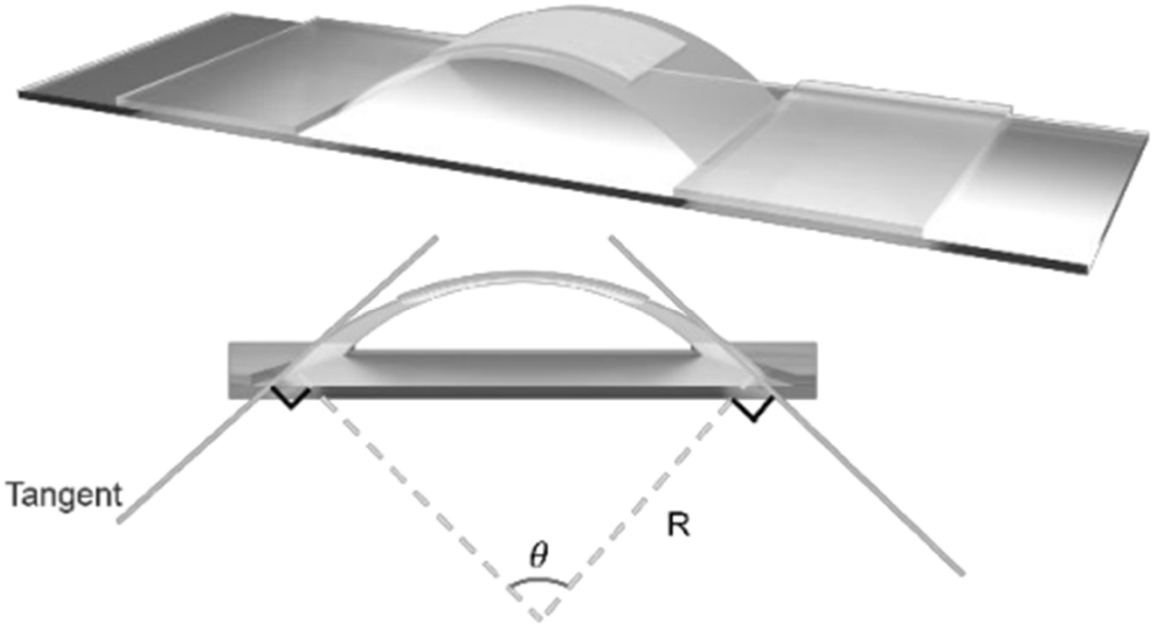

Normalized Intensity (a.u.)
1.0
0.5
1.0
0.5
1.0
0.5
20
40
60
80
100
Pump energy density (μJ/mm²)

FIG. 8G



Bending stress: $\sigma = -\frac{My}{I}$ (Units: Pa or MPa)

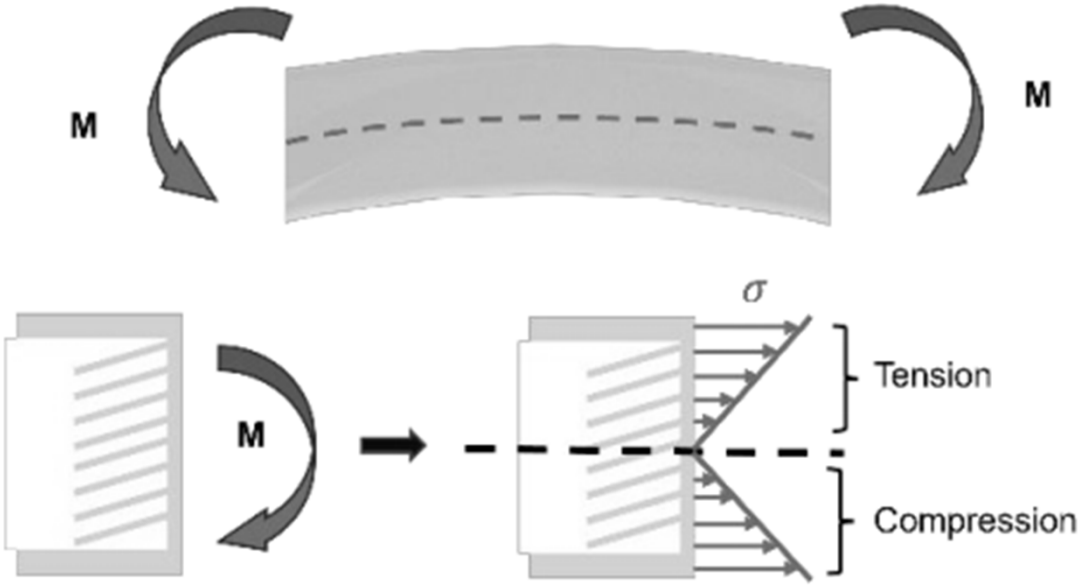
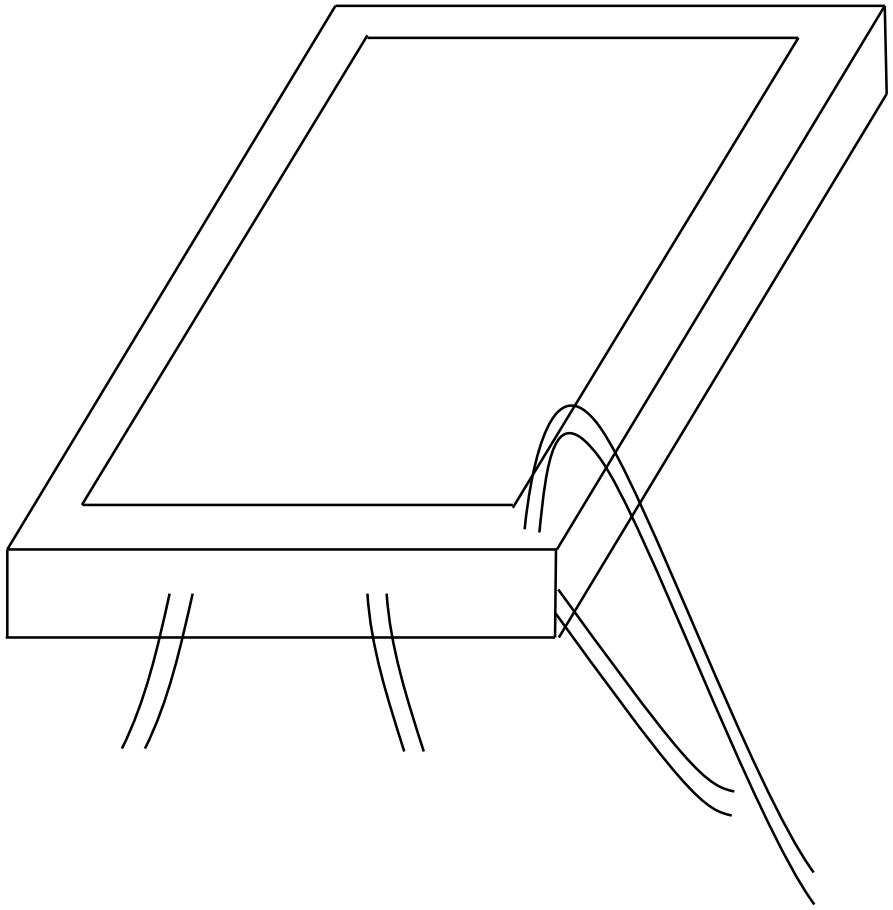


FIG. 8H

Incubator



Temperature Stability Test

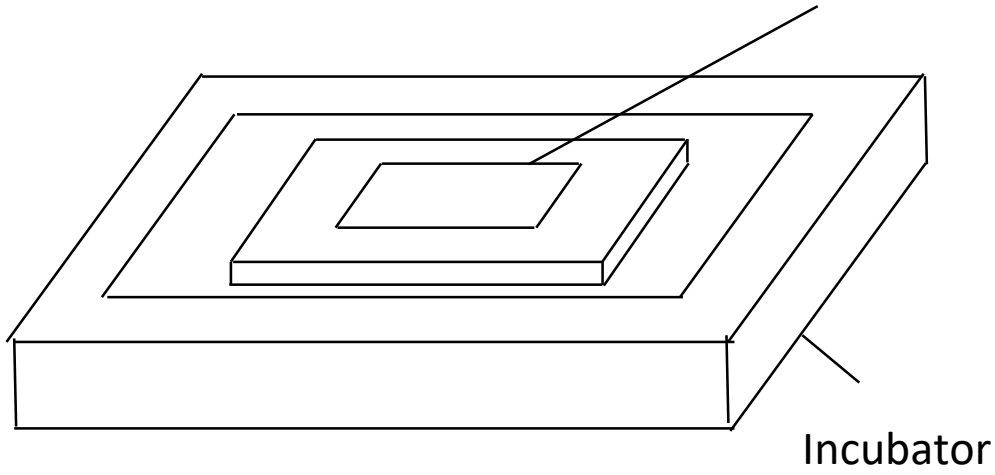


FIG. 8I

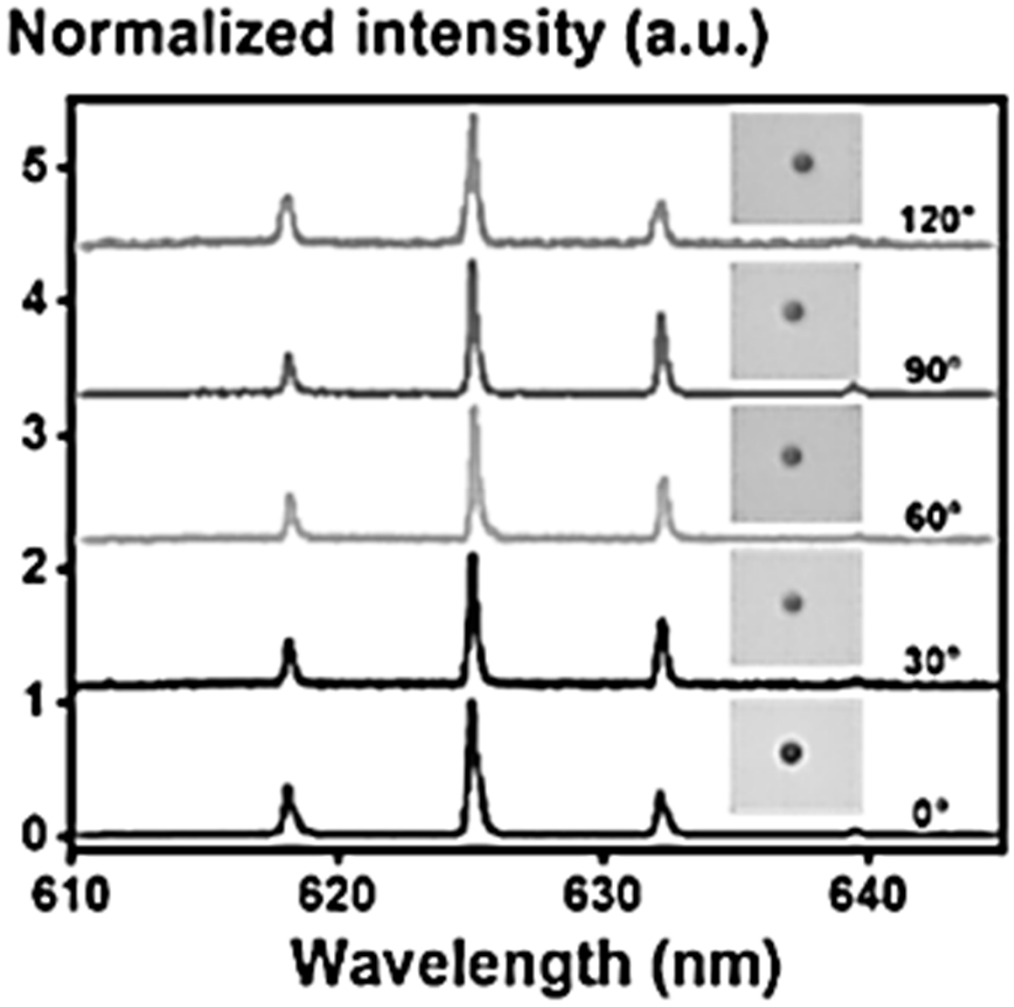

Normalized intensity (a.u.)
5
4
3
2
1
0
120°
90°
60°
30°
0°
610
620
630
640
Wavelength (nm)

FIG. 8J

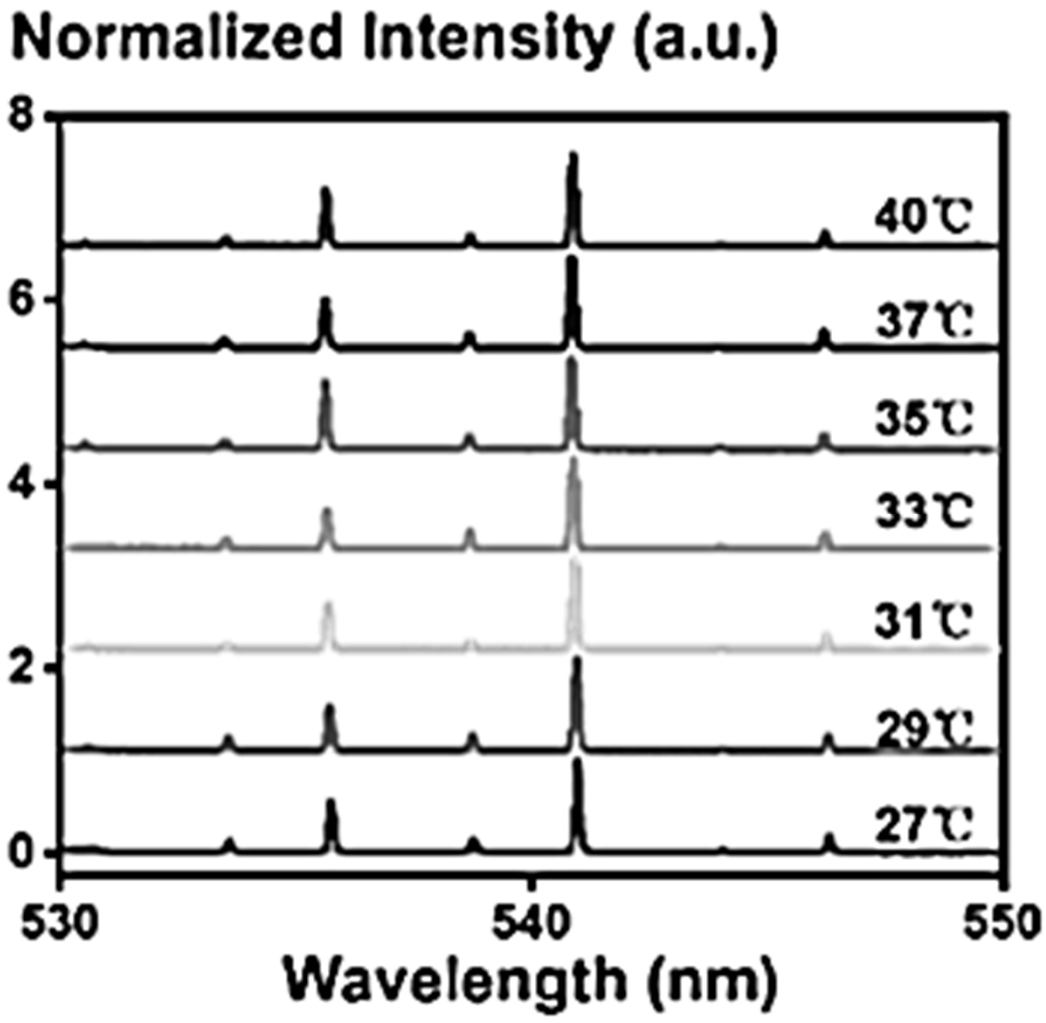

Normalized Intensity (a.u.)
8
6
4
2
0
40℃
37℃
35℃
33℃
31℃
29℃
27℃
530
540
550
Wavelength (nm)

FIG. 9A

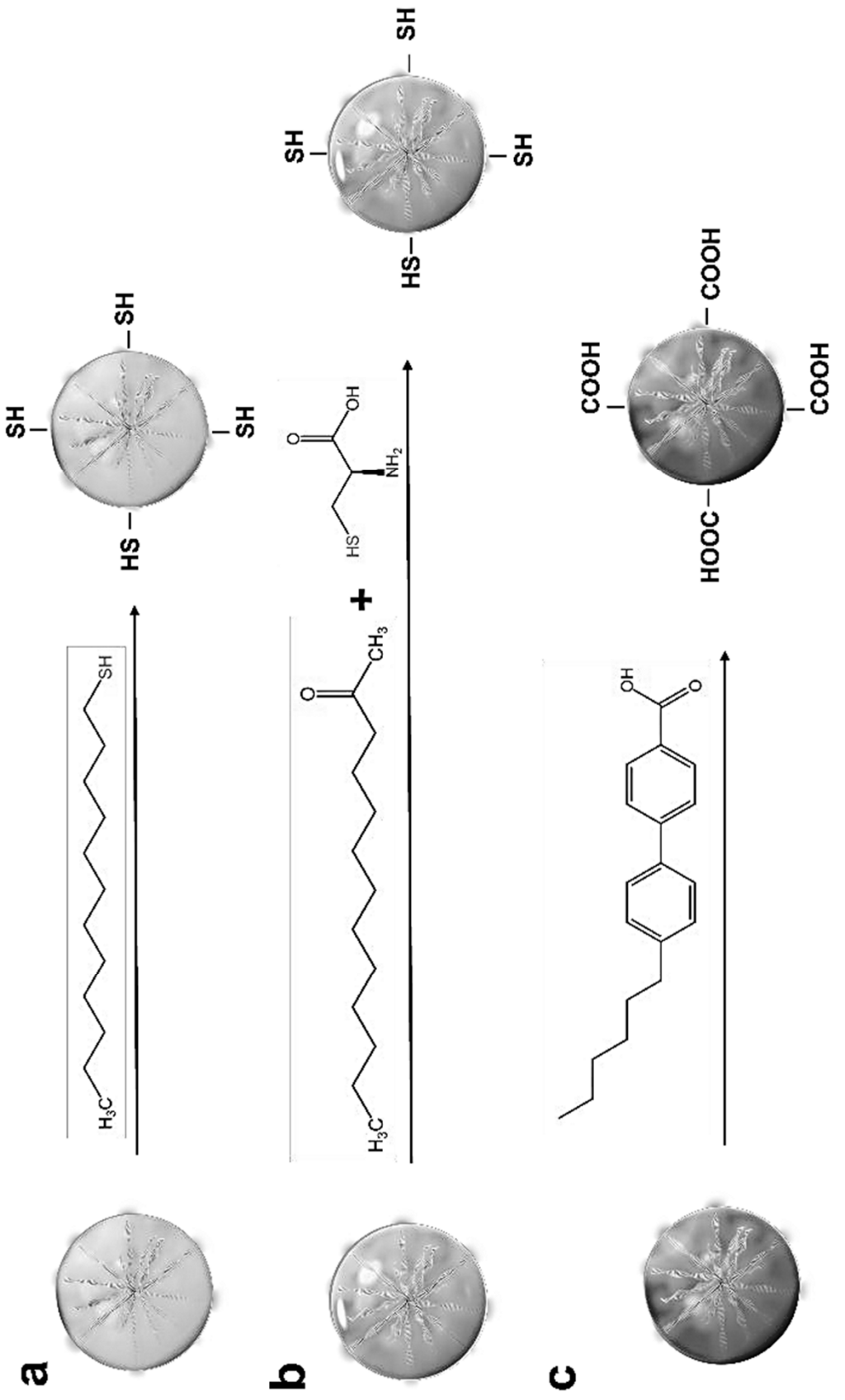

a
SH
SH
SH
HS
SH
H3C
b
SH
SH
SH
HS
OH
O
NH2
HS
+
CH3
O
H3C
c
COOH
COOH
COOH
HOOC
OH
O

FIG. 9B

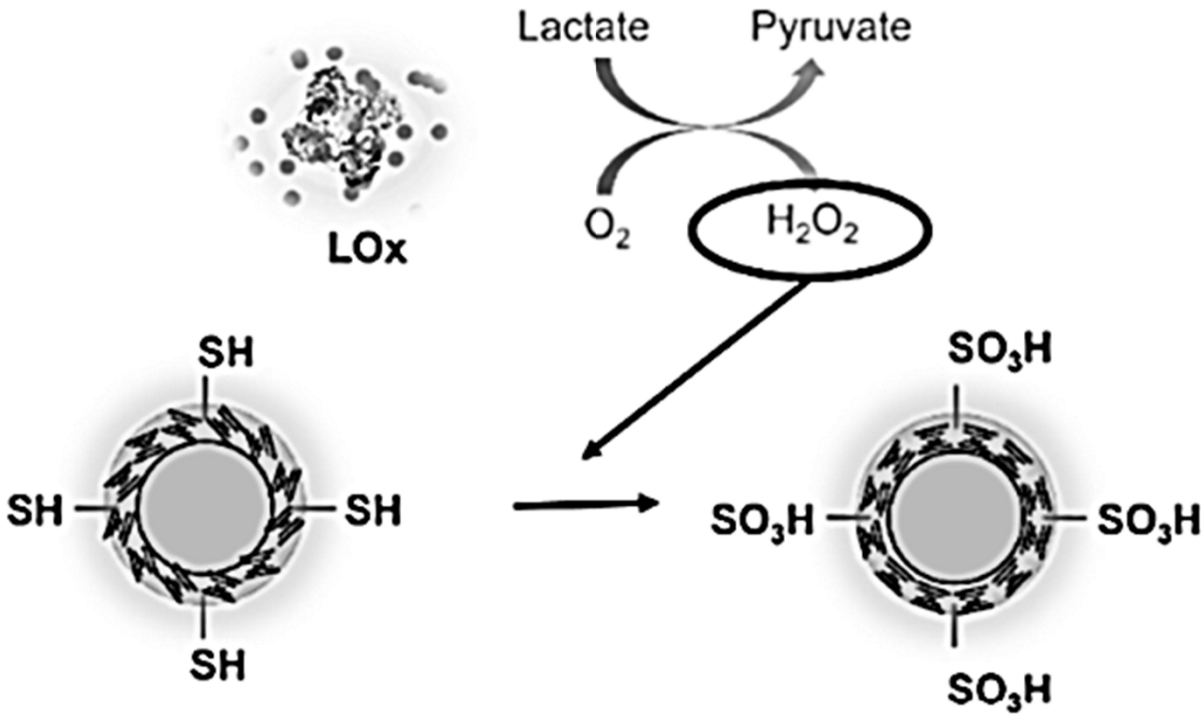


FIG. 9C

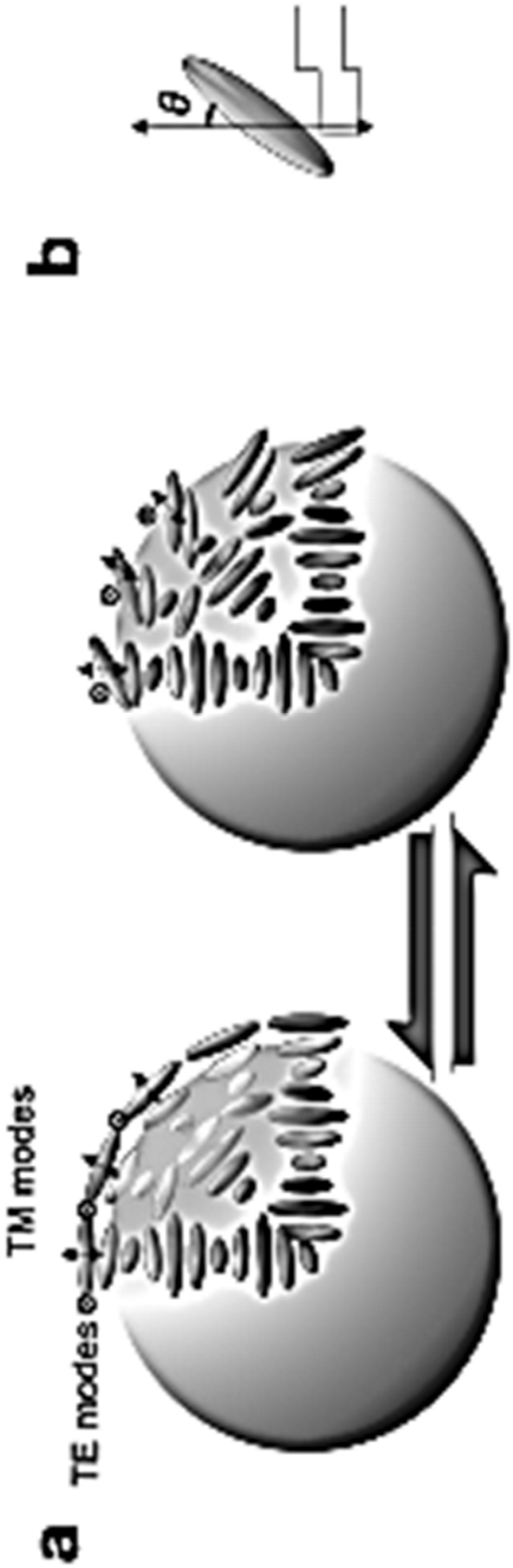


FIG. 9D

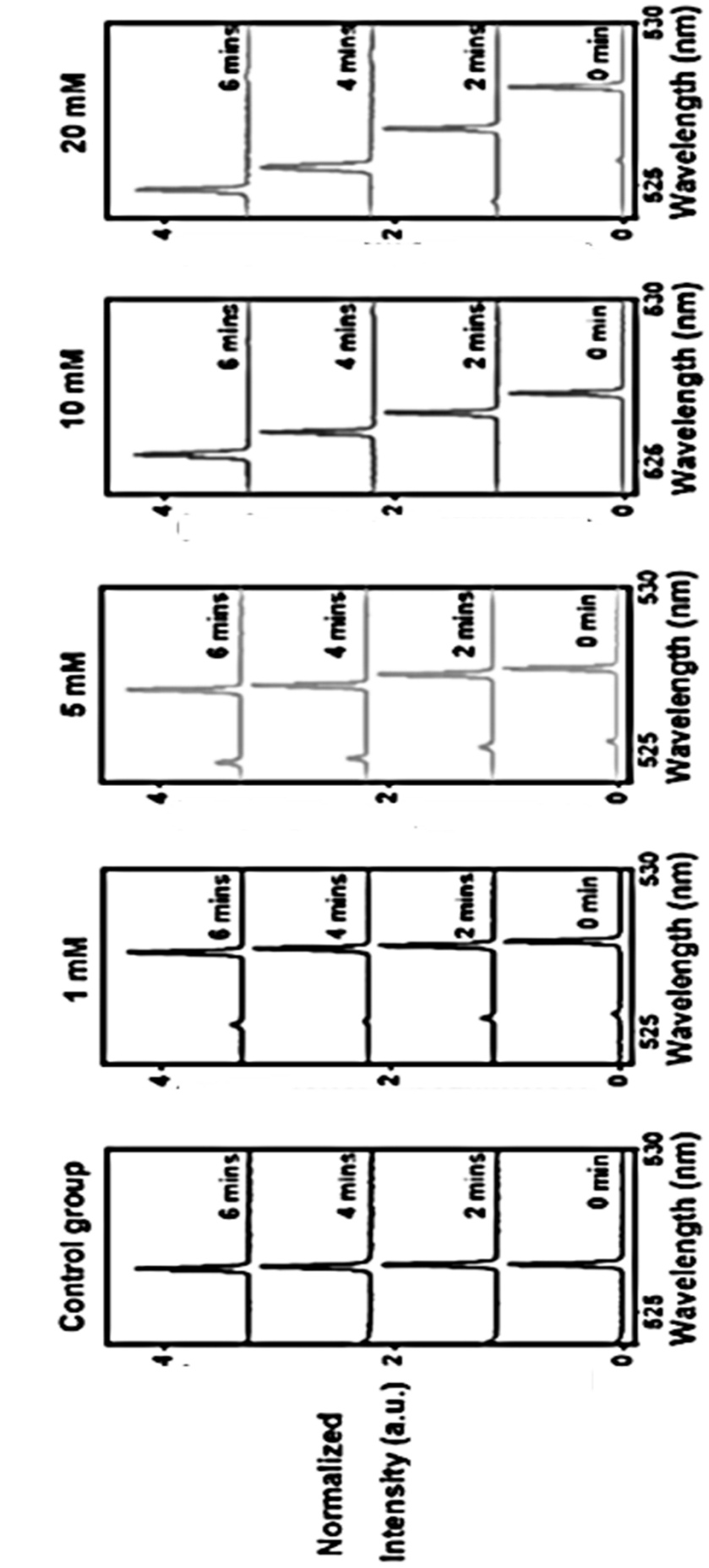

Control group
1 mM
5 mM
10 mM
20 mM
6 mins
4 mins
2 mins
0 min
Normalized Intensity (a.u.)
Wavelength (nm)
525
530
626
630

FIG. 9E

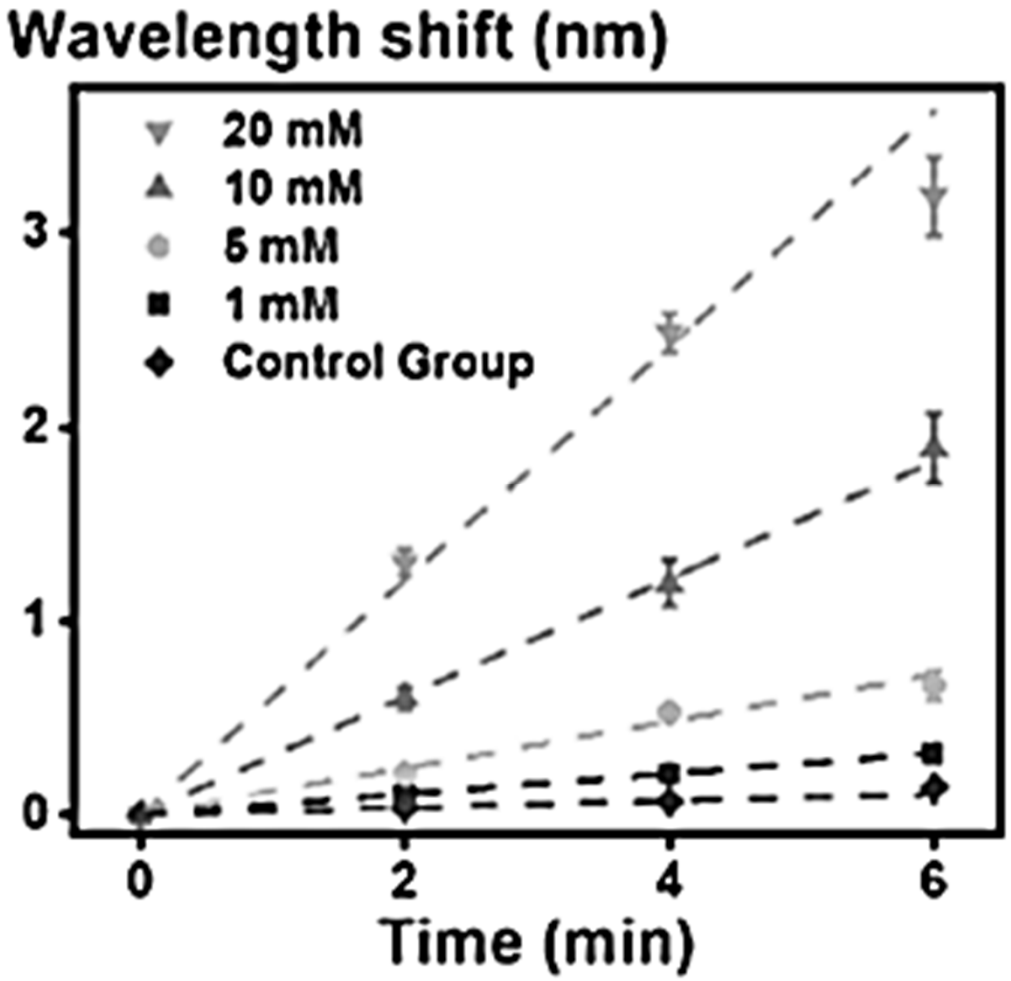

Wavelength shift (nm)
20 mM
10 mM
5 mM
1 mM
Control Group
3
2
1
0
0
2
4
6
Time (min)

FIG. 9F

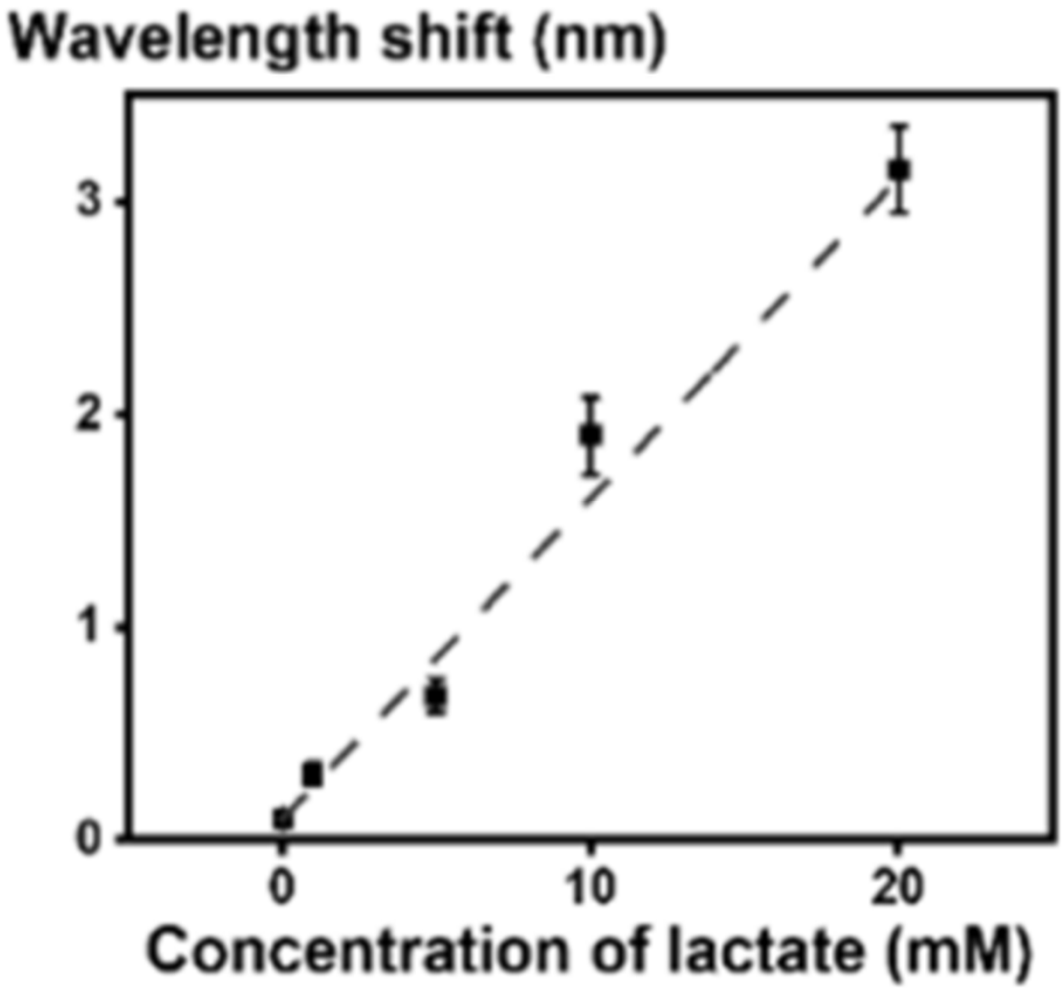

Wavelength shift (nm)
3
2
1
0
0
10
20
Concentration of lactate (mM)

FIG. 10A

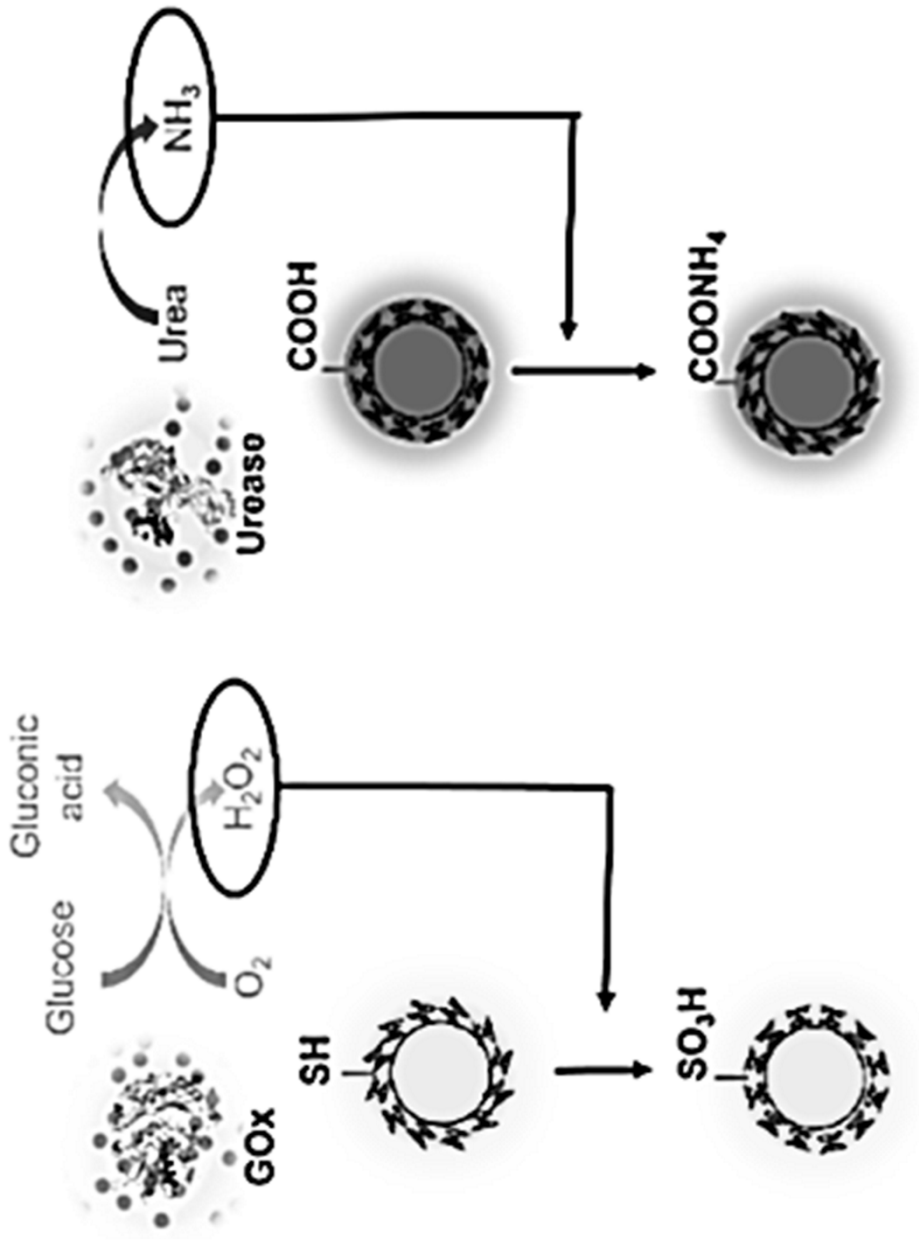

Urea
NH_3
Uroase
COOH
$COONH_4$
Gluconic acid
Glucose
O_2
H_2O_2
GOx
SH
SO_3H

FIG. 10B

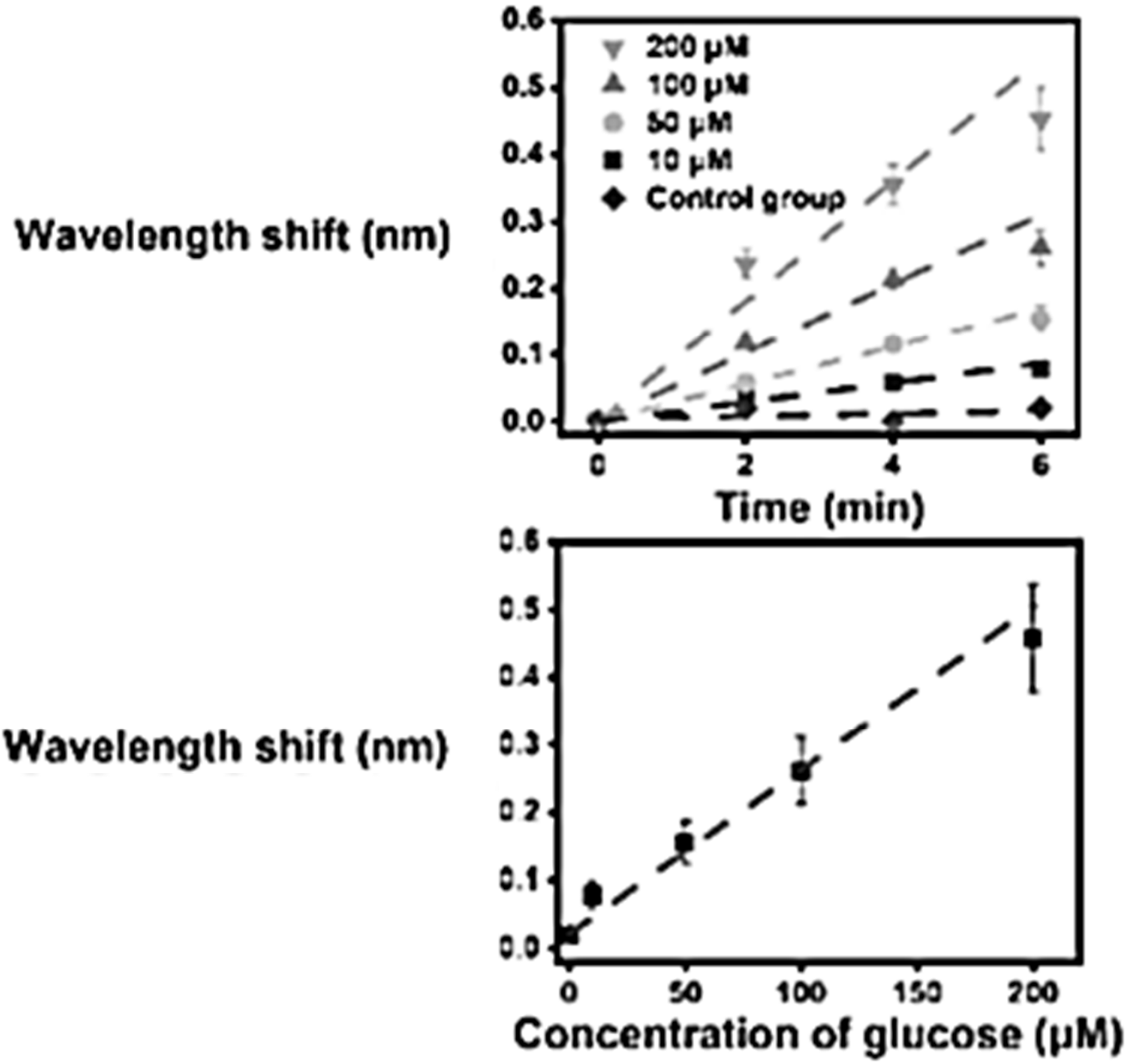

Wavelength shift (nm)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
200 μM
100 μM
50 μM
10 μM
Control group
0
2
4
6
Time (min)
Wavelength shift (nm)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
50
100
150
200
Concentration of glucose (μM)

FIG. 10C

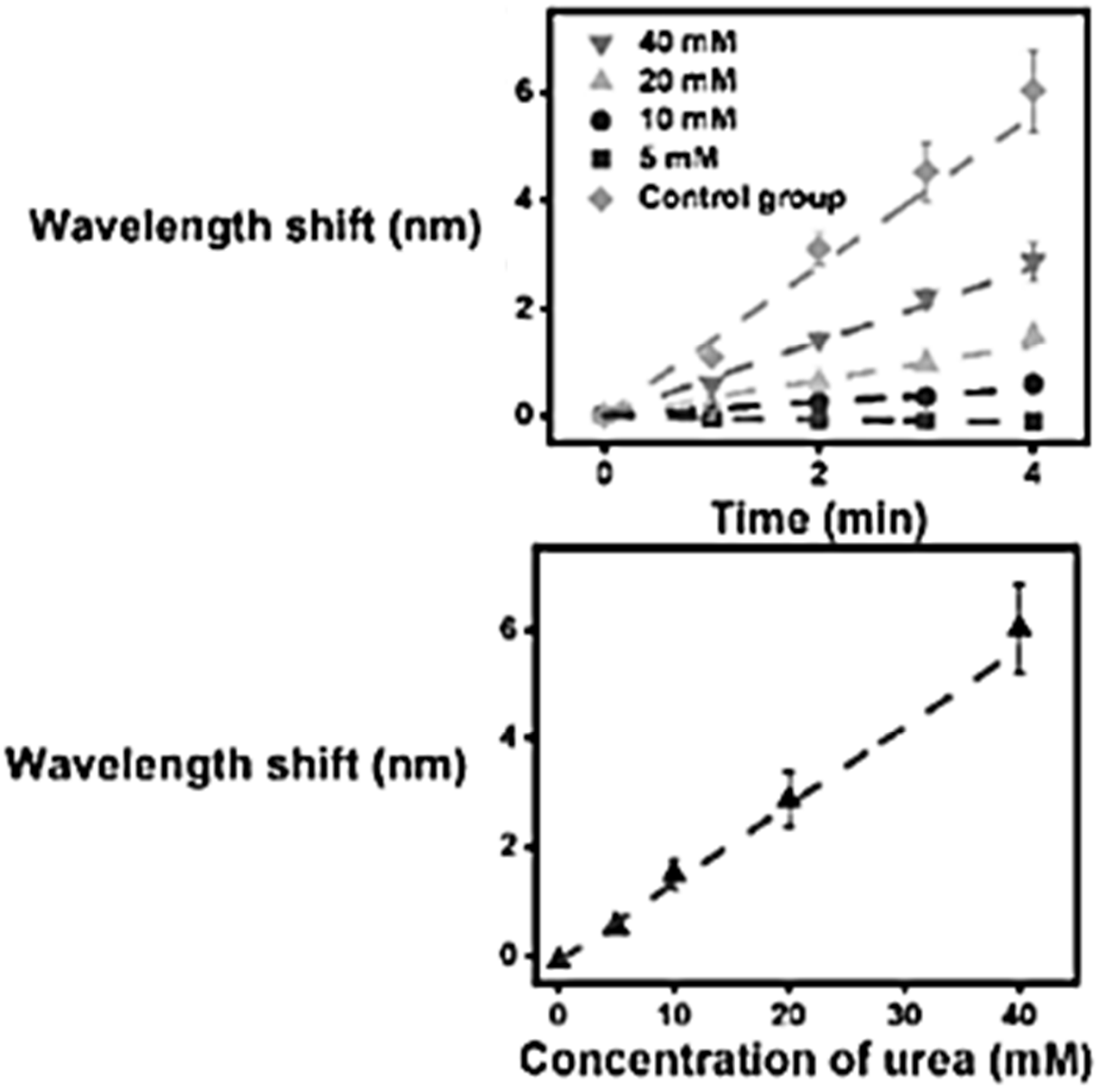

40 mM
20 mM
10 mM
5 mM
Control group
Wavelength shift (nm)
0
2
4
6
Time (min)
Wavelength shift (nm)
0
10
20
30
40
Concentration of urea (mM)

FIG. 10D

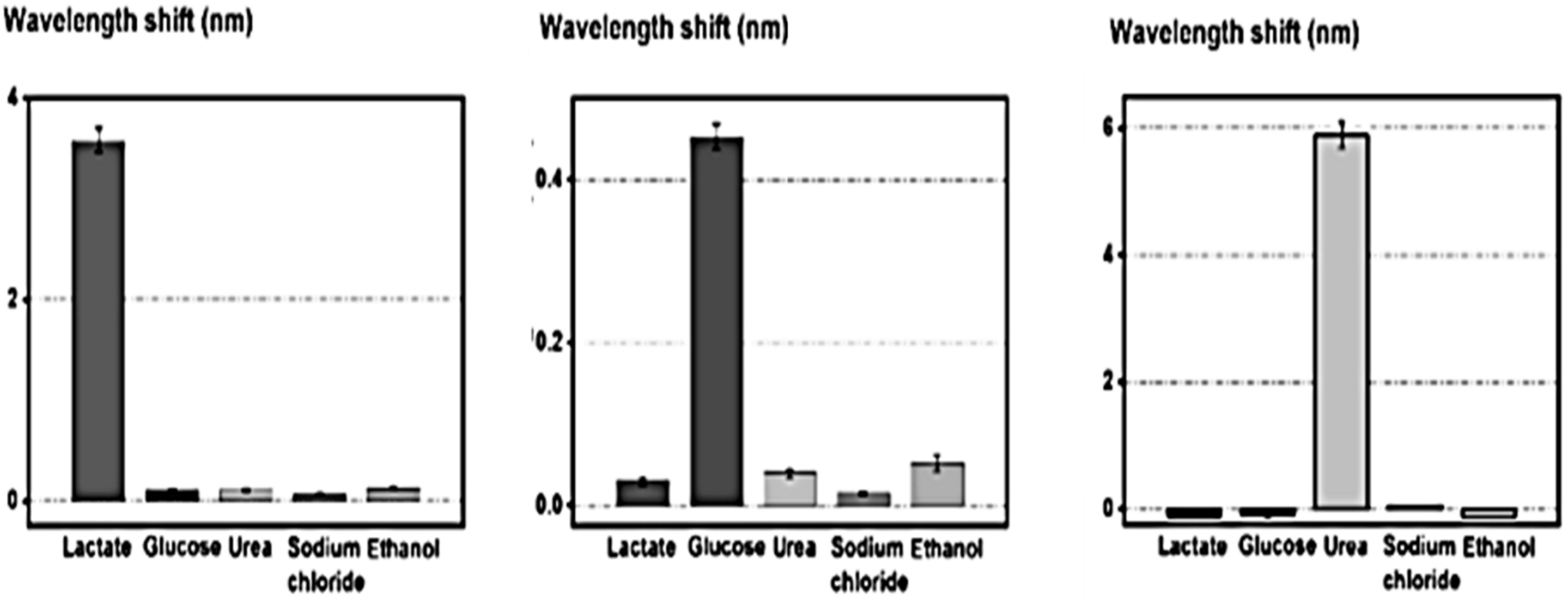

Wavelength shift (nm)
4
2
0
Lactate
Glucose
Urea
Sodium chloride
Ethanol
Wavelength shift (nm)
0.4
0.2
0.0
Lactate
Glucose
Urea
Sodium chloride
Ethanol
Wavelength shift (nm)
6
4
2
0
Lactate
Glucose
Urea
Sodium chloride
Ethanol

FIG. 11A

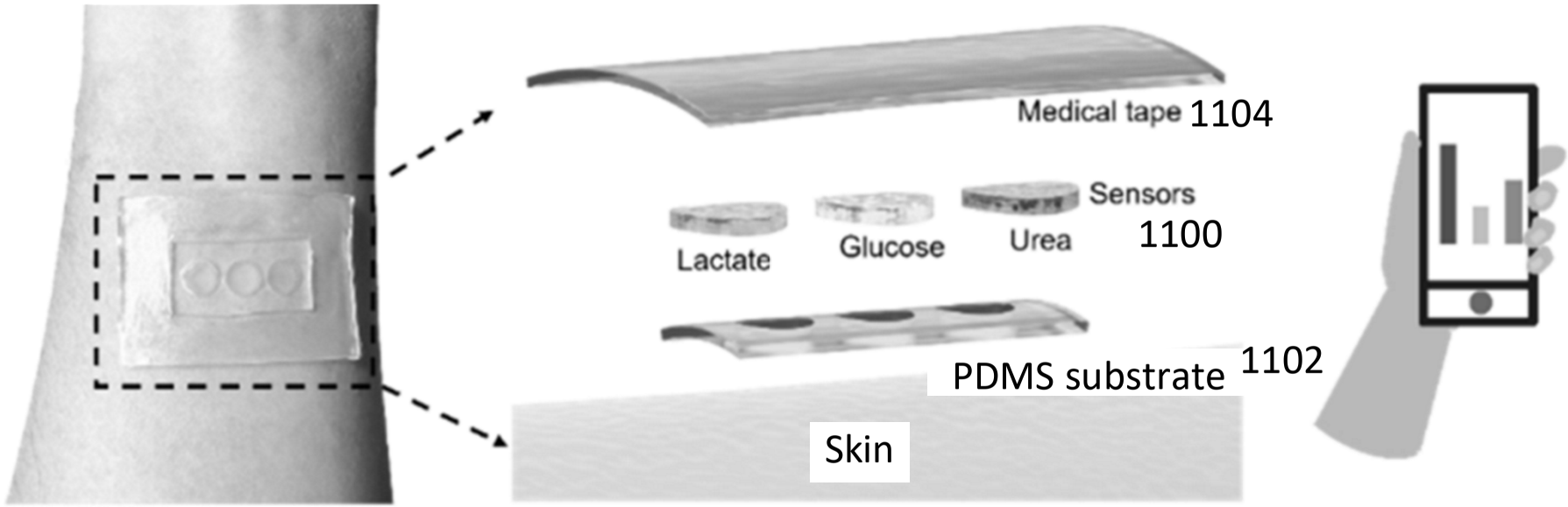

Medical tape 1104
Sensors
1100
Lactate
Glucose
Urea
PDMS substrate
1102
Skin

FIG. 11B

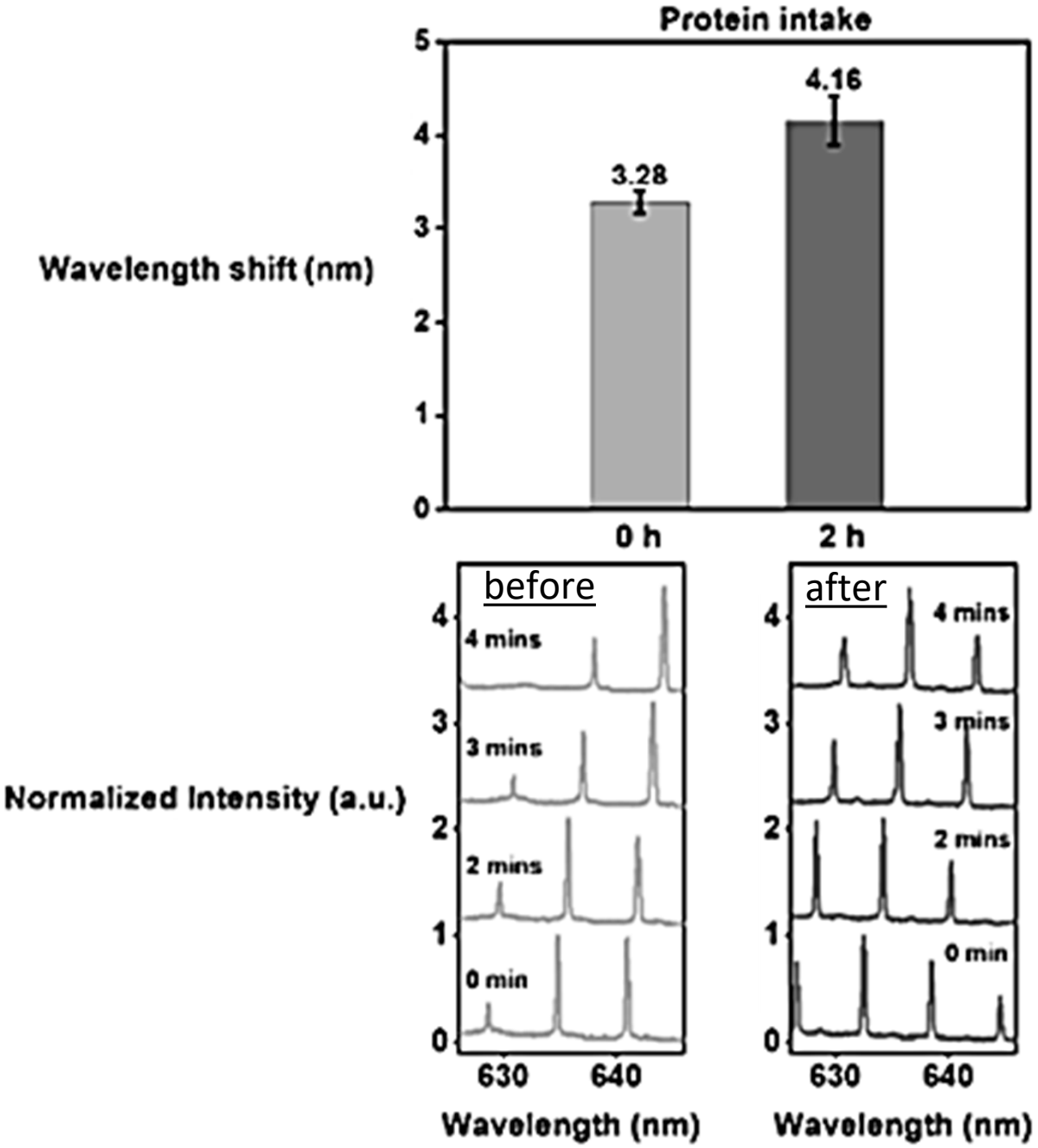

Protein intake
Wavelength shift (nm)
5
4
3
2
1
0
3.28
4.16
0 h
2 h
before
after
Normalized Intensity (a.u.)
4 mins
3 mins
2 mins
0 min
630
640
Wavelength (nm)

FIG. 11C

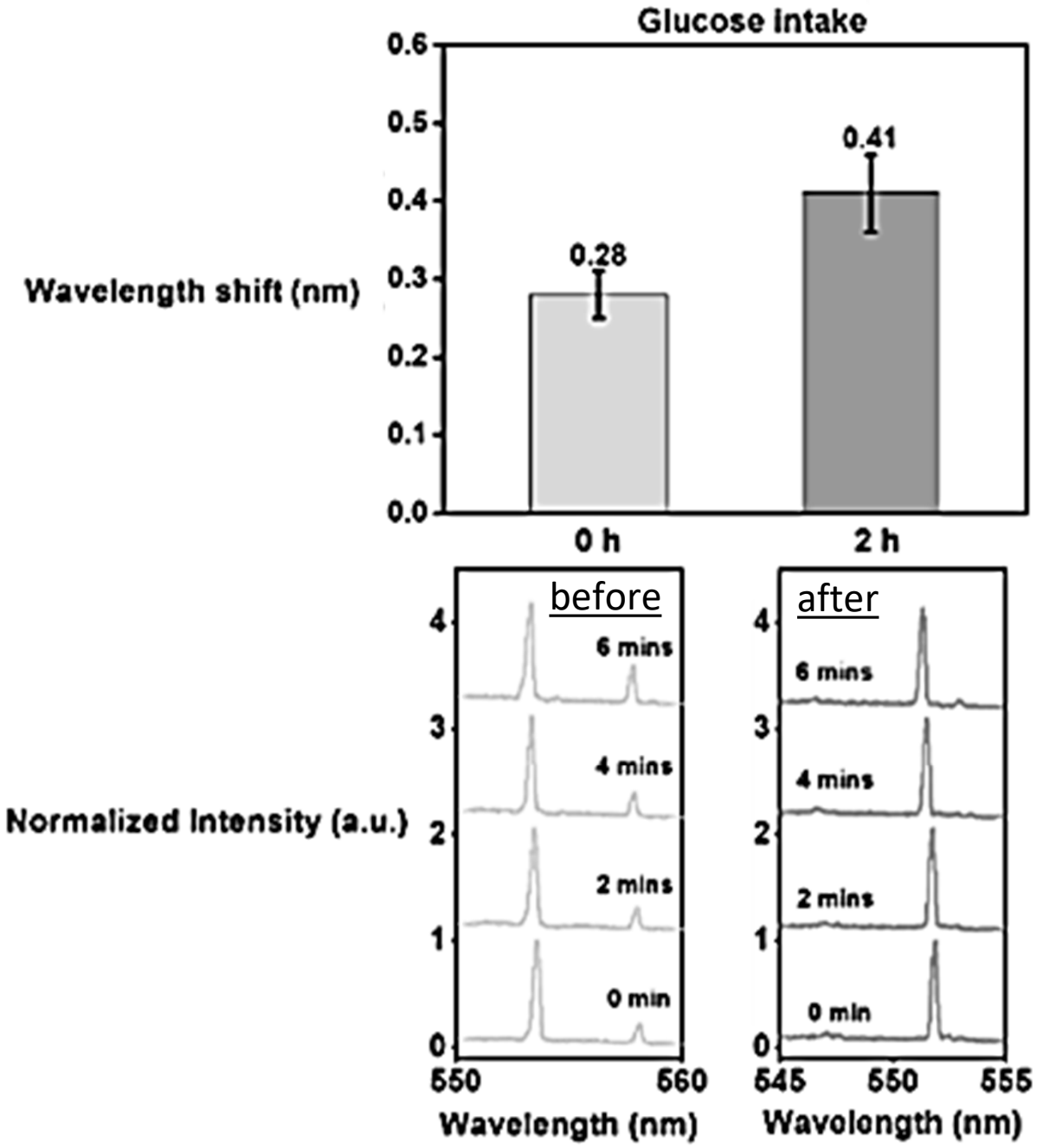
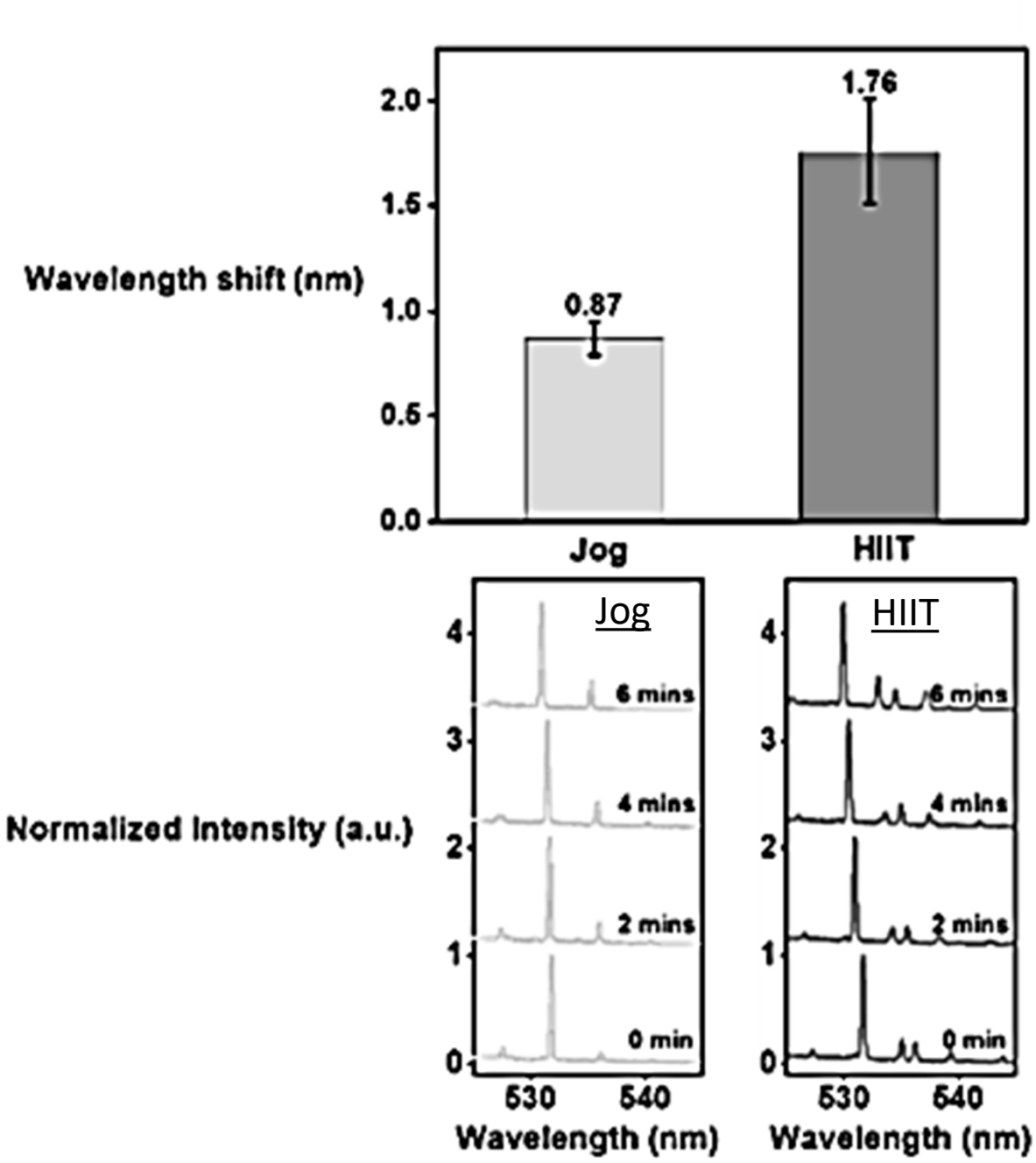

Glucose intake
Wavelength shift (nm)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.28
0.41
0 h
2 h
before
after
Normalized Intensity (a.u.)
6 mins
4 mins
2 mins
0 min
550
560
545
550
555
Wavelength (nm)
Wavelength (nm)

FIG. 11D


Wavelength shift (nm)
2.0
1.5
1.0
0.5
0.0
0.87
1.76
Jog
HIIT
Normalized Intensity (a.u.)
Jog
HIIT
6 mins
4 mins
2 mins
0 min
4
3
2
1
0
530
540
Wavelength (nm)