Simultaneous recognition of cysteine and cytosine using thiophene based organic nanoparticles decorated with Au NPs and bio-imaging for cells

Carlos Alberto Huerta-Aguilar[a, b], Brayan Ramírez-Guzmán[b], Thangarasu Pandiyan[a*], Jayanthi Narayanan[b] and Narinder Singh[c]

[a] Facultad de Química, Universidad Nacional Autónoma de México (UNAM), Ciudad Universitaria, Coyoacán, 04510 México D.F., México

[b] División de Nanotecnología, Universidad Politécnica del Valle de México, Av. Mexiquense, C.P. 54910 Tultitlán, Estado de México, México.

[c] Department of chemistry, Indian Institute of Technology (IIT), Ropar, India

Supplementary Information

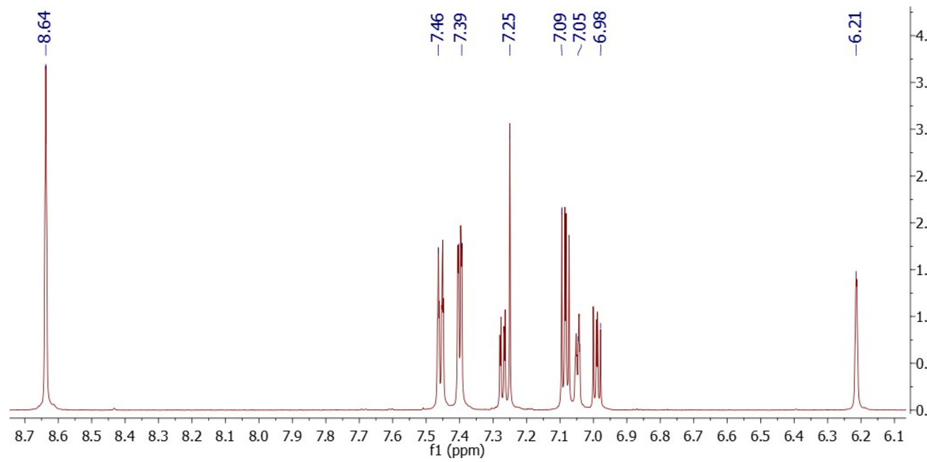


Figure S1. ^{1}H NMR spectra (400 MHz) of BMTM in $CDCl_3$.

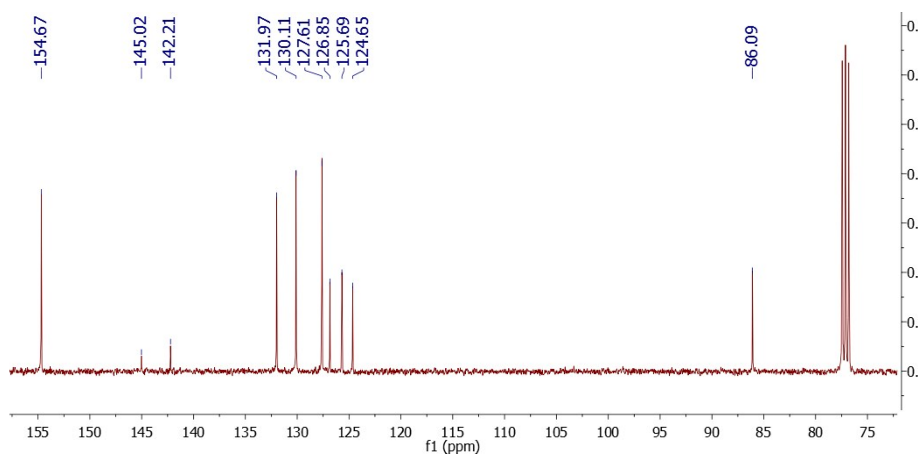


Figure S2. ^{13}C NMR spectra (400 MHz) of BMTM in $CDCl_3$.

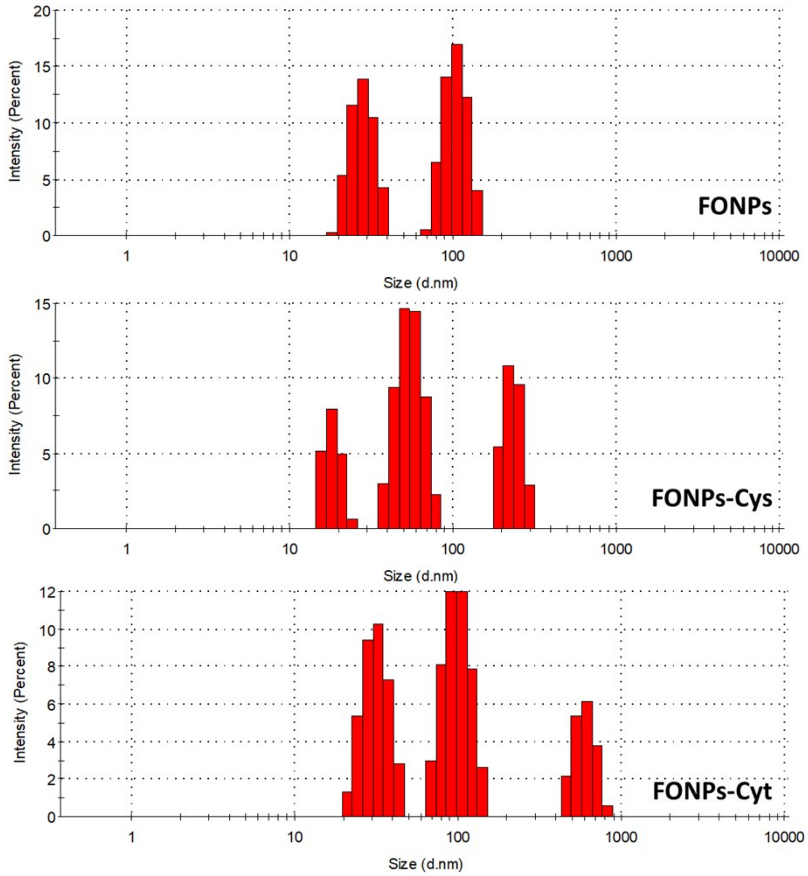


Figure S3. DLS analysis for FONPs and its interaction with cysteine and cytosine

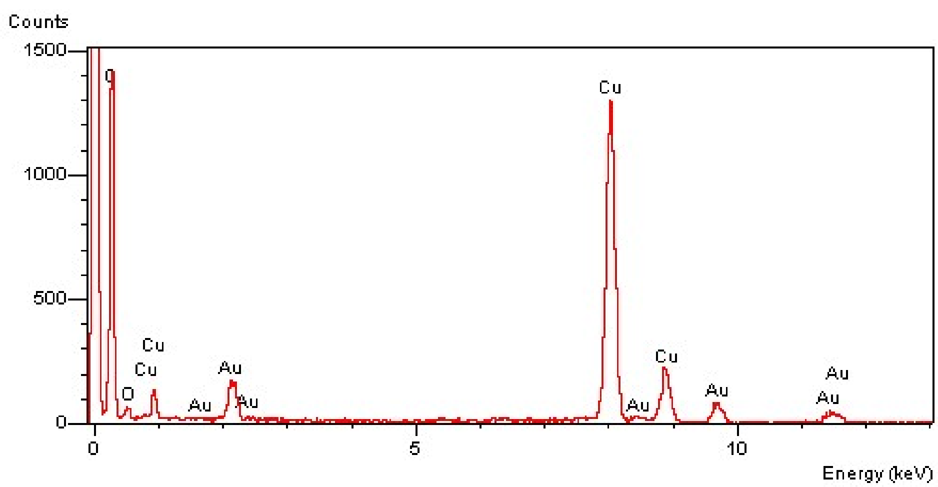


Figure S4. Energy Dispersive X-Ray Spectroscopy (EDS) spectra for FONPs.

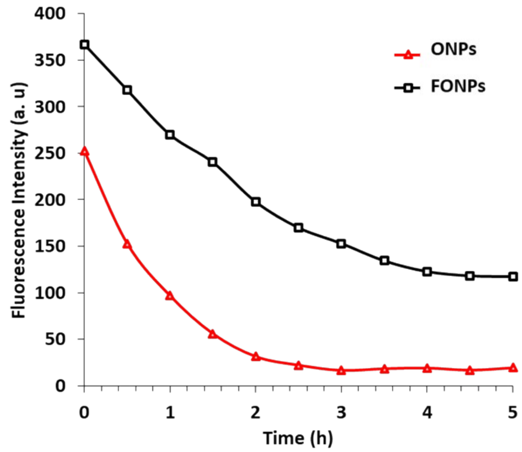


Figure S5. Fluorescence intensity against time at 425 nm emission for ONPs and FONPs (100 μM) in water

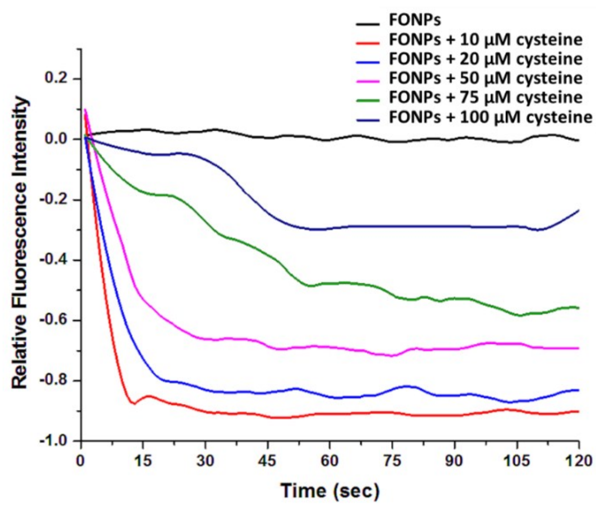


Figure S6. Changes in fluorescence as function of time for HNPs-Cystein interaction in full aqueous media

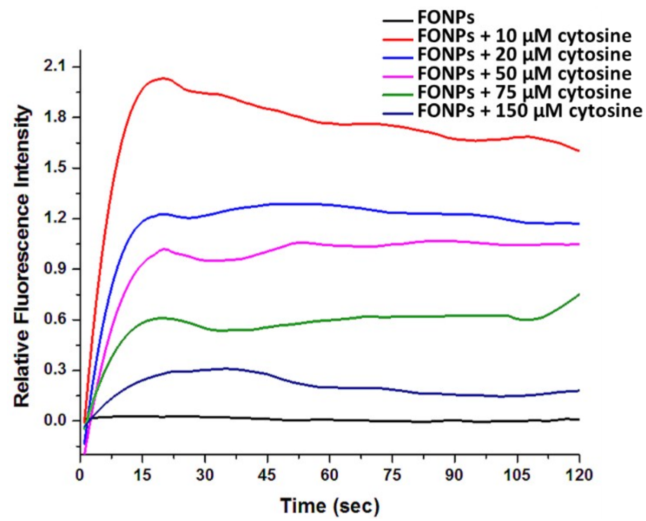


Figure S7. Change of fluorescence intensity against time for FONPs-Cytosine interaction in full aqueous medium

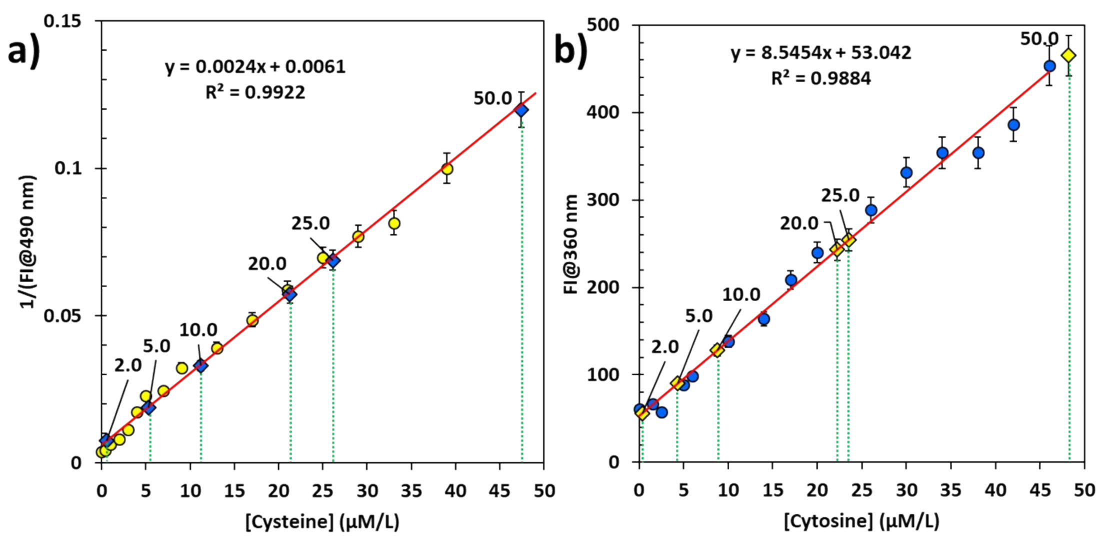
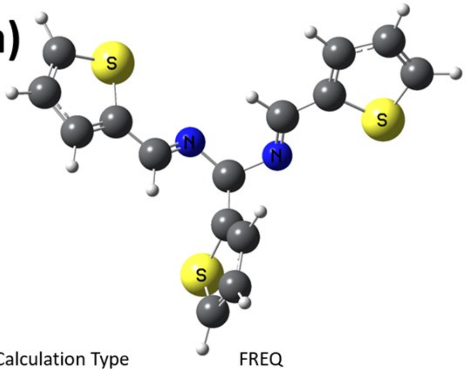


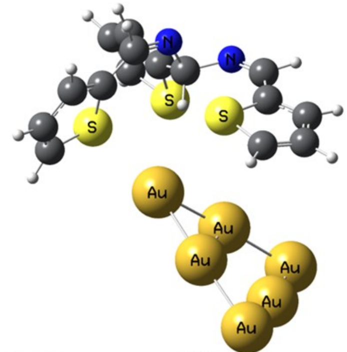
Figure S8. Method of validation for quantification: a) cysteine by FONPs, and b) cytosine by FONPs.

a)



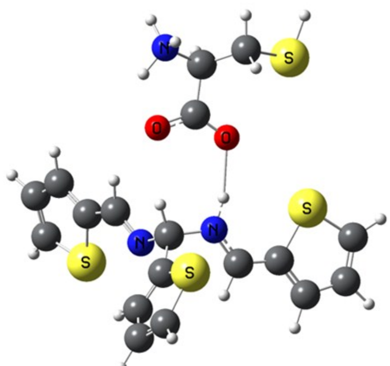
Calculation Type	FREQ	
Calculation Method	RB3LYP	
Basis Set	6-311+G(d,p)	
Charge	0	
Spin	Singlet	
E(UB3LYP)	-1882.87	a.u.
RMS Gradient Norm	0.00000423	a.u.
Imaginary Freq	0	
Dipole Moment	5.0697	Debye
Point Group	C1	

b)



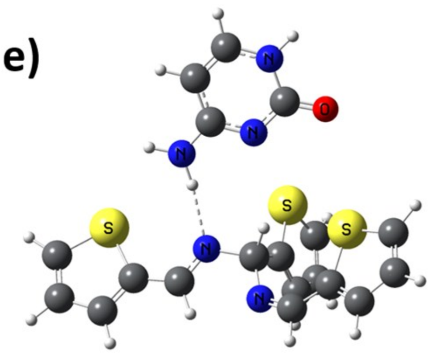
Calculation Type	FREQ	
Calculation Method	UB3LYP	
Basis Set	6-311+G(d,p)	
Charge	0	
Spin	Singlet	
E(UB3LYP)	-1531.38	a.u.
RMS Gradient Norm	0.000006	a.u.
Imaginary Freq	0	
Dipole Moment	7.6529	Debye
Point Group	C1	

d)



Calculation Type	FREQ	
Calculation Method	UB3LYP	
Basis Set	6-311+G(d,p)	
Charge	0	
Spin	Doublet	
E(UB3LYP)	-2604.95	a.u.
RMS Gradient Norm	0.00000535	a.u.
Imaginary Freq	0	
Dipole Moment	20.7310	Debye
Point Group	C1	

e)



Calculation Type	FREQ	
Calculation Method	RB3LYP	
Basis Set	6-311+G(d,p)	
Charge	0	
Spin	Singlet	
E(UB3LYP)	-2277.37	a.u.
RMS Gradient Norm	0.00000940	a.u.
Imaginary Freq	0	
Dipole Moment	6.7679	Debye
Point Group	C1	

Figure S9. DFT optimization-frequency parameters for a) BMTM; b) BMTM-Au_6; c)BMTM-cysteine; d) BMTM-cytosine obtained with a B3LYP/6-311+G(d,p) basis set.

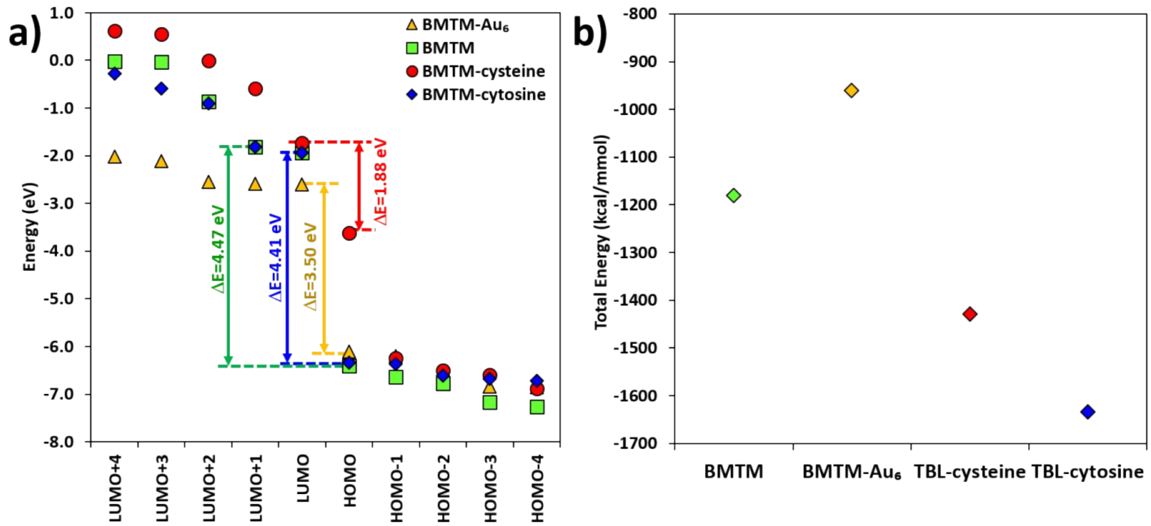


Figure S10. a) Frontier molecular energy diagram for BMTM, BMTM-Au_6, BMTM-cysteine and BMTM-cytosine interaction; b) Total calculated energy for BMTM, BMTM-Au_6, BMTM-cysteine and BMTM-cytosine interaction.

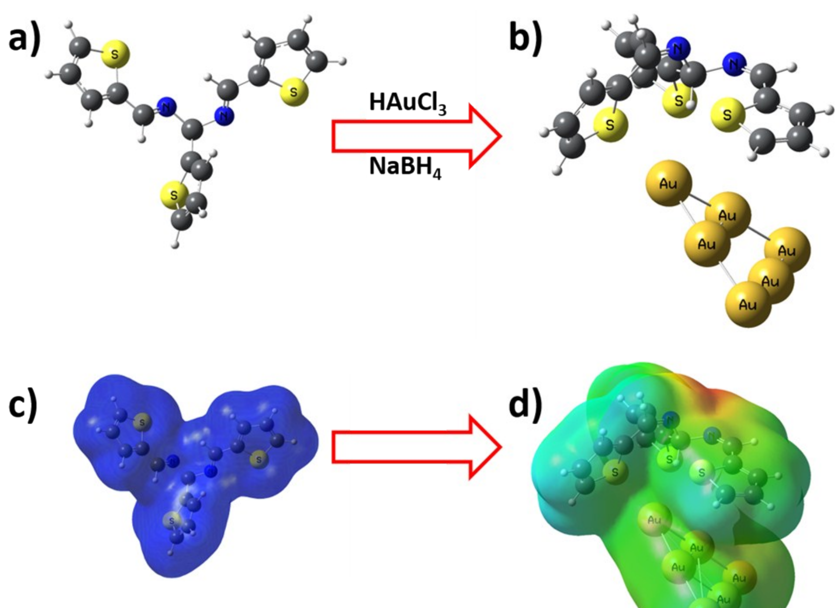


Figure S11 a) Optimized geometry a) BMTM and b) BMTM-Au6 in aqueous system; b) electron density mapping of c) BMTM and d) BMTM- Au_6 obtained through B3LYP/LANL2DZ basis set.

Table S1. Method of validation for the determination of cysteine and cytosine by FONPs

Stock concentration [μM]	[Cysteine]		[Cytosine]	
	[μM]	Error (%)	[μM]	Error (%)
2.0	0.57	1.6	0.35	82.6
5.0	5.30	-6.0	4.67	6.4
10.0	11.21	-12.1	8.77	12.2
20.0	21.28	-6.4	22.23	-11.1
25.0	26.11	-4.4	23.52	5.9
50.0	47.42	5.1	48.21	3.5
Error average	-	7.9	-	16.6

Table S2. Recognition of cysteine and cytosine in literature and compared with the present study

Probing compounds	Technique	Detection limit	Recognition species	Ref.
benzothiazole-based ligand 2-(2 -hydroxyphenyl) benzothiazole using cysteine an auxiliary reagent	Fluorescence	0.036 uM 1.16 M	Zn^{2+} and Cd^{2+}	Ref[1]
Nanohybrid of silica nanoparticles with gold nanoclusters	Fluorescence	0.35 mM.	Cysteine	Ref[2]
N-acetyl-L-cysteine-capped CdTe quantum dots	Fluorescence	-	panicillamine and Cu^{2+}	Ref[3]
Fingerprint-like pattern DNA-based sensing	Fluorescence	8.6 nM for L-Cys and 7.4 nM for D-Cys,	Thiols	Ref[4]
quinoline based ratiometric compound	Two-photon fluorescence	-	Cysteine and homocysteine	Ref[5]
Fluorescein-based compound	Colormetric and fluorescence	0.12 μM 0.13 μM	Glutathione and cysteine	
Flavone-based ligand (6-bromo-2-(9-ethyl-9H-carbazol-3-yl)-3-hydroxy-chromen-4-one)	Fluorescence	4.06×10^{-3} μM	Cysteine	Ref[6]
Iminocoumarins based compounds	Fluorescence	6.6 nM	cysteine	Ref[7]
fluorophore of 4-amino-7-nitrobenz-2-oxa-1,3-diazole	Fluorescence	26 nM.	Glutathione	Ref[8]
Magnetic Micronanoelectrodes	electrochemical	83 pM	Cysteine	Ref[9]
optical metal based nanopartcles sensor	Colorimetric	4.54×10^{-10} M.	Creatinine	Ref[10]
Rhodamine-derived probes	Fluorescence	1.26 uM	Cysteine	Ref[11]
8-carboxamidoquinoline derivative with Cu^{2+} complex	Fluorescence	1.92×10^{-7} mol/l	Cysteine	Ref[12]
Chitosan-capped silver nanoparticles:	Scanometry	2.1×10^{-6} mol L^{-1}	Tryptophan	Ref[13]
cinamaldehyde and pyrimidine base probe	Absorption spectra	0.10 M	Hg^{2+} and cysteine	Ref[14]
pyrene pyridoxal cascade compound	Fluorescence	1.59×10^{-7} M	Zn^{2+}, hydrogen phosphate and cysteine	Ref[15]
molecular imprinted SiO_2/AuNPs/SiO_2	electrochemical	-	Cysteine	Ref[16]

			isomers	
Cyclohexene based shift base ligand	Colorimetry and fluorescence	7.34 nM	Biothiols	Ref[17]
naphthalimide-functionalized Pillar[5]arene-based Multiresponsive Supramolecular Polymer	Fluorescence	-	Cyanide, Hg, and Cysteine	Ref[18]
Phthalimide-based probe	Fluorescence	6×10^{-8} M	Cysteine	Ref[19]
Coumarin-based ligand	Fluorescent	47.7 nM	Cysteine	Ref[20]
Graphene oxide embedded with Fe(phenathroline) as dual Reacting-mediated Strategy	Colorimetry	4.8 µM	Cysteine	Ref[21]
Metal-organic frameworks Fe-MIL-88NH(2)	fluorescence	1.17 uM	6-mercaptopurine	Ref[22]
nanomaterials of terbium hybrids for the detection of tryptophan	Luminiscence	-	Tryptophan	Ref[23]
Cytosine derivatized diethylenetriaminepentaacetic acid (dtpa) and Eu(III) complexes	fluorescence	5.11×10^{-7} mol L^{-1}	6-Thioguanine	Ref[24]
nitrogen-doped graphene quantum dot–mercury(II)system	fluorescence	1.3 nmol L^{-1}	Cysteine	Ref[25]
magnesium and nitrogen co-doped carbon quantum dots	fluorescence	0.02 µM.	Cysteine and Hg2+	Ref[26]
global DNA methylation	Colorimetry and electrochemistry	-	Methyl cytosine specific antibodies	Ref[27]
3-(2-hydroxyphenyl)-1-pyrenyl-2-propenone	fluorescence	10 pM/L	Cysteine	Ref[28]
Quantum mechanical studies	DFT	_	Cytosine and adenine	Ref[29]
Pyrene-appended 5-hydroxyisophthalic acid derivative	Colorimetry and Fluorescence	32 nM	Cytosine	Ref[30]
Picolinamide	Biochemical reactions	-	Nucleobases	Ref[31]
Gold nanorods vs. gold nanoparticles with molecularly imprinted polymer	electrochemical	0.75 ng mL^{-1}	Cytosine beta-D-arabinoside	Ref[32]
bis(2,2'-bithienyl)methane molecularly imprinted polymer	Electrochemical Fluorescence	-	6-thioguanine,	Ref[33]
hypoxanthine in pyrrolidinyl peptide nucleic acid	fluorescence	-	Cytosine	Ref[34]
Thiophene based organic nanoparticles decorated with Au NPs	Fluorescence	2.12 nM 258 nM	Cysteine and cytosine	Present work

Note: Yen Wei co workers showed clearly how aggregation-induced emission (AIE) is essential for many biomedical applications; for example, several polymers based on acetylenic [35], amphiphilic[36], dye with β cyclodextrin[37], poly(amino acid)s[38] were prepared and successfully applied to develop cell imaging [39-41] as well as for bio-/chemosensors [42] through AIE. Furthermore, they also adopted several easy methods to prepare luminescent active polymeric nano particles such as (i) non-covalent fabrication methodology[43]; (ii) fluorescent organic nanoparticles by multi-component approach [44] [45]; (iii) surface modification strategy such as fluorescent silica nanoparticles via AIE dye[46]; (iv) catalyst-free azide-alkyne click reaction[47] or catalyst-free thiolyne click reaction [48]; (v) ultrasound or microwave assisted multi-component reactions for polymer nanoparticles [49] [50] [51]; (vi) metal-free photo-initiated process[52]; polymeric nanoparticles (FPNs) via post modification of synthetic polymers [53]; (vii) fluorescent organic nanoparticles via emulsion [54], and (viii) luminescent hyaluronic acid through AIE [55]. Similarly, nano-diamonds with hyperbranched polymers were studied to use for drug delivery[56].

Table S3. Frontier molecular orbital (FMO) energies

Molecular Orbital	BMTM	BMTM-Au_6	BMTM-cysteine	BMTM-cytosine
	Energy (eV)			
LUMO+4	0.018	-2.016	0.613	0.282
LUMO+3	-0.029	-2.112	0.550	-0.587
LUMO+2	-0.866	-2.547	-0.011	-0.904
LUMO+1	-1.808	-2.593	-0.586	-1.815
$\Delta E_{LUMO+1-LUMO}$	0.126	0.004	1.149	0.117
LUMO	-1.934	-2.598	-1.734	-1.932
$\Delta E_{HOMO-LUMO}$	4.479	3.509	1.885	4.412
HOMO	-6.413	-6.107	-3.619	-6.343
$\Delta E_{HOMO-1-HOMO}$	0.223	0.102	2.633	0.021
HOMO-1	-6.636	-6.210	-6.251	-6.365
HOMO-2	-6.772	-6.675	-6.505	-6.611
HOMO-3	-7.166	-6.843	-6.597	-6.679
HOMO-4	-7.266	-6.862	-6.886	-6.715

References

1 J. Li, Y. H. Chen, T. T. Chen, J. Qiang, Z. J. Zhang, T. W. Wei, W. Zhang, F. Wang, X. Q. Chen, A benzothiazole-based fluorescent probe for efficient detection and discrimination of Zn2+ and Cd2+, using cysteine as an auxiliary reagent, *Sens. Actuator B.*, 2018, **268**, 446-455.

2 N. Xu, Y. Q. Yuan, C. W. Lan, W. Q. Wei, L. Meng, L. Z. Fan, A novel dual-emission fluorescent nanohybrid containing silica nanoparticles and gold nanoclusters for ratiometric determination of cysteine based on turn-on fluorescence strategy, *New J. Chem.*, 2018, **42**, 10092-10099.

3 Y. M. Huang, J. D. Yang, H. Y. Yuan, Y. Guo, X. Q. Zeng, J. W. Cheng, Y. H. Zhang, A novel competitive-displacement fluorescence assay for L-penicillamine based on the reaction between the target and N-acetyl-L-cysteine-capped CdTe quantum dots for copper ions, *Anal. Method.*, 2018, **10**, 2263-2271.

4 H. Qiu, F. Pu, X. Ran, Y. Q. Song, C. Q. Liu, J. S. Ren, X. G. Qu, Fingerprint-like pattern for recognition of thiols, *Sens. Actuator B.*, 2018, **260**, 183-188.

5 Q. Q. Wu, K. N. Wang, Z. A. Wang, Y. T. Sun, D. X. Cao, Z. Q. Liu, R. F. Guan, S. F. Zhao, X. Y. Yu, Two 3-hydroxyflavone derivatives as two-photon fluorescence turn-on chemosensors for cysteine and homocysteine in living cells, *Talanta*, 2018, **181**, 118-124.

6 H. Ren, J. L. Zhou, X. C. Dong, W. L. Zhao, A simple, water soluble flavone-based fluorescent probe for fast detection of Cys, *J. Photochem. Photobiol.A-Chem.*, 2018, **355**, 72-77.

7 X. J. Liu, D. L. Yang, W. Q. Chen, L. Yang, F. P. Qi, X. Z. Song, A red-emitting fluorescent probe for specific detection of cysteine over homocysteine and glutathione with a large Stokes shift, *Sen. Actuator B-Chem.*, 2016, **234**, 27-33.

8 J. L. Zhou, J. Zhang, H. Ren, X. C. Dong, X. Zheng, W. L. Zhao, A turn-on fluorescent probe for selective detection of glutathione using trimethyl lock strategy, *J. Photochem. Photobiol. A.Chem.*, 2018, **355**, 94-100.

9 H. F. Zhou, G. X. Ran, J. F. Masson, C. Wang, Y. Zhao, Q. J. Song, Rational Design of Magnetic Micronanoelectrodes for Recognition and Ultrasensitive Quantification of Cysteine Enantiomers, *Anal. Chem.*, 2018, **90**, 3374-3381.

10 U. Sivasankaran, T. C. Jos, K. G. Kumar, Selective recognition of creatinine - Development of a colorimetric sensor, *Anal. Biochem.*, 2018, **544**, 1-6.

11 Y. Q. Zhao, Y. Xing, L. H. Li, J. J. Ma, Characterization and cysteine sensing performance of nanocomposites based on up-conversion excitation host and rhodamine-derived probes, *Spectrochim. Acta A.*, 2018, **191**, 134-142.

12 G. P. Chai, Q. W. Liu, Q. Fei, J. L. Zhang, X. X. Sun, H. Y. Shan, G. D. Feng, Y. F. Huan, A selective and sensitive fluorescent sensor for cysteine detection based on bi-8-carboxamidoquinoline derivative and Cu2+ complex, *Lumin.*, 2018, **33**, 153-160.

13 M. Jafari, J. Tashkhourian, G. Absalan, Chiral recognition of tryptophan enantiomers using chitosan-capped silver nanoparticles: Scanometry and spectrophotometry approaches, *Talanta*, 2018, **178**, 870-878.

14 M. Jung, C. Kim, R. G. Harrison, A dual sensor selective for Hg2+ and cysteine detection, *Sens. Actuator B-Chem.*, 2018, **255**, 2756-2763.

15 Y. Upadhyay, T. Anand, L. T. Babu, P. Paira, G. Crisponi, S. K. A. Kumar, R. Kumar, S. K. Sahoo, Three-in-one type fluorescent sensor based on a pyrene pyridoxal cascade for the selective detection of Zn(II), hydrogen phosphate and cysteine, *Dalton Trans.*, 2018, **47**, 742-749.

16 J. Zhang, W. S. Tan, Y. X. Tao, L. H. Deng, Y. Qin, Y. Kong, A novel electrochemical chiral interface based on sandwich-structured molecularly imprinted SiO2/AuNPs/SiO2 for enantioselective recognition of cysteine isomers, *Electrochem. Commun.*, 2018, **86**, 57-62.

17 M. Z. Zhang, H. H. Han, S. Z. Zhang, C. Y. Wang, Y. X. Lu, W. H. Zhu, A new colorimetric and fluorescent probe with a large stokes shift for rapid and specific detection of biothiols and its application in living cells, *J. Mater. Chem. B*, 2017, **5**, 8780-8785.

18 Q. Lin, K. P. Zhong, J. H. Zhu, L. Ding, J. X. Su, H. Yao, T. B. Wei, Y. M. Zhang, Iodine Controlled Pillar 5 arene-Based Multiresponsive Supramolecular Polymer for Fluorescence Detection of Cyanide, Mercury, and Cysteine, *Macromolecules*, 2017, **50**, 7863-7871.

19 Y. M. Shen, X. Y. Zhang, Y. Y. Zhang, C. X. Zhang, J. L. Jin, H. T. Li, A new simple phthalimide-based fluorescent probe for highly selective cysteine and bioimaging for living cells, *Spectrochim. Acta A.*, 2017, **185**, 371-375.

20 R. F. Zeng, J. S. Lan, X. D. Li, H. F. Liang, Y. Liao, Y. J. Lu, T. Zhang, Y. Ding, A Fluorescent Coumarin-Based Probe for the Fast Detection of Cysteine with Live Cell Application, *Molecules*, 2017, **22**.

21 H. H. Rao, Y. Li, G. L. Zhang, Z. H. Xue, G. H. Zhao, S. Y. Li, X. Z. Du, A New Colorimetric Sensor for Cysteine Determination Based on Dual Reacting-mediated Strategy, *Bull. Korean Chem. Soc.*, 2017, **38**, 1023-1027.

22 Z. J. Sun, Y. L. Liu, Y. F. Li, Selective recognition of 6-mercaptopurine based on luminescent metal-organic frameworks Fe-MIL-88NH(2), *Spectrochim. Acta A.*, 2015, **139**, 296-301.

23 S. T. Pang, Z. Zhou, Q. M. Wang, Smart 0D nanomaterials assembled by green luminescent terbium hybrids for the detection of tryptophan, *J. Nanoparticle Res.*, 2013, **15**.

24 F. Y. Tian, F. Yang, X. Q. Jiang, X. K. Dou, G. H. Liu, P. P. Ren, J. Wang, Y. T. Song, Z. Q. Xing, G. X. Han, Cytosine derivatized diethylenetriaminepentaacetic acid (dtpa) and Eu(III) complexes for selective recognition of 6-Thioguanine, *Sens. Actuators B-Chem.*, 2017, **247**, 374-383.

25 Z. Z. Liu, Y. Gong, Z. F. Fan, Cysteine detection using a high-fluorescence sensor based on a nitrogen-doped graphene quantum dot-mercury(II) system, *J. Lumin.*, 2016, **175**, 129-134.

26 T. Liu, N. Li, J. X. Dong, H. Q. Luo, N. B. Li, Fluorescence detection of mercury ions and cysteine based on magnesium and nitrogen co-doped carbon quantum dots and IMPLICATION logic gate operation, *Sens. Actuator B-Chem.*, 2016, **231**, 147-153.

27 M. H. Haque, R. Bhattacharjee, M. N. Islam, V. Gopalan, N. T. Nguyen, A. K. Lam, M. J. A. Shiddiky, Colorimetric and electrochemical quantification of global DNA methylation using a methyl cytosine-specific antibody, *Analyst*, 2017, **142**, 1900-1908.

28 B. K. Rani, S. A. John, A novel pyrene based fluorescent probe for selective detection of cysteine in presence of other bio-thiols in living cells, *Biosens. Bioelectronic.*, 2016, **83**, 237-242.

29 J. Basumatary, B. Bezbaruah, R. Kalita, T. K. Barman, C. Medhi, Quantum mechanical studies on the existence of AC mismatches through prototopic tautomerization pathway in adenine and cytosine recognition, *J. Theor. Comput. Chem.*, 2017, **16**.

30 H. S. Sarkar, S. Das, D. Mandal, M. R. Uddin, S. Mandal, P. Sahoo, "Turn-on" fluorescence sensing of cytosine: development of a chemosensor for quantification of cytosine in human cancer cells, *RSC Adv.*, 2017, **7**, 54008-54012.

31 R. A. Dengale, S. R. Thopate, T. Lonnberg, Metal-Dependent Nucleobase Recognition by Picolinamide, *Chempluschem*, 2016, **81**, 978-984.

32 B. B. Prasad, R. Singh, A. Kumar, Gold nanorods vs. gold nanoparticles: application in electrochemical sensing of cytosine beta-D-arabinoside using metal ion mediated molecularly imprinted polymer, *RSC Adv.*, 2016, **6**, 80679-80691.

33 T. P. Huynh, A. Wojnarowicz, M. Sosnowska, S. Srebnik, T. Benincori, F. Sannicolo, F. D'Souza, W. Kutner, Cytosine derivatized bis(2,2 '-bithienyl)methane molecularly imprinted polymer for selective recognition of 6-thioguanine, an antitumor drug, *Biosens. Bioelectronic.*, 2015, **70**, 153-160.

34 C. Vilaivan, W. Srinarang, N. Yotapan, W. Mansawat, C. Boonlua, J. Kawakami, Y. Yamaguchi, Y. Tanak, T. Vilaivan, Specific recognition of cytosine by hypoxanthine in pyrrolidinyl peptide nucleic acid, *Org. Biomolecular Chem.*, 2013, **11**, 2310-2317.

35 J. Z. Liu, J. W. Y. Lam, B. Z. Tang, Acetylenic Polymers: Syntheses, Structures, and Functions, *Chemical Reviews*, 2009, **109**, 5799-5867.

36 Z. Long, M. Y. Liu, K. Wang, F. J. Deng, D. Z. Xu, L. J. Liu, Y. Q. Wan, X. Y. Zhang, Y. Wei, Facile synthesis of AIE-active amphiphilic polymers: Self-assembly and biological imaging applications, *Mater. Sci. Eng. C.*, 2016, **66**, 215-220.

37 H. Y. Huang, D. Z. Xu, M. Y. Liu, R. M. Jiang, L. C. Mao, Q. Huang, Q. Wan, Y. Q. Wen, X. Y. Zhang, Y. Wei, Direct encapsulation of AIE-active dye with beta cyclodextrin terminated polymers: Self-assembly and biological imaging, *Mate. Sci. Eng. C.*, 2017, **78**, 862-867.

38 J. W. Tian, R. M. Jiang, P. Gao, D. Z. Xu, L. C. Mao, G. J. Zeng, M. Y. Liu, F. J. Deng, X. Y. Zhang, Y. Wei, Synthesis and cell imaging applications of amphiphilic AIE-active poly(amino acid)s, *Mater. Sci. Eng. C.*, 2017, **79**, 563-569.

39 R. M. Jiang, H. Liu, M. Y. Liu, J. W. Tian, Q. Huang, H. Y. Huang, Y. Q. Wen, Q. Y. Cao, X. Y. Zhang, Y. Wei, A facile one-pot Mannich reaction for the construction of fluorescent polymeric nanoparticles with aggregation-induced emission feature and their biological imaging, *Mater. Sci. Eng. C.*, 2017, **81**, 416-421.

40 X. Y. Zhang, K. Wang, M. Y. Liu, X. Q. Zhang, L. Tao, Y. W. Chen, Y. Wei, Polymeric AIE-based nanoprobes for biomedical applications: recent advances and perspectives, *Nanoscale*, 2015, **7**, 11486-11508.

41 X. Y. Zhang, X. Q. Zhang, B. Yang, M. Y. Liu, W. Y. Liu, Y. W. Chen, Y. Wei, Polymerizable aggregation-induced emission dye-based fluorescent nanoparticles for cell imaging applications, *Polym. Chem.*, 2014, **5**, 356-360.

42 L. C. Mao, Y. Z. Liu, S. J. Yang, Y. X. Li, X. Y. Zhang, Y. Wei, Recent advances and progress of fluorescent bio-/chemosensors based on aggregation-induced emission molecules, *Dyes Pigment.*, 2019, **162**, 611-623.
43 Q. Wan, Q. Huang, M. Y. Liu, D. Z. Xu, H. Y. Huang, X. Y. Zhang, Y. Wei, Aggregation-induced emission active luminescent polymeric nanoparticles: Non-covalent fabrication methodologies and biomedical applications, *Appli. Mater. Today*, 2017, **9**, 145-160.
44 Z. Long, M. Y. Liu, R. M. Jiang, Q. Wan, L. C. Mao, Y. Q. Wan, F. J. Deng, X. Y. Zhang, Y. Wei, Preparation of water soluble and biocompatible AIE-active fluorescent organic nanoparticles via multicomponent reaction and their biological imaging capability, *Chem. Eng. J.*, 2017, **308**, 527-534.
45 Z. Long, L. C. Mao, M. Y. Liu, Q. Wan, Y. Q. Wan, X. Y. Zhang, Y. Wei, Marrying multicomponent reactions and aggregation-induced emission (AIE): new directions for fluorescent nanoprobes, *Polym. Chem.*, 2017, **8**, 5644-5654.
46 L. Huang, S. J. Yang, J. Y. Chen, J. W. Tian, Q. Huang, H. Y. Huang, Y. Q. Wen, F. J. Deng, X. Y. Zhang, Y. Wei, A facile surface modification strategy for fabrication of fluorescent silica nanoparticles with the aggregation-induced emission dye through surface-initiated cationic ring opening polymerization, *Mater. Sci. Eng. C.*, 2019, **94**, 270-278.
47 R. M. Jiang, M. Y. Liu, T. T. Chen, H. Y. Huang, Q. Huang, J. W. Tian, Y. Q. Wen, Q. Y. Cao, X. Y. Zhang, Y. Wei, Facile construction and biological imaging of cross-linked fluorescent organic nanoparticles with aggregation-induced emission feature through a catalyst-free azide-alkyne click reaction, *Dyes Pigment.*, 2018, **148**, 52-60.
48 Q. Y. Cao, R. M. Jiang, M. Y. Liu, Q. Wan, D. Z. Xu, J. W. Tian, H. Y. Huang, Y. Q. Wen, X. Y. Zhang, Y. Wei, Preparation of AIE-active fluorescent polymeric nanoparticles through a catalyst-free thiol-yne click reaction for bioimaging applications, *Mater. Sci. Eng. C.*, 2017, **80**, 411-416.
49 R. M. Jiang, M. Y. Liu, H. Y. Huang, L. C. Mao, Q. Huang, Y. Q. Wen, Q. Y. Cao, J. W. Tian, X. Y. Zhang, Y. Wei, Facile fabrication of organic dyed polymer nanoparticles with aggregation-induced emission using an ultrasound-assisted multicomponent reaction and their biological imaging, *J. Colloid Interface Sci.*, 2018, **519**, 137-144.
50 Q. Y. Cao, R. M. Jiang, M. Y. Liu, Q. Wan, D. Z. Xu, J. W. Tian, H. Y. Huang, Y. Q. Wen, X. Y. Zhang, Y. Wei, Microwave-assisted multicomponent reactions for rapid synthesis of AIE-active fluorescent polymeric nanoparticles by post-polymerization method, *Mater. Sci. Eng. C.*, 2017, **80**, 578-583.
51 R. M. Jiang, M. Y. Liu, C. Li, Q. Huang, H. Y. Huang, Q. Wan, Y. Q. Wen, Q. Y. Cao, X. Y. Zhang, Y. Wei, Facile fabrication of luminescent polymeric nanoparticles containing dynamic linkages via a one-pot multicomponent reaction: Synthesis, aggregation-induced emission and biological imaging, *Mater. Sci. Eng. C*, 2017, **80**, 708-714.
52 J. Y. Chen, M. Y. Liu, Q. Huang, L. Huang, H. Y. Huang, F. J. Deng, Y. Q. Wen, J. W. Tian, X. Y. Zhang, Y. Wei, Facile preparation of fluorescent nanodiamond-based polymer composites through a metal-free photo-initiated RAFT process and their cellular imaging, *Chem. Eng. J.*, 2018, **337**, 82-90.
53 Y. Z. Liu, L. C. Mao, X. H. Liu, M. Y. Liu, D. Z. Xu, R. M. Jiang, F. J. Deng, Y. X. Li, X. Y. Zhang, Y. Wei, A facile strategy for fabrication of aggregation-induced emission (AIE) active fluorescent polymeric nanoparticles (FPNs) via post modification of synthetic polymers and their cell imaging, *Mater. Sci. Eng. C.*, 2017, **79**, 590-595.
54 X. Y. Zhang, X. Q. Zhang, B. Yang, M. Y. Liu, W. Y. Liu, Y. W. Chen, Y. Wei, Fabrication of aggregation induced emission dye-based fluorescent organic nanoparticles via emulsion polymerization and their cell imaging applications, *Polym. Chem.*, 2014, **5**, 399-404.

55 H. Y. Huang, M. Y. Liu, Q. Wan, R. M. Jiang, D. Z. Xu, Q. Huang, Y. Q. Wen, F. J. Deng, X. Y. Zhang, Y. Wei, Facile fabrication of luminescent hyaluronic acid with aggregation-induced emission through formation of dynamic bonds and their theranostic applications, *Mater. Sci. Eng. C.*, 2018, **91**, 201-207.
56 H. Y. Huang, M. Y. Liu, R. M. Jiang, J. Y. Chen, L. C. Mao, Y. Q. Wen, J. W. Tian, N. G. Zhou, X. Y. Zhang, Y. Wei, Facile modification of nanodiamonds with hyperbranched polymers based on supramolecular chemistry and their potential for drug delivery, *J. Colloid Interface Sci.*, 2018, **513**, 198-204.