Front. Chem. Sci. Eng. 2020, 14(1): 1–3
https://doi.org/10.1007/s11705-019-1910-4

EDITORIAL

Special issue on “Fluorescent probes”

Adam C. Sedgwick (✉)[1], Tony D. James (✉)[2]

1 Department of Chemistry, University of Texas at Austin, Austin, TX 78712-1224, USA
2 Department of Chemistry, University of Bath, Bath, BA2 7AY, UK

Fluorescent probes are intelligently designed molecules that transform the act of binding/reacting with a target analyte into an optical signal [1,2]. Their high sensitivity and specificity coupled with high spatial and temporal resolution offers a non-invasive approach to observe a specific analyte within complex biological environments in real time with high precision [3]. These “molecular tools” have the capability to interrogate the role of specific biomarkers that are associated with a particular disease state or can be used to improve our understanding of the role or certain species in a biological pathway [4,5]. In addition to their biological applications, fluorescent probes have found use for the detection of environmental, agricultural, and industrial pollutants, making them critically important for public health and safety [6].

This special issue on “fluorescent probes” serves to highlight and illustrate various approaches towards fluorescent probes and their potential applications. Gunnlaugsson and co-workers have developed a series of 4-amino-1,8-naphthalimide fluorescent probes to evaluate the substitution effects on the extent of pH dependent photoinduced electron transfer (PeT) quenching [7]. These molecules were used as pH dependent lysosomal imaging agents. Biological processes are complex involving more than one biomarker, this has led to the use of fluorescence based molecular logic probes [8–14], an example includes the development of a dual enzyme activated fluorescent probe by Odyniec et al. [15]. Fluorescence imaging often suffers from poor light penetration and high background interference from autofluorescence of endogenous proteins. To overcome these limitations, researchers have begun to pursue near infrared (NIR) imaging agents [16,17]. O’Shea and co-workers report on a series of NIR aza-BODIPY fluorophores for the potential application of fluorescence guided surgery [18]. Peng and co-workers report on a NIR fluorescent probe for the subcellular imaging of the COX-2 enzyme in cancer cells [19].

Porphyrin-based systems have unique photophysical properties with the ability to form a range of metal complexes [20]. As such, Sessler and co-workers exploited the metal coordination properties of the expanded porphyrin Texaphyrin to detect heavy metals in drinking water [21]. Whereas Payne and co-workers have developed a diporphyrin tweezer to measure enantiomeric excess [22]. Azulene has unique photophysical properties [6], this prompted Lewis and co-workers to exploit the organic transformation of an aminoazulene to a diazo-azulene for the colorimetric detection of nitrite in drinking water [23]. Fluorescent probes are not just limited to small molecules, Minami and co-workers developed a “ligand-free” conjugated copolymer for the fluorescence detection of Copper(II) [24]. Giordani and co-workers synthesized *N*-heterocycle-based fluorophores attached to multilayer fullerenes—nano-onions for material-based applications [25]. Lastly, James and co-workers have developed a fructose responsive fluorescent hydrogel as a first step on the road to develop saccharide responsive molecular devices for clinical applications [26].

Upon reading this editorial, if you have found yourself intrigued and excited about the endless possibilities of fluorescent probes. Please join us at the 7th International Conference on Molecular Sensors & Molecular Logic Gates (MSMLG 2020) a celebration of the career of Seiji Shinkai in Reno, Nevada.

Received November 22, 2019

E-mails: a.c.sedgwick@utexas.edu (Sedgwick A C), chstdj@bath.ac.uk (James T D)

References

1. Sedgwick A C, Wu L, Han H H, Bull S D, He X P, James T D, Sessler J L, Tang B Z, Tian H, Yoon J. Excited-state intramolecular proton-transfer (ESIPT) based fluorescence sensors and imaging agents. Chemical Society Reviews, 2018, 47(23): 8842–8880
2. Wu D, Sedgwick A C, Gunnlaugsson T, Akkaya E U, Yoon J, James T D. Fluorescent chemosensors: The past, present and future. Chemical Society Reviews, 2017, 46(23): 7105–7123
3. Chan J, Dodani S C, Chang C J. Reaction-based small-molecule fluorescent probes for chemoselective bioimaging. Nature Chemistry, 2012, 4 (12): 973–984
4. Wu L, Sedgwick A C, Sun X L, Bull S D, He X P, James T D. Reaction-based fluorescent probes for the detection and imaging of reactive oxygen, nitrogen, and sulfur species. Accounts of Chemical Research, 2019, 52(9): 2582–2597
5. Perry G, Cortezon-Tamarit F, Pascu S I. Detection and monitoring prostate specific antigen using nanotechnology approaches to biosensing. Frontiers of Chemical Science and Engineering, 2020, 14(1): 4–18
6. Lopez-Alled C M, Sanchez-Fernandez A, Edler K J, Sedgwick A C, Bull S D, McMullin C L, Kociok-Köhn G, James T D, Wenk J, Lewis S E. Azulene-boronate esters: Colorimetric indicators for fluoride in drinking water. Chemical Communications (Cambridge), 2017, 53(93): 12580–12583
7. Martínez-Calvo M, Bright S A, Veale E B, Henwood A F, Williams D C, Gunnlaugsson T. 4-Amino-1,8-naphthalimide based fluorescent photoinduced electron transfer (PET) pH sensors as liposomal cellular imaging agents: The effect of substituent patterns on PET directional quenching. Frontiers of Chemical Science and Engineering, 2020, 14(1): 61–75
8. Sedgwick A C, Han H H, Gardiner J E, Bull S D, He X P, James T D. The development of a novel AND logic based fluorescence probe for the detection of peroxynitrite and GSH. Chemical Science (Cambridge), 2018, 9(15): 3672–3676
9. Sedgwick A C, Dou W T, Jiao J B, Wu L, Williams G T, Jenkins A T A, Bull S D, Sessler J L, He X P, James T D. An ESIPT Probe for the Ratiometric Imaging of Peroxynitrite Facilitated by Binding to Abeta-Aggregates. Journal of the American Chemical Society, 2018, 140(43): 14267–14271
10. Wu L, Han H H, Liu L, Gardiner J E, Sedgwick A C, Huang C, Bull S D, He X P, James T D. ESIPT-based fluorescence probe for the rapid detection of peroxynitrite 'AND' biological thiols. Chemical Communications (Cambridge), 2018, 54(80): 11336–11339
11. Erbas-Cakmak S, Kolemen S, Sedgwick A C, Gunnlaugsson T, James T D, Yoon J, Akkaya E U. Molecular logic gates: The past, present and future. Chemical Society Reviews, 2018, 47(7): 2228–2248
12. Odyniec M L, Sedgwick A C, Swan A H, Weber M, Tang T M S, Gardiner J E, Zhang M, Jiang Y B, Kociok-Kohn G, Elmes R B P, Bull S D, He X P, James T D. 'AND'-based fluorescence scaffold for the detection of ROS/RNS and a second analyte. Chemical Communications (Cambridge), 2018, 54(61): 8466–8469
13. Romieu A. "AND" luminescent "reactive" molecular logic gates: A gateway to multi-analyte bioimaging and biosensing. Organic & Biomolecular Chemistry, 2015, 13(5): 1294–1306
14. Kolanowski J L, Liu F, New E J. Fluorescent probes for the simultaneous detection of multiple analytes in biology. Chemical Society Reviews, 2018, 47(1): 195–208
15. Odyniec M L, Gardiner J E, Sedgwick A C, He X P, Bull S D, James T D. Dual enzyme activated fluorescein based fluorescent probe. Frontiers of Chemical Science and Engineering, 2020, 14(1): 117–121
16. Sedgwick A C, Han H H, Gardiner J E, Bull S D, He X P, James T D. Long-wavelength fluorescent boronate probes for the detection and intracellular imaging of peroxynitrite. Chemical Communications (Cambridge), 2017, 53(95): 12822–12825
17. Sedgwick A C, Gardiner J E, Kim G, Yevglevskis M, Lloyd M D, Jenkins A T A, Bull S D, Yoon J, James T D. Long-wavelength TCF-based fluorescence probes for the detection and intracellular Imaging of biological thiols. Chemical Communications (Cambridge), 2018, 54(38): 4786–4789
18. Wu D, Durán-Sampedro G, O'Shea D F. Synthesis and properties of water-soluble 1,9-dialkyl-substituted BF_2 azadipyrromethene fluorophores. Frontiers of Chemical Science and Engineering, 2020, 14(1): 97–104
19. Gurram B, Li M, Fan J, Wang J, Peng X. Near-infrared fluorescent probe for fast track of cyclooxygenase-2 in Golgi apparatus in cancer cells. Frontiers of Chemical Science and Engineering, 2020, 14(1): 41–52
20. Brewster J T, Root H D, Mangel D, Samia A, Zafar H, Sedgwick A C, Lynch V M, Sessler J L. UO_2^{2+}-mediated ring contraction of pyrihexaphyrin: Synthesis of a contracted expanded porphyrin-uranyl complex. Chemical Science (Cambridge), 2019, 10(21): 5596–5602
21. Root H D, Thiabaud A, Sessler J L. Reduced texaphyrin: A ratiometric optical sensor for heavy metals in aqueous solution. Frontiers of Chemical Science and Engineering, 2020, 14(1): 19–27
22. Payne D T, Chahal M K, Březina V, Webre W A, Ariga K, D'Souza F, Labuta J, Hill J P. Diporphyrin tweezer for multichannel spectroscopic analysis of enantiomeric excess. Frontiers of Chemical Science and Engineering, 2020, 14(1): 28–40
23. Murfin L C, López-Alled C M, Sedgwick A C, Wenk J, James T D, Lewis S E. A simple, azulene-based colorimetric probe for the detection of nitrite in water. Frontiers of Chemical Science and Engineering, 2020, 14(1): 90–96
24. Deng W, Sun P, Fan Q, Zhang L, Minami T. Highly selective detection of copper(II) by a "ligand-free" conjugated copolymer in nucleophilic solvents. Frontiers of Chemical Science and Engineering, 2020, 14(1): 105–111

25. Maffeis V, Moni L, Stefano D D, Giordani S, Riva R. Diversity-oriented synthesis of blue emissive nitrogen heterocycles and their conjugation with carbon nano-onions. Frontiers of Chemical Science and Engineering, 2020, 14(1): 76–89
26. Xu S, Sedgwick A C, Elfeky S A, Chen W, Jones A S, Williams G T, Jenkins A T A, Bull S D, Fossey J S, James T D. A boronic acid-based fluorescent hydrogel for monosaccharide detection. Frontiers of Chemical Science and Engineering, 2020, 14(1): 112–116

Selfie of Tony D. James (Left) and Adam C. Sedgwick (Right) at the Weizmann Institute in Israel (January 2019)

Adam C. Sedgwick is a Postdoctoral research fellow working under the supervision of Prof. Jonathan L. Sessler at The University of Texas in Austin, Texas. He obtained his PhD with Prof. Tony D. James and Prof. Steven D. Bull at the University of Bath focusing on the development of new synthetic transformations for application in fluorescence sensing. This includes the development of a single molecule that can simultaneously detect multiple biologically relevant analytes at one time (molecular logic gates). His current research interests are in the realms of stimuli-responsive materials, molecular imaging agents, and theranostics agents. To date he has published >40 papers in international peer reviewed journals and has a h-index of 15 (December 2019, google scholar).

Tony D. James is a Professor at the University of Bath and Fellow of the Royal Society of Chemistry, who currently holds a prestigious Royal Society Wolfson Research Merit Award (2017−2022). He has developed a broad interdisciplinary approach to research, with an underpinning focus on the development of modular sensors where he has pioneered a range of reporting regimes.

He has been a visiting professor at Tsukuba, Osaka, Kyushu and Sophia Universities, an AMADEus invited professor at the University of Bordeaux and is a guest Professor at East China University of Science and Technology, Xiamen University, Shandong Normal University, Nanjing University, Shaanxi University of Science and Technology, Changzhou University, Zhejiang University, Qufu Normal University, Henan Normal University and is a Hai-Tian (Sea-Sky) Scholar at Dalian University of Technology.

He has published over 314 publications, including two books, 9 book chapters and 303 papers in international peer reviewed journals. He has an h-index of 67 (December 2019, google scholar). In addition, he received the Daiwa-Adrian Prize for developing scientific networks with Japan in 2013, the inaugural CASE Prize for establishing scientific networks with China in 2015, and the MSMLG Czarnik Award in 2018. Since 2019, he has been a member of the editorial board of *Frontiers of Chemical Science and Engineering*.