Synlett Y. Yang, J. Fan Cluster

Cluster Preface: Functional Dyes

Youjun Yang[*a]
Jiangli Fan[*b]

[a] State Key Laboratory of Bioreactor Engineering, Shanghai Key Laboratory of Chemical Biology, School of Pharmacy, East China University of Science and Technology, Shanghai 200237, China, youjunyang@ecust.edu.cn
[b] State Key Laboratory of Fine Chemicals, Dalian University of Technology, Dalian 116024, China
fanjl@dlut.edu.cn

Published as part of the Cluster *Functional Dyes*

Received: 23.11.2023
Accepted after revision: 23.11.2023
Published online: 08.12.2023 (Version of Record)
DOI: 10.1055/s-0043-1763657; Art ID: st-2023-p00124-c

Youjun Yang (left) received his BS (2002) from the University of Science and Technology of China, and his PhD (2007) with Prof. Robert M. Strongin at Louisiana State University. Then, he joined the Anslyn group at UT Austin as a postdoc. In 2010, he joined the faculty of the school of pharmacy, East China University of Science and Technology (ECUST). His research interests include NIR fluorescent dyes, photo-responsive dyes, and fluorescent molecular probes.
Jiangli Fan (right) obtained her PhD at Dalian University of Technology (2005). Now she is a Professor at the School of Chemical Engineering at Dalian University of Technology, and she received the Distinguished Young Scholars of NSFC (2019). Her research interests mainly focus on the development of functional dyes for biomedical analysis and disease treatment.

Dyes are organic substances that impart color by partially subtracting the ambient light. Nowadays such dyes for aesthetical purposes are often called traditional dyes, to distinguish them from functional dyes. Functional dyes also absorb light and impart color if they happen to absorb the light in the visible spectrum. Yet, they are used not for their color, but for a property associated with their excited state, i.e., heat generation, light emission, or sensitization of other chemical entities. The term of functional dyes emerged late in the 20th century with the growth of the high-tech industry. Yet, human functional use of dyes dated centuries back if not Millennium. For example, psoralen, a natural substance found in the leguminous herb, was exploited in treating skin disorders in ancient Egypt and India. Actually, the functional use of dyes is not a human invention. Mother Nature has been using porphyrin for harvesting light energy for synthesis for billion years. The animal vision is based on the photochemical conversion of iminium from the condensation of retinal and opsin lysine side chain.

Nowadays, functional dyes are a dynamic research area to develop novel molecules capable of conversion of light energy for functional purposes. In this SYNLETT cluster dedicated to 'functional dyes', nine communications and seven accounts are presented by active scientists of this area.

Functional dyes spectrally actively in the visible spectral range, such as α-cyanostilbenes,[1] BOPHY dyes,[2] and aza-BODIPY dyes[3] are reviewed by Kanvah, Hao, and Ravikanth, respectively. Yang and co-workers reported a synthesis of mono-benzannulated xanthene dyes[4] (EC4/ESi4/EP4 dyes) with a deep-red absorption and emission maxima. Yet, functional dyes do not have to absorb light in the visible range. It is a cutting edge of the field to develop dyes absorb beyond the eye-sight limit of ca. 360–780 nm. Therefore, we invited the groups of Yuan to summarize their signature NIR hemicyanine fluorophores[5] and Lei to review their rationale and progress on NIR CX dyes[6].

Fluorescence bioimaging and biosensing is a pillar of modern chemistry, biology, and medicine. Fan and co-workers reported an RNA-binding azo-cyanine dye to distinguish Gram$^{+/-}$ bacteria.[7] Li and co-workers developed an AIE-type small-scaffold fluorescent molecule for lipophagy imaging.[8] While most of the probes are intensity-based, lifetime-based fluorescent probes are sought after for sensing microenvironmental parameters. Xiao and colleagues contributed such a lifetime probe for cell surface pH.[9]

Photosensitizers conventionally refers to molecules to promote the triplet oxygen to singlet oxygen. Now, this term seems to broadly compass functional dyes whose function originates from their triplet-state. There works of this topic by Li,[10] Mula,[11] Chen,[12] and Jiang[13] respectively, are included.

The use of dyes as building blocks of large molecular cage or supramolecular assembly is a challenging research topic. Cao and co-workers reported such a cationic light-

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

absorbing molecular cage for antibiotics.[14] Xu and his group reported an anion-sensitive fluorescent cage.[15] Mahata and co-workers reported assembly-dependent optical properties of perimidinium imide dyes.[16]

Functional dyes are a branch of applied chemistry. Understanding their photophysical and photochemical properties is the basis for their function. However, this is not possible without the ingenuity of generations of organic chemists. For this reason, the aim of SYNLETT is to extend its scope to current work on functional dyes. For this reason, this cluster was organized at the invitation of Prof. Ang Li, an associate editor of SYNLETT. We greatly appreciate the support of all authors contributing to this cluster and thank them for bringing their first-class work to SYNLETT.

Conflict of Interest

The authors declare no conflict of interest.

References

(1) Dahiwadkar, R.; Kaloo, M. A.; Kanvah, S. *Synlett* **2023**, DOI: 10.1055/a-2091-0916.
(2) Yu, C.; Sun, Y.; Jiao, L.; Hao, E. *Synlett* **2023**, DOI: 10.1055/a-2045-2369.
(3) Yadav, B.; Ravikanth, M. *Synlett* **2023**, DOI: 10.1055/s-0042-1751480.
(4) Li, J.; Wei, R.; Zhang, X.; Luo, X.; Qian, X.; Yang, Y. *Synlett* **2023**, DOI: 10.1055/s-042-1752719.
(5) Huang, J.; He, L.; Wang, J.; Xu, J.; Yuan, L. *Synlett* **2023**, DOI: 10.1055/a-2071-4549.
(6) Cheng, J.; Lei, Z. *Synlett* **2023**, DOI: 10.1055/a-2033-8557.
(7) Wu, R.; Li, Z.; Xia, T.; Cai, W.; Du, J.; Fan, J.; Peng, X. *Synlett* **2023**, DOI: 10.1055/s-0042-1751462.
(8) Shi, L.; Yu, A.-W.; Meng, W.-H.; Xie, K.-P.; Li, K. *Synlett* **2023**, DOI: 10.1055/a-2201-3612.
(9) Wu, S.; Zhang, X.; Li, X.; Sun, S.; Wang, Z.-H.; Li, D.; Xiao, Y. *Synlett* **2023**, DOI: 10.1055/a-2012-0232.
(10) Shan, S.; Pang, S.; Qu, Y.; Lu, Y.; Cheng, X.; Li, L. *Synlett* **2023**, DOI: 10.1055/s-0042-1752654.
(11) Koli, M.; Mula, S. *Synlett* **2023**, DOI: 10.1055/a-2086-0530.
(12) Wang, W.; Yao, Q.; Xu, R.; Wang, A.; Chen, P.; Peng, X. *Synlett* **2023**, DOI: 10.1055/a-2082-0818.
(13) Zhou, M. Hu X.; Zhang, D.; Cui, T.; Jiang, X.-D. *Synlett* **2023**, DOI: 10.1055/a-2082-0688.
(14) Dong, Y.; Cheng, L.; Duan, Y.; Xu, H.; Dong, R.; Guo, B.; Cao, L. *Synlett* **2023**, DOI: 10.1055/a-2109-0055.
(15) Zeng, Z.-Y.; Zhao, X.; Huang, J.; Zhu, J.; Jin, T.; Hu, L.; Dou, W.-T.; Xu, L. *Synlett* **2023**, DOI: 10.1055/s-0042-1751486.
(16) Roy, T.; Debnath, I.; Mahata, K. *Synlett* **2023**, DOI: 10.1055/a-2138-7080.