New Bio-imaging Approaches Based on G-quadruplex Fluorescent Complex

Prof. Zhou Nie

College of Chemistry and Chemical Engineering, Hunan University

Abstract

In molecular biology, G-quadruplex secondary structures are formed in nucleic acids that are rich in guanine by Hoogsteen hydrogen bonding and π-π stacking. The unimolecular forms often occur naturally near the ends of the chromosomes, better known as the telomeric regions, and in transcriptional regulatory regions of multiple genes and oncogenes. Likewise, the presence of G4-sequences has been reported in various viruses, and they play crucial roles in the in a virus life cycle. We developed a series of G-quadruplex probes, and exploited their applications in bioimaging, including 1） by exploiting the enzymatically generated randomly arrayed G-quadruplex, we developed a simple, sensitive, and label-free method to in situ detect DNA fragments in apoptotic cells and tissues, which avoids the use of modified nucleotides and tedious washing procedures in traditional methods. 2） We developed several DNA mimics of RFP that exhibit attractive photo-physical properties, including high quantum yield, large Stokes shifts, excellent anti-photo-bleaching properties, and two-photon fluorescence, and further applications of these RFP mimics in long-term real-time imaging of target protein were achieved. 3) We developed a new type of benzothiazole G-quadruplex fluorogenic probe named ThT-NE for HCV genomic RNA imaging and monitoring based on its high specificity to HCV RNA G-quadruplex and favorable cell permeation efficiency. 4) We developed a DNA-based sensor for the ratiometric probing of signaling molecules (e.g. SO_2 derivatives and NO) in the cell membrane microenvironment via molecular engineering of the assembly of DNA motifs with synthetic cofactors. Moreover, with the use of functional nucleic acids as the toolkits, we presented a DNA-mediated chemically induced dimerization (D-CID) nanodevice for non-genetic receptor engineering to control cell behaviors, as well as a near-infrared light-activated DNA-agonist nanodevice for non-genetically and remotely controlled cellular signaling and behaviors in live animals.

Biography

Zhou Nie is a professor at College of Chemistry and Chemical Engineering, Hunan University. He obtained bachelor degree from Nankai University in 2002, and obtained Ph.D. degree from Institute of Chemistry, Chinese Academy of Science in 2007. Since 2007, He started his career at State Key Laboratory of Chemo/Biosensing and Chemometrics at Hunan University. From 2011 to 2012, he received his postdoctoral training at Purdue University. His current research is focused on the development of new chemical-biological tools for detection and regulation of key factors in crucial biological events, such as cellular signal transduction and transcription regulation. Since 2009, He has published 60 papers as correspondence author in high impact journals (IF>5), including ***J. Am. Chem. Soc., Angew. Chem. Int. Ed., Nano Lett., Nucleic Acids Res., Chem. Sci., Anal. Chem., Chem. Commun.*** All his SCI papers have been cited 2700 times by research peers during the past five years (H-index = 36). He was awarded by the National Science Fund for Distinguished Young Scholars in 2017, the "Cheung Kong Scholar" for Young Scholars in 2015, the Ten Thousand Talent Program for Young Top-notch Talent in 2014, the National Science Fund for Excellent Young Scholars in 2012, and Chinese Chemical Society Award for Outstanding Young Chemist in 2015. Now he is an associate editor of "RSC Advances".

References

1. X. Luo, B. Xue, Z. Nie and et al. *J. Am. Chem. Soc.*, 2019, 141, 5182-5191.
2. G. Feng, X. Luo, Z. Nie and et al. *Angew. Chem. Int. Ed.*, 2019, 58, 6590-6594.
3. M. Wang, Z. Nie and et al. *Nano Lett.* 2019, 19, 2603-2613.
4. H. Li, Z. Nie and et al. *Angew. Chem. Int. Ed.*, 2018, 57,10226-10230.
5. G. Feng, Z. Nie and et al. *Nucleic Acids Res.*, 2017, 45, 10380-10392.
6. Z. Liu, X. Luo, Z. Nie and et al. *Anal. Chem.*, 2017, 89, 1892-1899.
7. Z. Liu, Z, Nie and et al. *Chem. Commun.*, 2014, 50, 6875-6878.