A three-dimensional ratiometric sensing strategy on unimolecular fluorescence—thermally activated delayed fluorescence dual emission

With the support by the National Natural Science Foundation of China and partially by the National Key Research and Development Program of China, the research team led by Prof. Zhu LiangLiang (朱亮亮) at the State Key Laboratory of Molecular Engineering of Polymers, Department of Macromolecular Science, Fudan University, cooperated with the research team led by Prof. Ågren Hans from KTH Royal Institute of Technology and Dr. Deng Chao from Zhejiang University, reported recently on a three-dimensional ratiometric sensing strategy on unimolecular fluorescence—thermally activated delayed fluorescence dual emission, which was published in *Nature Communications* (2019, 10: 731).

Visualized sensing through fluorescence signal is a powerful method for chemical and physical detection. In addition to sensing those certain species and substances, it becomes much prosperous currently to apply fluorescent sensors into the local microenvironment, for monitoring different behaviours of the surroundings in various chemical or biological processes. Zhu's group presented a new paradigm for the creation of fluorescence (FL)—thermally activated delayed fluorescence (TADF) Dual Emission on a single molecular emitter. The teams expect that simultaneous change in emission wavelength and lifetime of the TADF signal from the emitter in sensing will ultimately generate a breakthrough to address the above-mentioned obstacles from a multi-mode perspective. Furthermore, from the self-calibration perspective, the general strategy also relies on the dual-emission characteristic, in which the TADF signal served as a sensing signal with its wavelength and lifetime both altered correlated to environmental polarity, whereas the FL one always kept unchanged and played the role as an internal reference. They demonstrated that a 3-D ratiometric luminescent sensing system upon the ratiometric wavelength (*Y*-axis) and lifetime (*Z*-axis) versus polarity (*X*-axis) can be built, which can be applied to reduce the measurement error by half on average, relative to that with generally using a 2-D curve only. After the establishment of the 3-D ratiometric luminescent sensing strategy, the sensor was further applied into a precise detection of the microenvironmental polarity variation in a complex phospholipid system both *in vitro* and *in vivo*, towards providing new insights for convenient and accurate diagnosis of membrane lesions.

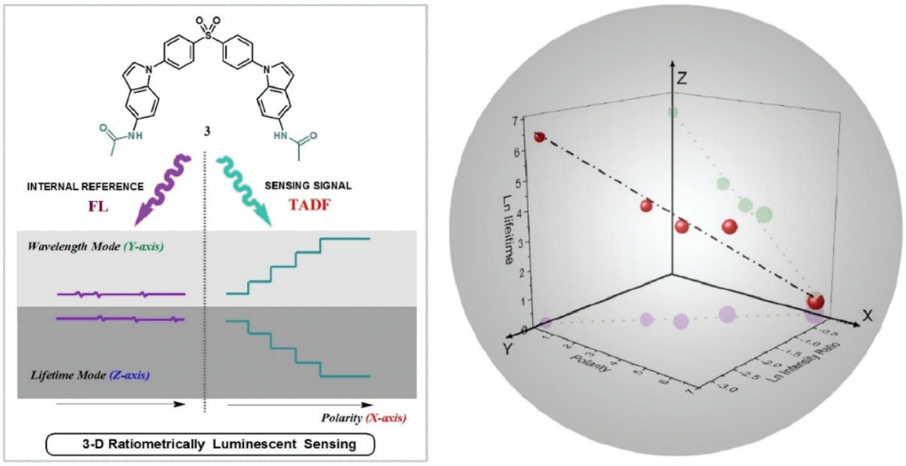

Figure Outline for the construction of a 3-D ratiometric luminescent sensor (wavelength and lifetime ratio versus polarity), with the employment of the TADF from a CT state as a sensing signal, and the FL from the LE state as an internal reference.