Abstract in English

Diketopyrrolopyrrole-based fluorescent probes for cations

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In the past decade, there has been a considerable growth in applying fluorescence technique to cellular imaging. This technique provides unique advantages such as high sensitivity, low cytotoxicity, low cost and non-invasiveness, and makes it a promising tool. Among the wide range of applications of fluorescence technique, sensing of various cations is one of the most important and active areas.

The main objective of my PhD dissertation was the design and synthesis of new generation of fluorescent probes and investigation of their optical properties and bioimaging applications. I have started with extending the novel synthetic methodology for the synthesis of fully asymmetrical diketopyrrolopyrroles developed in our laboratory. Condensation between aromatic nitriles and pyrrolidin-2-one leads to 1,4-diketopyrrolo[4,3-*c*]pyrrole (DPP) derivatives possessing two different C-aryl substituents. The first part of this Thesis explored how the direct linkage of molecular recognition unit to DPP core can affect the optical properties. Taking advantage of the new methodology, I have designed and synthesized new class of diketopyrrolopyrrole sensors directly from nitriles possessing (aza)crown ethers leading to macrocycle-dye hybrids. Their strong interaction with cations possessing Lewis acid character such as Li^+, Mg^{2+} and Zn^{2+} leads to significant changes of optical properties, hence to the new fluorescent probes.

In the second part of my work, I synthesized novel highly sensitive potassium probes with the strategic placement of a recognition crown ether unit at most conjugated position of the second aryl substituent of diketopyrrolopyrrole core. These D-A-D' hybrid fluorophores exhibits very high fluorescence quantum yields (Φ_{fl} = 0.8-0.9%) even in CH_3CN. An additional lariat alkoxy group at *ortho* position to aza-18-crown-6 induces strong coordination to K^+ with 80 nm blue-shift of fluorescence. The incorporation of PPh_3^+ group enables the probe to be selectively accumulated

in mitochondria of cardiac H9C2 cells and it makes it possible to observe the fast efflux/influx of mitochondrial K^+ upon stimulation with nigericin.

In the final part of my thesis, I designed and synthesized diketopyrrolopyrrole-based novel highly sensitive fluorescent zinc sensors directly from pyridine-derived nitriles possessing dipicolylamine as a zinc recognition unit. The obtained DPP sensors showed favorable photophysical properties including strong bathochromic shifts (≈80nm) of fluorescence upon complexation with Zn^{2+} and high fluorescence quantum yields. The probes decorating with PPh_3^+ and morpholine units are selectively localized in mitochondria and lysosomes of cardiac H9C2 cells respectively.