Development of Cyclodextrin-Based Fluorescent Probes in Water

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There is a growing interest in the development of host molecules capable of recognizing ions and molecules in water, due to their potential use in analytical chemistry and biomedical research. Cyclodextrins (CDs) are attractive host molecules because they possess hydrophobic cavities that incorporate organic molecules in water. However, the cavity size of CDs limits the range of guests to be incorporated. In addition, it is difficult to detect complexation of CDs by simple and sensitive methods such as fluorescence spectroscopy, since CDs are optically transparent. To overcome those limitations, we have developed CD-based fluorescent probes by combining CDs with other host molecules and fluorophores.

The CD-based fluorescent probes can be divided into three categories: (i) inclusion complexes between a fluorescent probe and CD; (ii) inclusion complexes between a host molecule and a fluorophore-modified CD, or inclusion complexes between a fluorophore and modified CD possessing another guest binding site; (iii) modified CDs possessing both a fluorophore and another guest binding site. An example of the first category is the inclusion complex between γ-CD and the crown ether probe possessing pyrenyl moiety. The crown ether probe is selective to Na^+ in organic solvent; however, it forms a 2:1 complex with γ-CD, which provides a highly selective binding site for K^+ in water. An example of the second category is the inclusion complex between the pyrene-appended α-CD and the alkyl chain-modified crown ether, which selectively responds to K^+ in water. The molecular recognition functions of CD-based fluorescent probes will also be presented.