Fluorescent nucleic acid systems are widely applied in various fields, from fundamental biological probes to nano-construction. Nucleic acids are used as a scaffold for arranging aromatic fluorophore assemblies, either by insertion into the DNA base pairs or by stacking via the duplex. Moreover, chemical modifications of nucleic acids are accessible by the modified DNA phosphoramidites or postsynthetic approach, and provide with new and interesting fluorescent nucleic acids systems. Fluorescent nucleic acid systems represent an extensive and exciting research area in chemistry as well as in biotechnology and photophysics. We synthesized and investigated new fluorescent nucleic acid systems for probing single nucleotide polymorphisms (SNPs), structural changes of DNA, ligand interaction with RNA bulge, and applying various optical devices.

We have developed the new type of molecular beacon, quencher-free molecular beacon (QF-MB), that exhibits several advantageous features, including a high level discrimination between the target and its single-mismatched congeners and an economical device set-up due to the absence of the quencher. We have also designed and synthesized the probing system for quadruplex structures of DNA, G-quadruplex and i-motif, and B-Z transition. Strong π–π stacking interactions in nucleic acids can be used to generate novel secondary structures. We investigated the fluorescent phenomena and structures of pyrene modified oligodeoxyadenylate and oligodeoxyguanylate. The covalently linked pyrenes induced the formation of a self-assembled oligodeoxyadenylate duplex and divergent structures of oligodeoxyguanylate with unique fluorescence phenomena.