Vivian W.W. Yam

Lavoisier Lectures – Title and Abstracts

I. From Simple Discrete Metal Complexes to Supramolecular Assembly and Nanostructures

Recent works in our laboratory have shown that novel classes of light-absorbing and luminescent metal-containing molecular materials could be assembled through the use of various metal-ligand chromophoric building blocks. In this presentation, various design and synthetic strategies will be described. A number of these metal-ligand chromophoric complexes have been shown to display rich optical and luminescence behavior. Correlations of the chromophoric and luminescence behavior with the electronic and structural effects of the metal complexes have been made to elucidate their spectroscopic origins. These simple discrete metal complexes are found to undergo supramolecular assembly to give a variety of nanostructures and morphologies. By understanding the spectroscopic origin and the structure-property relationships, different approaches and assembly motifs have been employed to tune their electronic absorption and emission characteristics. Subtle changes in the microenvironment and nanostructured morphologies have led to drastic changes in both the electronic absorption and emission properties of these supramolecular assemblies. Explorations into the underlying factors that determine their spectroscopic properties and morphologies as well as their assembly mechanisms have provided new insights into the understanding of the interplay of the various intermolecular forces and interactions for the directed assembly of novel classes of metal-containing soft materials and hybrids.

II. New Strategies Towards Design of Luminescent Metal-Ligand Chromophoric Ensembles, Conjugates and Nano-Assemblies for Sensing, Molecular Imaging and Bioassays

The constant search for materials with new and improved properties has led to a variety of investigations into molecular materials and a growing interest in the exploration of molecular-based functional materials research. Molecular functional materials are made up of molecules that could perform a specific function or task at the molecular level. This increasing interest in the search for new molecular materials based on pure organic and metal-organic systems mainly stems from the versatility of materials development through rational design studies and elucidation of the structure-property relationship at the molecular level. In this presentation, various new classes of chromophoric and luminescent metal complexes of selected metals will be described. A systematic study of the electronic spectroscopy of the metal complex systems has provided fundamental understanding on the spectroscopic and luminescence origin as well as the structure-property relationship of these complexes. Through a fine control of the interplay amongst various coordination motifs, electrostatic assembly and non-covalent metallophilic, hydrophobic-hydrophobic and π-π interactions, together with the modulation of various photo-induced electron and energy transfer processes, new strategies towards the rational design of luminescent metal-ligand chromophoric ensembles, conjugates and nano-assemblies that would lead to changes in the absorption and emission characteristics for potential applications and functions in luminescence sensing, molecular imaging and bioassays, have been made.

III. Versatile Chromophores and Excited States - From Fundamentals to Molecular Materials for Optoelectronic, Photonic and Memory Functions

Functional materials research is one of the top priority strategic areas of development in science and technology of the century. Organic and metal-organic molecules can serve as versatile building blocks for molecular-based functional materials; they can be rationally engineered and prepared, and their optical and electronic properties are tunable with a proper understanding of structure-property relationships. Development of molecular-based materials is deemed to provide impetus and offers enormous potential for materials science research and development in the forthcoming decades. There has been an immense interest in the search for versatile chromophores and excited states for efficient light harvesting and optoelectronic and photonic functions, in particular the design of metal-organic compounds with interesting luminescence properties for the applications in organic light-emitting devices (OLEDs) for solid-state lighting as well as organic and metal-organic materials with strong light-harvesting properties for the applications in solar energy harvesting and organic photovoltaic (OPV) devices. Recent works in our laboratory have shown that novel photofunctional materials could be assembled through the use of various organic and metal-ligand chromophoric building blocks. In this presentation, a number of metal-ligand chromophoric complexes, coordination compounds and molecules will be described. Through rational design and various strategies, these molecular materials may find potential applications and functions as photosensitizers, efficient triplet emitters for small-molecule and solution-processable organic optoelectronics, photonics, and as materials for photoresponsive molecular switches, optical memories and organic memories.