The supramolecular aggregates of $\pi$-conjugated molecules have become an area of great interest to the scientific community in recent years for their promise in biosensors and optoelectronic devices. Among various supramolecular aggregates, J- and H-aggregates of $\pi$-conjugated dye molecules are particularly interesting because of their unique optical and excitonic properties that are not given by individual molecules. H-aggregates are composed of dye molecules in a face-to-face stacking, giving rise to a blue-shifted absorption band compared with the monomer band and a strong emission quenching. In contrast, J-aggregates represent an edge-to-edge stacking of dye molecules, showing a red-shifted absorption band with respect to the monomer band and a strong fluorescence emission. However, the use of J- and H-aggregates in biosensors and optoelectronic devices remains a challenge because of the difficulty of controlling their sizes and morphologies.

In this dissertation, we develop two different paths for controlling the size and morphology of J- and H-aggregates. First, we show that the co-assembly of cyanine dyes and lithocholic acid (LCA) in ammonia solution can lead to the formation of mesoscopic J- and H-aggregate fibers, depending on the condition under which the co-assembly occurs. Second, we report the formation of mesoscopic J-aggregate tubes by using the preformed LCA tubes as a template. The structure, optical, and electronic properties of these J- and H-aggregate fiber and tubes are studied as a function of temperature. Finally, we exploit their applications as photo-induced electron transfer supramolecular probes for the detection of dopamine, an important neurotransmitter in central and peripheral nervous systems.

Major: Materials Science and Engineering

Educational Career:
Bachelor's of Physics, BS, 2014, Lycoming College

Committee in Charge:
Jiyu Fang, Chair, Materials Science and Engineering
Tengfei Jiang, Materials Science and Engineering
Stephen Florczyk, Materials Science and Engineering
Yajie Dong, Materials Science and Engineering
Shuo Pang, CREOL

Approved for distribution by Jiyu Fang, Committee Chair, on March 7, 2018.

The public is welcome to attend.