The supramolecular aggregates of π-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 π-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.