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Water-Soluble Conjugated Polymers: Self-Assembly and Biosensor Applications

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Homogeneous assays can be designed which take advantage of the optical amplification of conjugated polymers and the self-assembly characteristic of aqueous polyelectrolytes. For example, a ssDNA sequence sensor comprises an aqueous solution containing a cationic water soluble conjugated polymer such as poly(9,9-bis(trimethylammonium)-hexyl)-fluorene phenylene) with a peptide nucleic acid (PNA) labeled with a dye (PNA-C*). Signal transduction is controlled by hybridization of the neutral PNA-C* probe and the negative ssDNA target, resulting in favorable electrostatic interactions between the hybrid complex and the cationic polymer. Distance requirements for Förster energy transfer are thus met *only* when ssDNA of complementary sequence to the PNA-C* probe is present. Signal amplification by the conjugated polymer provides fluorescein emission >25 times higher than that of the directly excited dye. Transduction by electrostatic interactions followed by energy transfer is a general strategy. Examples involving other biomolecular recognition events, such as DNA/DNA, RNA/protein and RNA/RNA, will also be provided. The mechanism of biosensing will be discussed, with special attention to the varying contributions of hydrophobic and electrostatic forces, polymer conformation, charge density, local concentration of C*s and tailored defect sites for aggregation-induced optical changes. Finally, the water solubility of these conjugated polymers opens possibilities for spin casting onto organic materials, without dissolving the underlying layers. This property is useful for fabricating multilayer organic optoelectronic devices by simple solution techniques.