"Benefits of electrostatic interactions for solar energy and how to probe them"

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Electrostatics, a result of one of the fundamental forces of nature, govern and underlie fundamental processes of chemistry, biology and modern technologies, including solar-energy conversion. Peptides and other natural macromolecules owe their structural integrity and functionality to electrostatics. This talk will discuss two structural paradigms where electrical interactions play a central role. (1) Poly-L-lysine (PLL), along with other biological polyelectrolytes, can serve as templates for self-assembly of supramolecular structures and materials. Reported spectroscopic studies show that Eosin-Y (EY), a negatively charged dye, interacts with PLL to form structures with new electronic properties that can be potentially important for light harvesting and energy conversion. The structures of these biomimetics, however, is not well understood. Therefore, we undertook systematic studies to establish structure function relationships for PLL/EY self-assemblies. Circular dichroism (CD) shows feature of ordered helical structures of excitonically coupled moieties that the EY chromophores assume on the PLL templates, as the ellipticity in visible spectral region reveals. Furthermore, in the presence of EY, PLL exhibits CD features associated with protein alpha-helical conformations. In the absence of EY, PLL exists 100% as a random coil. This synergy between templated macromolecule and templated chromophores opens doors for explorations in photonics and biomimetic electronics. (2) Anthrilamides (Aa) are favored for their large dipoles and the strong localized electric fields they generate. We have demonstrated multiple times that these dipole-generated fields induce pronounced rectification of charge transfer. Despite its importance, the fields around Aa conjugates have not been experimentally characterized yet. By attaching electrochromic probes, such as an aminocoumarin, on either side of the electret moieties, allows us to use the induced Stark Effects for quantification of the dipole-generated electric fields. This approach toward direct quantification and mapping of the electric fields around molecular electrets can be readily adopted for facial optical probing of the electrostatic properties of biological structures, nanomaterials and materials interfaces.