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Online Proceedings

POSTER SESSION 2

Balcony, Easel 112

12:45 PM to 2:15 PM

Phase Behavior of Dilute Block Copolymer and Protein Mixtures

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Mary Gates Scholar

Mentor: Lilo Pozzo, Chemical Engineering

The behavior of polymer/protein mixtures has been widely studied within the framework of depletion forces, a colloidal phenomenon driving the attraction of like-particles due to osmotic pressure. However, the behavior of dilute polymer/protein mixtures is still not fully understood. Ordered protein structures, such as crystals and colloidal clusters, could be achieved by tuning excluded volume interactions through the modification of polymer conformation. The temperature-dependent morphology of block copolymers allows us to fine-tune these depletion interactions. To assess phase behavior in a model system, aqueous mixtures of protein (bovine serum albumin) and block copolymer (PEO_x-PPO_y-PEO_x) have been created. Electrostatic interactions between proteins were screened by adding salt to the mixtures. The dependence of phase behavior on these parameters was determined using UV-Vis spectroscopy to measure turbidity. The morphology and size of protein structures was also evaluated using optical microscopy and dynamic light scattering. Mixtures with higher polymer concentrations displayed an increased propensity to develop turbidity at low temperatures. This effect was mitigated upon reaching the polymer micellization temperature, whereupon the decreased osmotic pressure reversed protein aggregation, resulting in a clear solution. Defining the conditions required for the formation of ordered protein aggregates in polymer media has valuable implications for biology and medicine. This work represents a step towards determination of the optimum conditions for creating protein crystals suitable for structural proteomics and colloidal clusters for drug-delivery.

POSTER SESSION 2

Balcony, Easel 113

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Aqueous Dispersions of Composite Nanoparticles for Polymer Solar Cell Applications

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Mentor: Lilo Pozzo, Chemical Engineering

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Poly(3-hexylthiophene) (P3HT) and 6,6-phenyl-C60 butyric acid methyl ester (PCBM) are model materials used to study and understand the performance of polymer solar cells. A critical design parameter in improving device performance is the structural morphology of the active layer. Traditional processing of organic solar cells involves the deposition of a P3HT/PCBM composite film from a common solvent and then post-processing treatments (i.e. annealing) to influence the extent of phase segregation and improve the percolation of electron and hole transport pathways throughout the film volume. Therefore, the electronic properties of the resulting solar cells are inherently tied to how the film is processed (e.g. choice of solvent, annealing temperature, film thickness). While process optimization has led to improvements in laboratory performance, it is challenging to extend the same principles to improve the performance of large scale roll-to-roll processes because deposition conditions vary significantly. Increasingly, researchers recognize the need for methods that decouple film processing from active layer structure and device performance. My research involves the synthesis of P3HT/PCBM composite nanoparticles (CNPs) in aqueous dispersion as a means to circumvent the dependence of active layer structure on the specific mode of deposition of the P3HT/PCBM film. I have synthesized CNPs with variable content of P3HT/PCBM and different preparation procedures while also controlling particle size. The characterization of these particles focuses on spectroscopy, small angle X-ray scattering (SAXS), dynamic light scattering and the performance evaluation of devices produced with CNP active layers. This project will tie device performance to CNP structure regardless of active layer processing, and assist in identifying CNPs with optimized morphology without the need for annealing or post-processing.