254i Rheology and Sans of Block Copolymer - Protein Nanocomposites

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Self-assembled block copolymer phases, consisting of close-packed crystals of spherical and cylindrical micelles, provide control of the spatial location of templated proteins; bovine serum albumin and egg lysozyme. The mechanical properties and the nanometer structure of these protein-copolymer composite materials are characterized using rheology and small angle neutron scattering (SANS) under shear flow. PEO-PPO-PEO hydrogels are used in biotechnology applications involving controlled delivery of pharmaceuticals[1] and as sieving media for the electrokinetic separations of proteins and DNA.[2] Due to the increasing number of applications that involve dispersing biomolecules in these hydrogel phases, there is a need to fully characterize the properties and structure of these nanocomposites. In this work, significant concentrations (up to 50 mg/mL) of globular proteins have been fully dispersed in the polymer phase owing to the thermoreversible properties of the polymer (reverse gelation) and the repulsive protein-protein interactions. After full protein dispersion at low temperatures, the structured polymer phase is induced by increasing the sample temperature. The dispersed proteins then remain "trapped" in the interstitial cavities of the micelle crystals.[3] Here we evaluate the effects of relative size (protein and polymer template), relative concentration and shear on the rheology and nanometer structure of the nanocomposites. It is found that the mechanical properties are especially affected when the concentration of dispersed nanoparticles approaches and exceeds the number of available template sites. Finally, we evaluate the effect of the constrained environment on the thermal denaturing of the dispersed proteins.

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[2]Wu, C. H.; Liu, T. B.; Chu, B. J.; Schneider, D. K.; Graziano, V. Macromolecules 1997, 30, 4574-4583.

[3]Pozzo, D. C.; Hollabaugh, K. R.; Walker, L. M. J Rheol 2005, 49, 759.