14.0 Photon Correlation Spectroscopy and Applications

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14.1 Structure and Dynamics of Colloidal Solutions Studied by Small Angle Neutron Scattering and Photon Correlation Spectroscopy

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Small angle neutron scattering technique has been used to study systematically the structure and interaction of ionic and zwiterionic micelles formed from ionic and polar surfactants in aqueous solutions. A recently developed theory of highly asymmetic ionic liquids has been shown to apply to dense micellar solutions where the charge density on the micellar surface is very high. Combination of the structural studies and the theoretical evaluation of the inter-micellar correlations allow an unambiguous analysis of neutron scattering data to obtain: 1) micellar aggregation number; 2) renormalized micellar charge; and 3) micellar shape, size and hydration as functions of the surfactant and salt concentrations. Thus, the micellar growth and polydisperity can be simultaneously studied.

A series of zweiterionic micelles formed from short chain lecithins (dihexanoylphosphatidylcholine, diheptanoylphophatidylcholine, etc.) have been studied. In contrast to the long-chain lecithins (C_{14} and longer) which form bilayers and therefore are important for studies of artificial membranes, the short-chain lecithins form globular micelles. However, the conformational features of the head groups are expected to be the same in the two cases. We have analyzed the SANS data using a thermodynamic model, called ladder model, which is expected to be valid for cylindrical micelles. This model contains three parameters, namely, the minimum size micelle N_o, the free energy advantage of inserting N_o monomers in the straight section of the cylinder as compared to that in the end caps, $(\Delta - N_o)/\kappa_B T$, and the free energy of inserting a monomer, $\delta/\kappa_B T$, once the minimum micelle is formed. This model is capable of explaining the phenomenon of critical micelle concentration and the growth and polydispersity of the micellar system as functions of concentration and temperature. SANS data was shown to yield all three basic parameters of the theory and to provide the size and size distribution of the cylinders.

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A high resolution spectroscopic technique based on analyses of scattered light intensity fluctuations has been in use for some time. Our method is based on the digital time-domain pulse correlation technique using a 256-channel clipped correlator developed in the laboratory. The correlator-multichannel memory system is controlled by a PDP 11/MINC computer system which is capable of high-speed data acquisition and analysis necessary for the study of time-varying phenomena.

We have applied this photon correlation technique to study the Brownian dynamics of strongly interacting colloidal systems. Interesting results on the variation of mutual diffusion coefficient of the micellar solutions with addition of salts and alcohol have been observed.

Publications

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14.2 Basic Studies of Laser-Cell Interactions

Wan-Yuan Company, Beijing, Peoples Republic of China Contract

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An instrument consisting of a copper vapor laser coupled to an optical fiber/chemical injector catheter for the treatment of occluded arteries has been constructed and tested.

The combined application of three steps: the pre-irradiation injection of a light absorbing dye, HPD, brief copper laser irradiation (at 578 nm), and a urokinase infusion after the irradiation, produced the striking effect of liquification and resolution of thrombus. The histological examination of the arteries after the treatment showed no apparent damage of the arterial wall.

Publication

Wei, X.B., X.Y. Wang, and S.-H. Chen, "A Copper Vapor Laser and Optical Fiber Catheter System for Liquification and Removal of Thrombus in Occluded Arteries." Sent to Lasers in Surgery and Medicine. "Method and Apparatus for Laser Angiosurgery," to be published in 1987.