9. Optical Spectroscopy of Disordered Materials and X-Ray Scattering from Surfaces

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A. Studies of Micellar Liquid Crystals

In this program, we are studying the structure of ordered phases of surfactants. We use three experimental techniques. To study orientational long range ordering, we use quasielastic light scattering, while time-resolved spectroscopy gives us information on orientational short range order and dynamics. Finally, x-ray scattering is used to study positional order of the molecules.

In last year's report, we explained the theory behind the time-resolved method and how our data showed that dye probe molecules were oriented on average by the surfactant, but that dynamical information was difficult to obtain from probes whose fluorescence lifetime was only 2 to 2.5 ns. We have since tested dyes with significant triplet conversion and found one, rose bengal, whose fluorescence lifetime exceeds 12 ns. We have not yet used it to study the rotational diffusion of micelles. We have used birefringence measurements to study the average orientational order parameter in aqueous solution of the soap cesium perfluoro-octonate (CsPFO) and found a very weakly first order transition; it is not yet understood why this should be so weak.

B. Study of Surfaces

Our eventual plan is to study surfaces by x-ray scattering. Some of these will use an x-ray compatible high vacuum apparatus which is described in more detail in R. Birgeneau's report (see Chapter 5). This apparatus has recently been tested and obtained a vacuum of 10^{-11} Torr. Other surface experiments involve the spreading and ordering of organic molecules on liquid metal (e.g., mercury) substrates. We expect to use a combination of x-ray scattering and optical second harmonic generation to study the structure of these films. Preliminary experiments have been carried out where cyano biphenyl liquid crystals have been spread on mercury. These molecules are expected to lie flat on the surface and should provide a realization of a two-dimensional smectic material where only short range order is permitted according to current statistical mechanical concepts.

We have just spent a week studying CsPFO using an 8 pole wiggler beam line at the Stanford Synchrotron Radiation Laboratory. This has provided us with preliminary data while we await the commissioning of our beam line at the Brookhaven National Synchrotron Light Source.