LIQUID CRYSTAL MATERIALS RESEARCH CENTER

PHYSICS DEPARTMENT COLLOQUIUM

Optical Nanotomography of Anisotropic Fluids

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Abstract

The physical properties of anisotropic fluids can be manipulated on very short length scales of 100 nm or less by appropriate treatment of the confining substrate(s). This facilitates the use of ordered fluids, such as liquid crystals, in a variety of applications ranging from displays to switchable optical elements such as gratings and lenses. Future advances will require a full understanding of the liquid crystal's structure at the nanoscale level. But owing to diffraction limitations, high resolution three dimensional imaging of the fluids's molecular orientation profile has been beyond the reach of extant optical techniques. Here we present a powerful new imaging approach based on the use of polarized light emitted from a tapered optical fiber to investigate molecular orientation in three dimensions at nanoscale levels. We immerse the fibers tip inside a thin layer of the fluid — in our case a nematic liquid crystal — that sits atop a substrate and raster-scan the fiber at a series of heights above the surface. From the images collected in the far field we are able to obtain a three dimensional visualization of the liquid crystal's structure with a resolvable volume nearly three orders of magnitude smaller than attainable by extant methods. We demonstrate this technique by examining a nematic liquid crystal whose director orientation is controlled by a nanoscopic pattern scribed into the underlying polymer-coated substrate. We are able to image the extrapolation length L ~ 200 nm over which the molecular orientation relaxes due to the liquid crystals elastic forces. This technique of acquisition and analysis of image slices offers the intriguing possibility of 3D nanoscale reconstruction of a variety of other soft materials.

Wednesday March 19, 2008 at 4:00pm
Duane Physics G1B-20

Coffee, tea, and cookies before regular colloquia at 3:45 PM in Duane G1B31