LIQUID CRYSTAL MATERIALS RESEARCH CENTER

SPECIAL SEMINAR SERIES

Liquid Crystal Refractive Indices and Their Applications in Displays and Photonic Devices

Jun Li
Photonics and Display Group
College of Optics and Photonics/CREOL & FPCE
University of Central Florida
November 2, 2005

This seminar reports on the investigation of liquid crystal refractive indices and their applications in displays and photonic devices. Liquid crystals (LCs) are important materials for flat panel display and photonic devices. Most LC devices use electrical field-, magnetic field-, or temperature-induced refractive index change to modulate the incident light. Molecular constituents, wavelength, and temperature are the three primary factors determining the liquid crystal refractive indices: n_e and n_o for the extraordinary and ordinary rays, respectively. We derive several physical models for describing the wavelength and temperature effects on liquid crystal refractive indices, average refractive index, and birefringence. Based on these models, we develop some high temperature gradient refractive index LC mixtures for photonic applications, such as thermally tunable liquid crystal photonic crystal fibers and thermal solitons.

Wavelength effect on LC refractive indices is important for the design of direct-view displays. We derive the extended Cauchy models for describing the wavelength effect on liquid crystal refractive indices in the visible and infrared spectral regions based on the three-band model. The three-coefficient Cauchy model could be used for describing the refractive indices of liquid crystals with low, medium, and high birefringence, whereas the two-coefficient Cauchy model is favored for low birefringence liquid crystals. The critical value of the birefringence is ~0.12. Temperature is another important factor affecting the LC refractive indices. The thermal effect originated from the lamp of an LCD projector affects the performance of the employed liquid crystal. We derive the four-parameter and three-parameter parabolic models for describing the temperature effect on the LC refractive indices.

Liquid crystals exhibit a large thermal nonlinearity which is attractive for new applications using photonic crystal fibers. We derive the physical models for describing the temperature gradient of the LC refractive indices, dn_e/dT and dn_o/dT, based on the four-parameter model. We formulated two novel high dn_o/dT liquid crystals, UCF-1 and UCF-2. The dn_o/dT of UCF-1 is about 4X higher than that of 5CB at room temperature. We infiltrate UCF-1 into the micro holes around the silica core of a section of three-rod core PCF and set up a highly thermal tunable liquid crystal photonic crystal fiber cooperating with a Danish group. The thermal tuning sensitivity of the spectral position of the bandgap was measured to be 27 nm/^{o}C around room temperature, which is 4.6X higher than that using the commercial E7 LC mixture operated at a temperature above 50 ^{o}C. Lastly, I will present the study on index-matched polymer dispersed liquid crystals (PDLCs) based on extended Cauchy model and four-parameter model.

Wednesday, November 2 at 1:00 p.m.
Duane Physics 11th Floor Commons Room

Sponsored by the Liquid Crystal Materials Research Center
Department of Physics, University of Colorado.

http://flcmrc.colorado.edu