Nanoscale Alignment and Optical Nanoimaging of a Nematic Liquid Crystal

V. Barna [a], A. De Luca [b] and C. Rosenblatt [c]

[a] *Faculty of Physics, University of Bucharest, PO Box Mg-11, 077125, Bucharest, Magurele, Romania.*
[b] *LICRYL-CNR-INFM, Department of Physics, Ponte P Bucci, Cubo 33B, 87036 Rende (CS), Italy.*
[c] *Department of Physics, CaseWestern Reserve University, Cleveland, OH 44106-7079, USA.*

An anisotropic nanopatterning method, based on an atomic force microscopy (AFM) scribing technique of a thin polyimide film, is used to generate an alignment layer whose topography depends on the writing direction. Detailed experimental measurements are presented for the topographical anisotropy that arises when the polyimide alignment layer is scribed parallel and anti-parallel to the AFM cantilever orientation. Using a novel nanotomography technique, a thin optical fiber is raster-scanned at several fixed heights inside a liquid crystal film that covers the scribed substrate, while the optical retardation δ from the fiber's aperture to the polyimide interface was measured as a function of fiber position x,y,z, out to a height of z ~ 500 nm. With unprecedented resolution of only a few nanometers, visualization of the fluid's structure is possible with a resolvable volume 1/500 of that attainable by current methods. The optical results also replicate the spatially-varying depth of the medium due to the polymer film surface topography. Theoretical predictions for δ are in excellent agreement with both the obtained topographical and the high resolution nanoimaging experimental results. This novel nanotomography technique offers the intriguing possibility of three-dimensional nanoscale reconstruction of a variety of soft materials, here the first direct visualization and measurement of the liquid-crystal molecular orientation relaxation length.

References

(1) V. Barna, A. De Luca, C. Rosenblatt, *Nanotechnology*, **2008,** *19*, 32.
(2) A. De Luca, V. Barna, T. Atherton, G. Carbone, M. Sousa, C. Rosenblatt, *Nature Physics*,**2008**, *4*, 869.