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Modifying the Electrical Properties of Liquid Crystal Cells by Including TiO_2 Nanoparticles on a Substrate

Authors : V. Marzal, J. C. Torres, B. Garcia-Camara, Manuel Cano-Garcia, Xabier Quintana, I. Perez Garcilopez, J. M. Sanchez-Pena

Abstract : At the present time, the use of nanostructures in complex media, like liquid crystals, is widely extended to manipulate their properties, either electrical or optical. In addition, these media can also be used to control the optical properties of the nanoparticles, for instance when they are resonant. In this work, the change on electrical properties of a liquid crystal cell by adding TiO_2 nanoparticles on one of the alignment layers has been analyzed. These nanoparticles, with a diameter of 100 nm and spherical shape, were deposited in one of the substrates (ITO + polyimide) by spin-coating in order to produce a homogeneous layer. These substrates were checked using an optical microscope (objective x100) to avoid potential agglomerates. The liquid crystal cell is then fabricated, using one of these substrates and another without nanoparticles, and filled with E7. The study of the electrical response was done through impedance measurements in a long range of frequencies (3 Hz- 6 MHz) and at ambient temperature. Different nanoparticle concentrations were considered, as well as pure E7 and an empty cell for comparison purposes. Results about the effective dielectric permittivity and conductivity are presented along with models of equivalent electric circuits and its physical interpretation. As a summary, it has been observed the clear influence of the presence of the nanoparticles, strongly modifying the electric response of the device. In particular, a variation of both the effective permittivity and the conductivity of the device have been observed. This result requires a deep analysis of the effect of these nanoparticles on the trapping of free ions in the device, allowing a controlled manipulation and frequency tuning of the electrical response of these devices.

Keywords : alignment layer, electrical behavior, liquid crystal, TiO_2 nanoparticles
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