Development of high performance electro-optical films by sol-gel method

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GDLC (Gel-Glass Dispersed Liquid Crystal) materials were first reported in 1991 [1]. GDLCs are, in their nature sol-gel analogs to polymer dispersed liquid crystal materials (PDLCs) composing of organically modified silica [1-3] or mixed oxide [4] dispersed liquid crystal. GDLC material strongly scatters light in its normal state and changes its optical transmittance when electric field is applied, becoming more transparent. In order to achieve high performance, refractive index of the matrix must match the ordinary refractive index of the liquid crystal and the film thickness must be in order of 10μm. Achieving these conditions has been very difficult until now.

GDLC has several potential advantages over PDLC: smaller solubility of LC inside the matrix (smaller amount of LC needed in preparation of unit volume of the film material), better resistance to ultraviolet radiation, easier to control LC director field configuration through droplet shape and surface anchoring forces, determined by the chemical composition. Also, refractive index of the matrix is more easily tunable due to the availability of large amount of suitable precursors. The main potential applications of GDLC materials is “smart glass” (window with variable transmittance).

In this work we report the significant improvement compared to our previously reported results [3]. GDLC film preparation process was elaborated to incorporate titanium alkoxides in synthesis process. This enabled the adjustment of the refractive index of silica glass matrix without having destructive influence on macroscopic liquid crystal phase separation at the same time. A high-performance xerogel-liquid crystal composite electro-optical film that exhibits a 75.9 % change in its transmittance as an electric field is applied was prepared. Field-dependent scattering behaviour of a refractive index matched GDLC film over a broad spectral (from visible to near-IR) and temperature range was investigated. Transmittance vs. applied voltage measurements at different temperatures demonstrate electro-optical effects at least down to -13 °C which means that liquid crystal must be in molten (liquid crystal) state at these temperatures in the microscopic volume confined in xerogel matrix. That is remarkable since it is known that the used liquid crystal 4-cyano-4'-pentylbiphenyl crystallizes in macroscopic volume at 24.5 °C. The largest electro-optical effect was observed at 25.2 °C.

References

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Figure

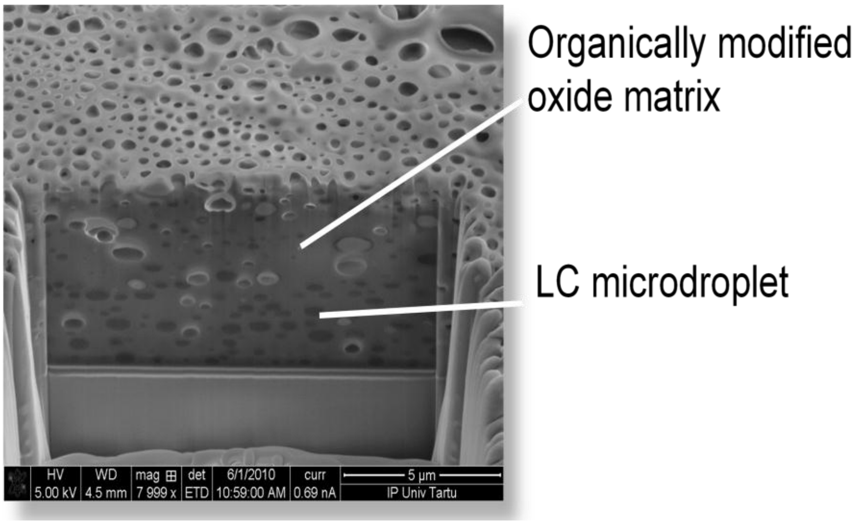

Fig. Cross-section of GDLC material.