

Mass production of patterned polymerizable liquid crystal devices by roll-to-roll technology

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Abstract

Roll-to-Roll fabrication of patterned liquid crystal films and film-based devices is one of the most promising and anticipated LCD technology of today. The constraint of mass production is the suitable alignment process. The problem of high anchoring patterned liquid crystal alignment on plastic substrates has been challenged for over a decade. We solved it. The possibility of R2R fabrication of retarders with custom azimuthal angle, patterned retarders and vortex retarders is demonstrated.

1. Key Points and Factors

Studying of alignment materials [1] and method [2] revealed that efficient fabrication of 'polymerizable liquid crystal devices on flexible substrates' needs re-thinking of the whole concept with respect to the factors pointed below.

The breakthrough innovation in production of patterned PLC devices by R2R technology is based of revolutionary approach to LC alignment process utilizing both novel low temperature materials and innovative high-speed patterned alignment technology.

Flexible substrate rolls require *low temperature process* materials with operation temperatures below 70°C enabling all kinds of standard plastic films including PET, TAC, PC and others available awing for reduction of substrate cost.

R2R technology means *full compatibility* of the process flow with the present available *roll handling equipment* allowing utilization of standard equipment for reduction of processing costs. However all process operations performing at each single rolling are *synchronized* for *high-speed* process with *high yield*.

The polymerization rate of suitable liquid crystal monomer film provides *degree of polymerization over 90+%* before rolling the substrate.

A wide range of thin film polymerizable liquid crystal devices were developed and currently are available by roll-to-roll technology in Minsk, Belarus.

2. Security Labels

Innovative security labels with hidden polarization images with dynamic effects that appear when your turn the polarizer, vario images (Fig.1) and many others were developed.

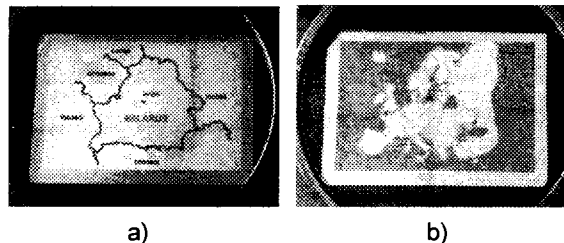


Figure 1: Vario image observed through polarizer: a) & b) change each other with polarizer rotation

3 Retarder Film

Thin film **retarder** on TAC substrates with custom azimuthal angle with respect to the roll direction are available in rolls and sheets. The $\lambda/4$ and $\lambda/2$ retarders @ 550 nm with diagonal 45 deg azimuthal alignment are available, while other retardation values are possible as well.

High resolution patterning of azimuthal direction allows **Patterned Retarder** with azimuthal angle step of less than < 2 deg. On optimizing both retardation value and azimuthal angle distribution we were able to fabricate **Vortex Retarder** also known as **q-plate** by R2R technology applicable for generation of orbital angular momentum of laser light beam at specified wavelength.

4. References

- [1] U.V. Mahilny, A.I. Stankevich, A.A. Muravsky, A.A. Murauski, Novel Polymer as Liquid Crystal Alignment Material for Plastic Substrates, J. Phys. D: Appl.Phys. **42**, p. 075303, 2009.
- [2] A. Muravsky, V. Agabekov, G. Zhavnerko, U. Mahilny, A. Stankevich, Patterned rubbing alignment technology, SID Int. Symp. Dig. Tech. Pap. **41**, p 1727, 2010.