Patterned Retarders and Polarizers Based on Reactive Mesogens Aligned by Plasma Beam

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ABSTRACT

Recently, we reported extension of ion/plasma beam alignment technique for the alignment of reactive mesogens (RM). The present study shows that this technique can be successfully used for the alignment pattering of RM films. A variety of prototypes of patterned retarders and dichroich polarizers is prepared.

1. INTRODUCTION

Along with photoalignment, ion/plasma beam alignment technique is presently considered as the most promising candidate to replace traditional rubbing alignment procedure in industrial alignment of liquid crystals (LC). Big capability of this technique was first observed for nematic LC [1,2] and than for smectic (SmC^*) LC [3]. Recently, we demonstrated that plasma alignment technique can also be successfully applied for reactive mesogens (RM) extensively used in production of passive optical films and organic electronic devises. On both macroscopic and microscopic levels, it provides very uniform alignment on practically all substrates used in modern LCD manufacturing (glass slides, silicon wafers, plastic strips) [4]. This technique does not require special alignment layers that simplifies and accelerates alignment procedure.

The current development stage of LCD (particularly, development of trasflective and 3D displays) requires optical films with spatially modulated polarizing and retardation properties. Recently we demonstrated that in-plane modulation of RM alignment can easily be achieved by using photoalignment layers of dichroic dyes. In the present paper we realized the same by plasma beam processing of *bare* substrates containing no alignment layers. Moreover, we realized patterns with the alignment modulated in the uptight direction. The strong and weak points of new pattering technique are discussed.

2. EXPERIMENTAL

As reactive mesogens (RM) we used RMM 256C and RMS04-007 mixtures from Merck, designed for planar and homeotropic alignment, respectively. The RM films were deposited on solid substrates by spin coating method. As the substrates we used bare and polyimide coated glass slides and plastic strips processed by plasma beam to impart alignment capability. The RM alignment was characterized by null ellipsometry method.

The plasma beam irradiations were carried out by using anode layer source with a race track shaped glow discharge area [2]. The source worked in a beam mode generating two "sheets" of accelerated plasma with a width of 25 cm. The anode potential determining particles' energy was 600 V and the beam current density was about 8 $\mu A/cm^2$. The incidence angle of plasma beam was set at 65^o. The distance between the discharge area and the treated substrates was about 20 cm. The substrate holder was moved with the PC controlled moving system providing cycling translation in the horizontal plane. The translation amplitude was 3 cm, while the translation speed was 2.5 mm/s. The translation regime of irradiation provided uniform treatment over the whole substrate area. The treatment time was varied between 1 and 30 min.

To realize alignment patterns we used masks made by perforation of thin plastic films. The perforations were of various size and shape depending on desired configuration of patterns. The masks were in close contact with substrates to ensure clear borders between the neighbour domains. The substrates were processed in one or several steps depending on structure of alignment patterns.

Below are given examples of structures realized by this approach.

3. RESULTS

3.1 Compensation films with +A/+A patterns and dichroic polarizers

In-plane modulation of RM alignment was realized for planar mixture RMM256C by using two-strep irradiation with different exposure

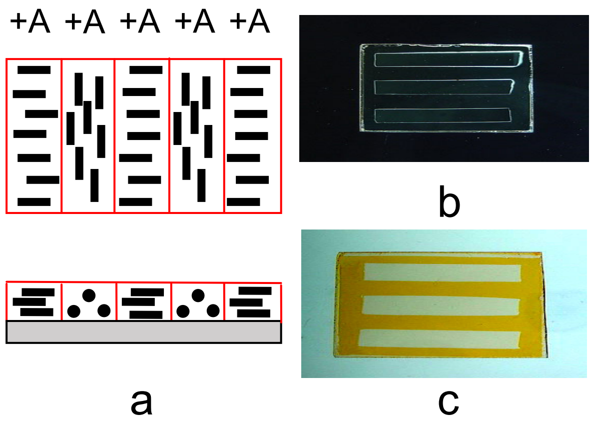

Fig. 1 Film of RMM 256C with a stripy alignment structure. The alignment directions in the neighbour domains are perpendicular. Optically each pattern acts as +A compensator. a – top and side projection of the structure; b – picture of the film placed between crossed polarizers; c – picture of the film doped by 5 wt. % of diazodye taken in polarized light.

directions in step 1 and step 2.

The structure realized for 90^0 angle between the irradiation directions is shown in Fig. 1.

By doping RM with a small amount (3-5 wt. %) of dichroic azodye the structure presented in Fig. 1a works as a patterned dichroic polarizer with mutually perpendicular polarization directions in the neighbouring domains. The photograph of this sample is presented in Fig. 1c.

Finally note that the alignment structure presented in Fig. 1a can be realized by combination of plasma beam technique with other alignment methods. For instance, first plasma irradiation (precessing of entire substrate) can be substituted by rubbing or photoalignment. In this case, however, special alignment layers should be introduced.

3.2 Compensation films with +A/+C and +O/+C patterns

These cases were realized by one-step processing of the layers of homeotropic polyimide through a mask. The parts of PI film protected by the mask caused homeotropic alignment of RMM 006. In turn, the parts of PI film processed by plasma beam provided tilted or planar alignment of RMM 04-007 depending on the exposure dose, Fig. 2.

3.3 Compensation films with +A/I and +C/I patterns

A +A/I retarder is strongly needed for the development of transflective displays. We realized it in the following way. First RMM 256C was uniformly aligned on the glass substarte entirely processed by plasma beam. Then the sample was UV irradiated through a mask and rinsed by toluene. The latter process removed RM film in the non-polymerized paterns. The obtained structure and corresponding sample are demonstrated by Fig. 3.

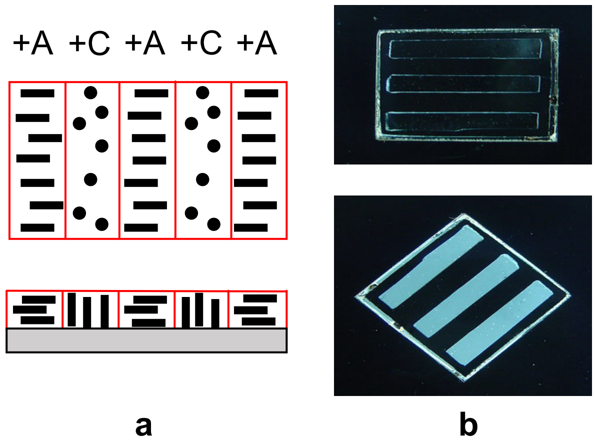

Fig. 2 Film of RMS 04-007 with a stripy alignment structure. The alignment in the neighbouring domains is planar and homeotropic (+A and +C compensation). a – top and side projection of the structure; b – photographs of corresponding sample.

The +C/I retarder can be prepared in a similar way by using alignment layer made of homeotropic PI and homeotropic RM mixture RMM 04-007.

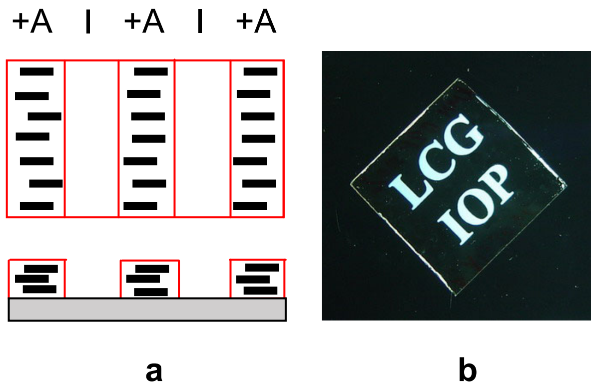

Fig. 3 Film of RMM 256C with +A and isotropic optical patterns. a – top and side view of the film structure; b – photograph of corresponding sample.

A variety of structures, which can be realized by the proposed method, is not limited by the presented examples. The more detailed classification will be presented in the forthcoming publication.

4. ACKNOWLEDGMENT

These studies were supported by the grants VC140 from NASU (Ukraine) and CERG 612406 and RPC07/08.EG01 (Hong Kong).

5. REFERENCES

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