Vertical Alignment Materiel with Uniform Tilt and Low Baking Temperature for Flexible Displays

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Abstract

The flexible display has become one of the most famous and prospective direction. The vertical alignment (VA) mode has been widely used in TVs, smart phones, *etc* [1], which shows a perfect contrast ratio because liquid crystal (LC) molecules are aligned vertically against the substrates in the initial dark state. Many groups are trying to achieve the VA mode from various directions, such as rubbed polyimide (PI) [2], oblique evaporation [3], self-assembled monolayer [4] and complicated combination with photoalignment [5]. Some of them need too high temperature process to fit flexible substrates, others cannot offer uniform tilt in bright state. In our present study, we combined sulphonic azo dye (SD1) and stearic acid chromium salt (Chromolane) as the alignment layer to fabricate VA cells. The cells have uniform black state and uniform tilt after being applied electric field. In the 2 states, the tilt angle can be turned in the range of 3—89° .

Introduction

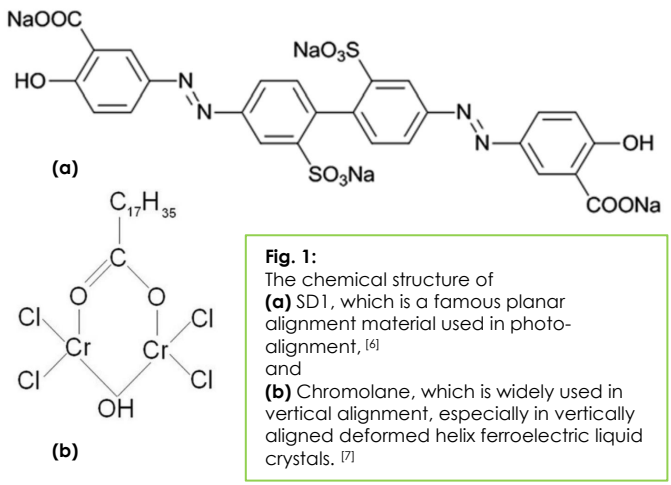

Fig. 1:
The chemical structure of
(a) SD1, which is a famous planar alignment material used in photo-alignment, [6]
and
(b) Chromolane, which is widely used in vertical alignment, especially in vertically aligned deformed helix ferroelectric liquid crystals. [7]

Experiment

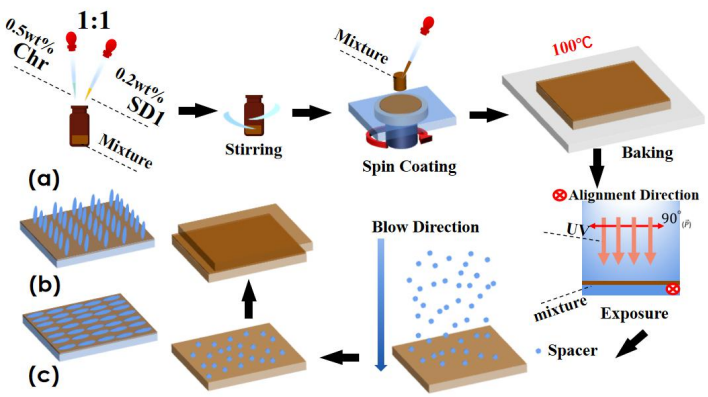

Fig. 2:
(a) The fabrication of cells. 2 materials are mixed with weight proportion of 1:1 and then stirred for 30s. Since there is a slow reaction between them, the mixture should be spin-coated (800 rpm for 5 s and 3000 rpm for 30 s) and baked (at 100℃ for 40 min) as soon as possible. All the substrates are exposed along the same direction to ensure the anti-parallel of top and bottom substrate. The cell gap of cells is 10.5 μm.
(b) When we do not apply electric field, the cell is at the dark state. LC molecules are aligned by Chromolane.
(c) When we apply electric field, LC molecules fall down, following the alignment direction of SD1. Therefore the cells can achieve uniform tilt.

Result

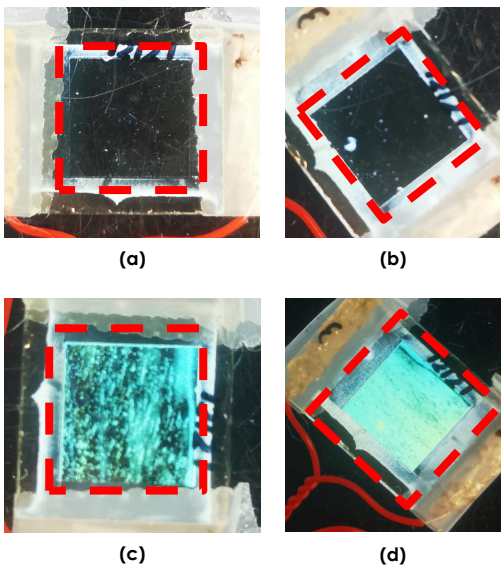

Fig. 3: The cell is placed between the cross polarizer.
(a) Without electric field, the cell has uniform dark state.
(b) Since the pretilt angle is close to 90° , after rotated 45° , the cell is still dark. The bright point is caused by particle.
(c) With electric field, LC molecules fall down and follow the same direction, so there is birefringence. The alignment layer is not so uniform so there is light leakage.
(d) With electric field, at 45, the cell is at bright state.

Conclusion

We combined SD1 and Chromolane, to fabricate the VA cells with uniform tilt after being applied electric field. The fabrication is simple and the materials are easy to get. The tilt angle can be changed between 3-89 ° . Since the process temperature is limited in 100℃, the materials can be used on plastic substrates. After further optimization, we believe the materials can be applied in flexible display and achieve the same performance of PI.

Reference

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