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Nanoengineering of aligning cibacron brilliant yellow using light: Application in flexible displays

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Abstract—**Photoalignment properties on commercially available textile dye cibacron brilliant yellow exhibits extraordinarily high photo-and thermal stability. The distinguished alignment properties of this dye extend the field of the sulfuric azo dyes effective for photoalignment. An attractive feature of this dye is its low curing temperature which is essential for plastic substrates to use it as flexible devices.**

Keywords-CBY; photoalignment; anchoring energy; flexible displays; liquid crystals.

I. Introduction

Photoalignment has been proposed and studied for a long time. In fact, the subject of light-molecule interactions has been a fascinating subject of research for a long time and is still capturing the imagination of many people. Over the past twenty years, a lot of improvements and variations have been made for photoalignment [1,2]. Commercial photoalignment materials are now readily available. Many new applications, in addition to the alignment of LCD, have been proposed and demonstrated. In particular, the application of photoalignment to active optical elements in optical signal processing and communications is currently a hot topic in photonics research. In spite of these potential advantages, there is still room for improvement and new materials are changing the way we are looking at the things. A lot of work has been devoted to light sensitive aligning materials (especially photo alignment) [3-6].

The alignment of liquid crystal (LC) molecules is an important research/development subject, because it is a key process in the fabrication of LC displays and devices [1]. Right from the beginning, polyimide (PI) rubbing technique has been routinely used to align liquid crystals. It produces quite reliable alignment commonly acceptable for state-of-the-art devices. However, it cannot satisfy strong demands of advanced technology. A principal drawback of this procedure is mechanical contact with the aligning substrate, which may destroy alignment layer and surface electronics. Besides, it causes surface charging and dusting. The LC alignment produced by rubbing is not perfectly uniform, especially on the microscopic level. Because of this, alignment methods avoiding mechanical contact with the aligning substrates are being actively studied. Among the most promising candidates for future industry is photoalignment. This technique excels in high uniformity, wide-range and smooth variation of the parameters of LC alignment. So far the planar alignment materials based on polyimides are the most widely used materials for alignment layers in LCDs. The preparation process of alignment layers made from such materials, however, requires high curing temperatures (190-220°C) and a long time (about 30 min) for completing the imidization (curing) process and therefore they are not appropriate for use in LCDs with flexible substrates. Moreover, the shelf-storage time of these materials is about several months at -10°C and their transportation is rather expensive since it requires special cooling conditions.

The effect of LC photoalignment is a direct consequence of the appearance of the photo-induced optical anisotropy and dichroic absorption in thin amorphous films, formed by molecular units with anisotropic absorption properties [7]. Figure 1 demonstrates the basic concepts of photoalignment where molecules are aligned in a particular direction when polarized UV light of suitable wavelength is shined on them. The phenomenon of liquid crystal photoalignment became a subject of extensive research after the effect was discovered for the azobenzene units attached to a substrate [8] and dispersed in a polymer matrix [9]. Although a huge variety of photoaligning materials developed so far, nevertheless, azo dye materials remain among the best candidates for

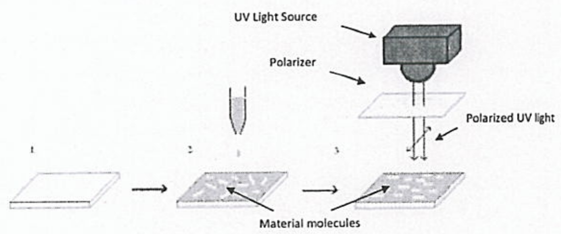

Figure 1: Concept of photoalignment, where 1, 2, 3 are the different steps to achieve high quality alignment.

technological application. The sulfuric azo dyes show the best promise. Earlier we discussed extraordinary good photoalignment properties of the sulfuric disazo dye SD-1 [10-12]. It possesses nice film forming properties and high