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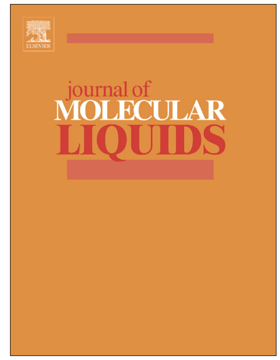

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Incorporation and orientational order of aligned carbon nanotube sheets on polymer films for Liquid Crystal-aligning transparent electrodes

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Abstract

Carbon nanotube (CNT) sheets can have several functionalities, such as transparent electrodes and more interestingly, as alignment layer for liquid crystals (LCs). Their flexibility, and mechanical strength make them ideal for flexible electronic applications. For this use, one aspect that needs to be addressed is their implementation with polymer substrates. The realization of the CNT films is quite easy, but a good adhesion between CNTs and substrates is not trivial. Here we explore the use of various polymer substrates focusing on the adhesion of the nanotubes on top. By using ethanol we improve the adhesion forcing the nanotubes to lie completely on the surface.However, this is at the expense of a decrease in orientational order of CNTs, which is detrimental for using them as aligning layer for LC. Poly(methyl methacrylate) (PMMA) has the best performance among the tested polymers, but it still shows a decrease in orientational order after deposition. Nevertheless, the CNT-PMMA substrates were able to impose some homogenous alignment on the nematic LC (4-Cyano-4'-pentylbiphenyl, 5CB) proving that aligned CNT sheets are suitable for a variety of electro-optic applications with LCs.

Keywords: carbon nanotube sheets, liquid crystal, anisotropic carbon nanomaterials, transparent conductive film, alignment layer, flexible electronics, information display.

Introduction

Transparent conductive electrodes are widely used in opto-electronic applications as in smart windows or displays [1]. There are not many materials being able to transmit light and have a low electrical resistance at the same time, since conductors have mainly imaginary part of the permittivity at visible frequencies, which means that the light is not transmitted, and the electro-magnetic field is expelled from the bulk of the material, as explained in, for example, Ref. [2]. Indium tin oxide (ITO) has been so far successfully employed in the majority of commercially available devices due to the fact that its plasma frequency is below the visible frequency range, i.e. in the infra-red spectral region. This results in a real part of the permittivity in the visible, i.e. a refractive