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Polymers for flexible displays: From material selection to device applications

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Abstract

With digitalization, plenty of information is being exchanged through electronic media, and consumers are demanding high quality, convenient, and portable digital devices. Currently, flat panel displays, such as liquid crystal displays (LCDs) and plasma display panels (PDPs), satisfy them with regard to quality. Convenience and portability will be realized with flexible displays in the future. Polymers are very promising materials for flexible displays with many advantageous charateristics including transparency, light weight, flexibility, and robustness. They are also some of the least expensive materials and are suitable for mass production via roll-to-roll processes. In this review, we will discuss the kinds of polymers that are used, where and how polymer materials are used and the challenges to overcome in developing flexible displays.

Keywords: Electro-optic material; Encapsulation; Flexible display; Flexible substrate; Transparent electrode

Contents

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1. Introduction

The topic of flexible displays has prompted many popular news stories. How do we define a flexible display? Flexible displays can be classified according to degree of flexibility: *flat* displays are made of plastic or another non-glass backplane, but only for the benefit of lightness or ruggedness; *formed* displays are bent once, such as a curved automobile dashboard, but do not flex further; *flexible* displays may be bent or flexed during use, but not over a range that includes folding or rolling; *rollable* displays are as flexible as fabric [1]. Recently, the literature on flexible displays has been expanding. It now includes a book on flexible flat panel displays written by Crawford [2] and a special edition of the *Proceedings of the IEEE* on flexible displays [3].

The prospects for flexible displays are promising, although the timing still depends on technical and manufacturing developments [4,5]. Electrophoretic displays such as electronic papers using plastic substrates, which have a relatively simple structure, are just beginning to be produced in quantities approaching high volume. Displays that are intended to flex or roll during use may reach the market in several years, pending further developments in backplane and fabrication processes. The near-term revenue in dynamic signage and mobile phones will lead to the development of larger and more sophisticated displays with flexibility and rollability. Fig. 1, which has been adapted from the data of the iSuppli Flexible Display Report, shows the market prospects for flexible displays from 2007 to 2013 [1].

Polymers are very promising materials for flexible displays with many advantages. They are transparent, light in weight, flexible, and robust. Polymers are a good alternative to the glass substrates that have been actively used for flat panel displays such as liquid crystal displays (LCDs) and plasma discharge panels (PDPs). Glass is so rigid that it is very difficult to use in a flexible display. Polymers have mechanical properties that vary from strong rigidity, such as in engineering plastics, to softness, such as in rubber or polyethylene films. They are some of the least expensive materials and are suitable for mass production via roll-to-roll (RTR)