New Flexible Applications Using Reflex™ Display Technology

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Abstract

Reflex™ display technology based on bistable, reflective, and flexible Cholesteric Liquid Crystal Displays is being developed and mass produced for new and non-traditional applications. These applications allow for personalization of mobile devices, very low cost display systems, and more. This display technology, its status, and new applications are discussed in this paper.

1. Introduction

Flexible displays are increasingly gaining attention throughout the consumer electronics industry. Flat panel display manufacturers are ever intrigued by the promise of increasing the pervasiveness of displays in consumer products through the development and production of flexible displays. Indeed, recent product announcements using flexible materials are evidence to the growing industry awareness and excitement. Display manufacturers are therefore coming up with unique technologies and display developments that are able to answer the market need.

Kent Displays has recently trademarked its proven Cholesteric Liquid Crystal Display[1,2] technology as Reflex™. The reflective and flexible nature of the display technology is now at the roots of its brand concept. Since Reflex™ technology can be driven using a passive matrix, these displays are relatively simpler to manufacture for flexible applications compared to other competing technologies. As such, this display technology has a significant benefit in terms of market introductions for various applications. At Kent Displays, we have also focused on non-traditional applications so as not to compete with well established LCD markets. It is these non-traditional applications and the status of flexible display manufacturing that will be discussed here.

The main thrust of the display technology today is in advanced innovation for next generation products and concepts. The manufacturing is in volume production for flexible displays. Roll-to-roll mass production is also ready. This is likely the first LCD complete roll-to-roll mass production manufacturing in the world. The throughput and yield enable Reflex™ displays to be highly competitive in the ever competitive display and flexible display industry.

2. Applications of Reflex™ Displays

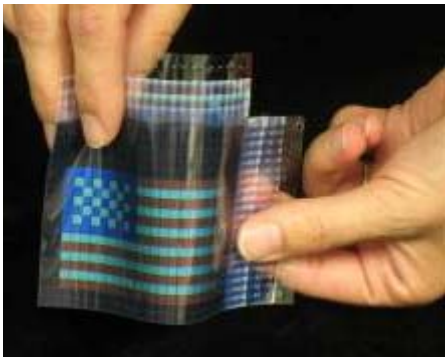

Fig. 1: Flexible cholesteric display using Reflex™ technology.

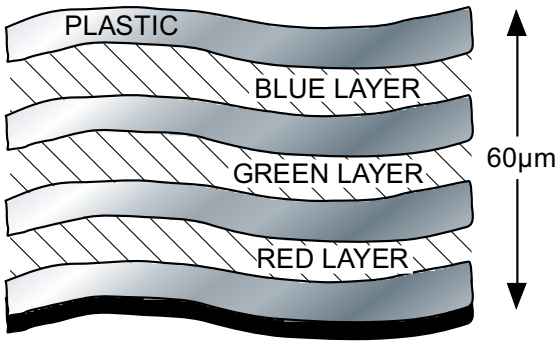

Fig. 2: Cross sectional view of eGo™ electronic film.

One of the most compelling applications being actively developed at present is eGo™ electronic skins.[2,3] This uses a stacked configuration using

ultra thin substrates (see Fig. 1 for example). The total thickness is on the order of about 60µm. Fig. 2 shows a cross sectional view of the eGo™ film. The electrode material is flexible conducting polymer that is coated roll-to-roll. There is no patterning and as such the cost structure is very low. These skins can then be applied to consumer electronic devices such as digital cameras, mobile phones, digital music players, etc. Indeed, the associated applications are numerous including personalization, indication, etc. Integration of these non-traditional displays can be achieved through lamination, thermoforming, and molding – processes which are typically used in electronic device manufacturing.

Fig. 3: Concept phone using integrated eGo™ showing red, blue, and green colors.

This material can be cut to custom shapes and bent to tight radii for ultimate device integration. The colors can be selected via simple drive pulses. Since power is only required during a color change, the battery drain for eGo™ is extremely small. Fig. 3 shows a conceptual mobile phone with integrated eGo™ electronic skin switched to a few different colors. Significantly, there are tight curvatures on the sides, a hole in the middle for a sub-display, and a uniquely cut shape including inside corners.

The eGo™ electronic skin is being manufactured and developed for typical mobile phone temperature requirements. The material is rugged enough to withstand a wide gamut of environmental testing including high heat, high humidity and thermal cycling. The electronic skin typically has a hard clear cover over it and as such, is mechanically robust. Display driving is performed via a simple ASIC with driver and controller functionality. The simplicity of the integration and compact design allows customers to integrate the device with little effort.

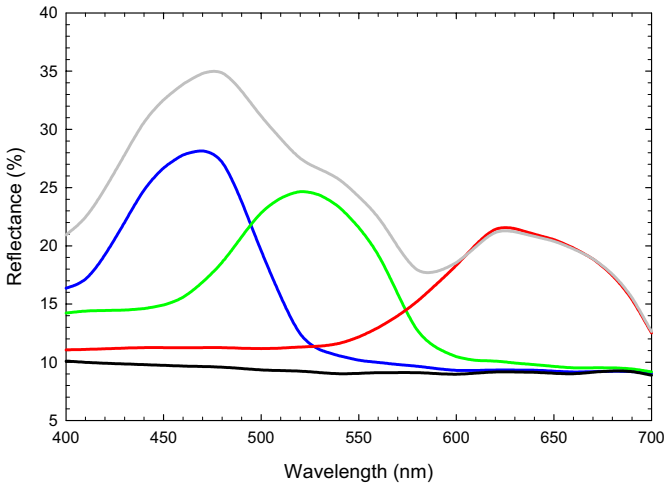

Fig. 4: Reflection spectra for typical eGo™ electronic skin.

Since eGo™ electronic skins are based on Reflex™ display technology, they are reflective and bistable. Fig. 4 shows the reflection spectra for a typical eGo™ electronic skin showing R, G, B, White, and Black. The data is measured inside an integrating sphere with the specular component included. The high reflectivity for the colors is due to the fact that the entire area is used to reflect each of the primary colors, i.e., vertical stacking. The area is not shared (as in typical color LCDs and other electronic paper displays). The aperture ratio is also 100% since there is only one pixel. These unique features of Reflex™ displays makes them ideally suited for color reflective applications.

Another application being developed with Reflex™ display technology is a simple writing tablet where pressure is used to draw on the surface and a simple

voltage pulse is used to erase the image.[5] This is a unique application of the Reflex™ technology where only conducting polymer electrodes are used and there is no patterning of the conductor. The initial products are single layer devices with a monochrome look. Fig. 5 shows pictures of writing tablets with drawings on them using a stylus. Pressure from a finger can also be used. The voltage to erase is very low (on the order of 18Vrms) and therefore the power consumption is low. Some applications have been used with a sealed battery compartment (i.e., battery lasts the life of the product). The cost of the display material, electronics, and packaging is low. The look and feel of this application is very compelling and draws the user further in with each use.

Fig. 5: Examples of writing tablet in toy applications.

The writing tablet is generally in the focal-conic state and external pressure forces the liquid crystal material to flow. The flow is controlled via a polymer network and encapsulation so as to keep the line strokes sharp. The flow causes the liquid crystal to transition to the planar texture, thereby creating contrast. The textures stay once the pressure is removed due to bistability. The technology is being marketed in a variety of fields such as school, office, executive, and toys. Initial uses are intended for indoor environments and the writing tablet embodiments have excellent environmental performance.

The waveform for switching is simple and does not need to be changed for the entire operating range of the writing tablet. As such, the driving electronics are very simple and low cost. The pressure response for the writing tablet is shown in Fig. 6. Grayscale can be achieved as evident from the data. The lack of optical response with lower pressures allows resting of a hand on the device without affecting the texture. This feature adds to the practicality of such an LCD device.

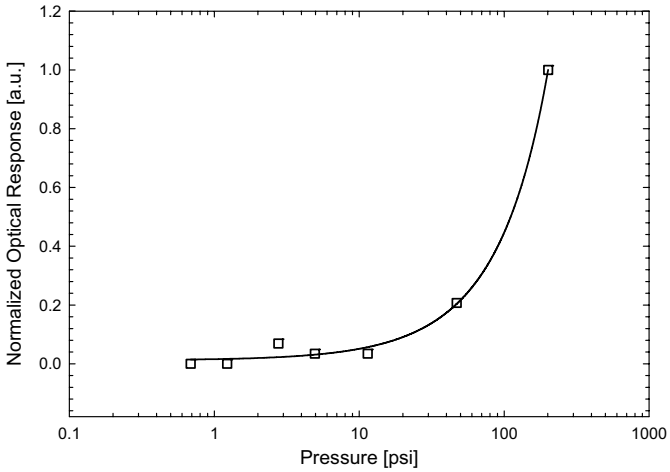

Fig. 6: Normalized pressure response for the writing tablet.

Both eGo™ electronic skins and writing tablet using Reflex™ technology are fabricated using roll-to-roll manufacturing. The input is rolls of coated plastic material and the output is fully built displays with back coatings. Simple electrical connections are made since the devices are single pixel. The driving waveforms for both eGo™ and writing tablet are very simple owing to a single pixel design. In the simplest form, a single set of drive parameters are used over a wide temperature range requiring no temperature compensation. When grayscale is used in eGo™, temperature sensing and subsequent compensation is

required.

3. Impact of New Flexible Display Applications on the Future of the Technology

Non-traditional applications using flexible Reflex™ display technology are a unique entry point for flexible LCDs. Both eGo™ electronic skins and writing tablets aim to introduce displays into entirely new markets, where displays were not previously used. This lowers market entry barriers and demonstrates the potential for display industry growth. The elegance is in the simplicity and low cost nature of the display architecture; therefore, allowing applications in areas such as electronic skins and writing tablets for toys, in addition to numerous others. The combination of roll-to-roll manufacturing and unpatterned conductors make this a high yielding low cost display system. The automation and economy of scale allow manufacture within the United States. The impact of this and other related applications has far reaching consequences in the traditional display industry. These and other applications will certainly mark the entry of flexible LCDs into the mass consumer market.

4. Conclusions

The Reflex™ display technology is poised to penetrate the consumer markets in 2009 and 2010. Mobile phones with eGo™ electronic skins and writing tablets in home, office, and school environments will mean a much greater level of attraction and attention to this unique display technology. Indeed, eGo™ electronic skins are even being applied to other consumer electronic devices such as mobile computing, digital cameras and music players. The extreme personalization, low cost, and ease of integration dictate that this technology will be pervasive in the market place.

5. Acknowledgements

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