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Analysis of MEMS controlled Paper-like transmissive flexible display using Comsol multiphysics

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ABSTRACT

Micro Electro Mechanical System (MEMS) *controlled* paper-like flexible display was designed with basic cantilever structure using comsol software. This model increased the picture clarity by spacer design. Foldable and flexible display achieved by having the flexible substrate. Low operating voltage can be obtained for the device by proper material usage and thickness of the layers. Electro static analysis showed that the distribution of the potential and the stability. This model promised for high picture clarity with more compact structure.

Introduction

To increase the display area in electronic device many industry is manufacturing flexible display. Production of flexible display is a dynamic and continuously evolving in the industry. Developments of flexible display are made rapidly as technology improves and new discoveries are made by Engineers and scientists.. Flexible display designed with the flexible substrate concepts used in such applications as electro wetting cell (Shamai R (2008)) and other newly developed electronic devices. Electronic paper, e-paper and electronic ink are a range of display technologies which are designed to mimic the appearance of ordinary ink on paper. Electronic paper is often considered to be more comfortable to read than conventional displays. An ideal E-paper display can be read in direct sunlight without the image appearing to fade.

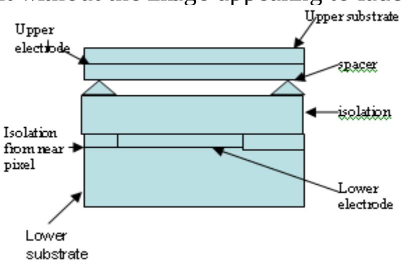

Figure 1: Model cross sectional plot of MEMS controlled paper-like flexible display

Structure:

The transmissive flexible display consists of six layers as shown in fig no.1.It is of two electrodes, two substrates and a spacer and isolation layer. Fig no.1 shows model schematic plot of display device. Each layer has different materials. Table no.1 shows the properties of the different layers. Poly Ethylene is used as a substrate material for rigidity in lower (bottom) and for flexibility in upper (top layer). Electrode is mainly responsible for conductivity. In this display different metals (Aluminum, copper, iron) used as electrodes. The transparent isolation layer (SiO2) is placed in between the electrodes to provide electronic charge insulation (Lo C.-Y (2009)) and color modification. Schematic plot of MEMS controlled transmissive flexible display designed using Comsol multiphysics shown in

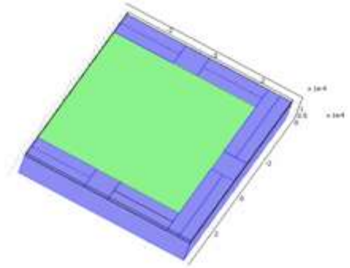

Figure 2: Schematic plot of device designed using Comsol multiphysics

Triangle spacers are designed for free movement of electrodes like a cantilever beam. Fig. no.3 shows the top view of the spacer for a single pixel. The spacer is designed with air gaps (Cheng-Yao Lo (2010)) in order to improve color purity and pixel clarity

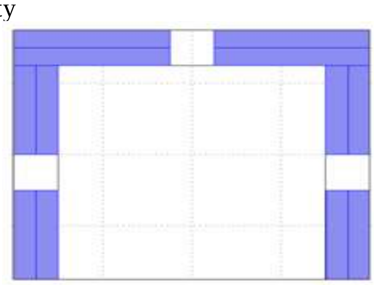

Figure3: Top view of Spacer layer in the model

Concept:

When the DC voltage is applied to pixel, electrostatic force

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is produced in between the two electrodes and it accumulate from center of the pixel. Due to electrostatic force the upper layer will be get attracted towards the lower layer this willresultsin electric potential distribution in the pixel. The spacer layer is in between the two electrodes which support the surroundingareasofpixel.

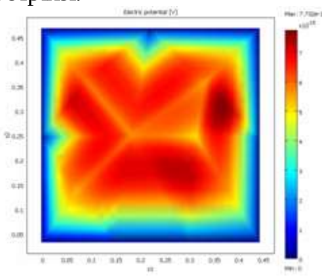

Figure 4a: Electric potential distribution luminium(Al)material

With the well controlled distance between two electrodes Fabry perot color interference (Taii Y (2006)) appeared because of interaction of light waves.

Analysis:

Electro static analysis was done in MEMS controlled paper like flexible transmissive display. This analysis explains the potential distribution under various electric potential levels based on applied voltages applied between the electrodes. Electric potential is applied to any one of electrodes. Potential applying to the electrodes may be of any kind. This analysis presents the stability of the device under high voltage application more over these results shows that proper working of the device under low voltage condition. Table.no.2 provides the maximum and minimum voltage distribution as per our analysis result. We have done analysis for different material under different driven voltage levels. Fig.no.4a, 4b, 4c shows the electric potential distribution of Aluminium (Al), copper (Cu) and Iron (Fe) under various voltages respectively.

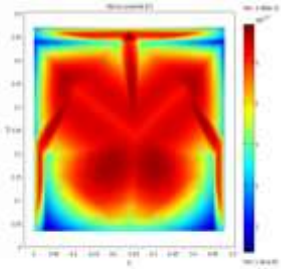

Figure 4b: Electric potential distribution of Copper (Cu) material

According to simulation results 20nm iron shows maximum distribution under low voltage itself but maximum distribution is happened at the edges of the pixel. While comparing copper and aluminium, since Cu had more conductivity, Al is chosen for its uniform distribution based on analysis.

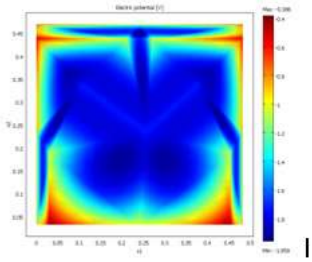

Figure 4c, Electric potential distribution of Iron (Fe) material.

Conclusion:

MEMS *controlled Paper-like transmissive flexible display* was designed and analyzed with fine mesh generation using Comsol Multiphysics software. An electro static analysis was done with simple cantilever movement. Analyses showed the results for different materials. By using, triangle shape in spacer, uniform potential distribution at various levels was achieved successfully. This device promises flexibility and compatibility with the thickness of less than 0.2mm. As per the analysis result, display device was properly working under low operation voltage as well as more stable at high operating potentials.

References

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Table No.1 Properties of Flexible Display Device Layers

Layers Property	Substrate		Electrode		Isolation	Spacer
	Lower	Upper	Lower	Upper		
Shape	Rectangle	Rectangle	Square	Rectangle	Rectangle	Tri Angle
Width	700 μm	700 μm	600 μm	700 μm	700 μm	50 μm
Height	125 μm	16 μm	20 nm	20 nm	160 nm	0.6 μm
Materias	Poly ethylene	Poly Ethylen	Al	Al	Sio_2	Boro silicate

Table No 2. potential distribution values of materials

S.no	Material	Applied voltage	Electric potential distribution	
			Minimum	Maximum
1	Copper(cu)	5v	0.5	4.7
		20v	5	19
		100v	0	95
2	Iron (fe)	5v	0.3	4.5
		20v	0	18
		100v	0.2	92
3	Aluminium(al)	5v	0.5	4.5
		20v	0.3	19.5
		100v	0.8	95