# A Backplane Fabricated by Evaporation Printing for the Production of a Cost-Competitive Electrophoretic e-Paper Electronic Shelf Label Display


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## Abstract

*An "evaporation printing" process for making active-matrix backplanes has been used to manufacture electrophoretic display modules for electronic shelf labels (ESLs). Recent advances in the evaporation printing manufacturing process enables ESLs to be more competitive in the marketplace of signage and point-of-sale displays.*



## Author Keywords

Active-Matrix; E-Paper; Electronic-Shelf-Labels; Signage; Evaporation-Printing.


## 1. Objective and Background

The goal of this project was to develop a backplane that drives an electrophoretic e-paper frontplane developed by E Ink. The result would be a display module that could be used in the signage and point-of-sale information displays, specifically electronic shelf labels.

The consumer store companies profit margins are typically small, often less than 5%. This forces the technological improvement in stores to be critically examined resulting in a highly competitive market place for signage for advertising and point-of-sale information displays such as electronic shelf labels. Most of these displays are passive, segmented, and relatively small. Advantech had developed an active-matrix backplane process for OLED displays. Recently improvements in the process improved the quality of the backplane and thin-film-transistors(TFT) so that it could drive an e-paper frontplane such as E Ink's Pearl film.

## 2. Methods

The process uses the evaporation printing method developed by Advantech. The process itself was developed much earlier. It is a vacuum deposition process that uses shadow-masks to control the location of the deposits on the substrates. The improvements came on both the mask manufacture and the accuracy in aligning the masks for the various layers.

We were able to manufacture masks with feature sizes less than 10 um. Also, the masks are mounted uniquely that maintains its accuracy over the process. This is a major improvement for shadow-masks. Previously, aligning the masks during the several step process caused problems. The new process improved greatly the alignment accuracy to better than 1 um.

With these improvements on the process, we were able to obtain a very high quality cadmium-selenide thin film transistor. The quality of the TFT enabled the application of a one-transistor-one-capacitor pixel driving circuit, which would help on increasing yield and reliability.

This first part of the project, a 1-inch by 1.5-inch array was selected. This will prove the concept. Larger sizes has already been proved possible.

The final steps of the project implements this process on a multi-chamber inline manufacturing line as one machine and all under vacuum. This inline machine is named miniLine. This miniLine reduces "tack-time" to about 5 minutes, which is a large improvement of other manufacturing processes.

## 3. Results

The results are in two stages. First the quality of the TFT is examined. Then, the entire display is tested. Figure 1 illustrates a typical transfer characteristic curve for the TFT that is typically used on the backplane.

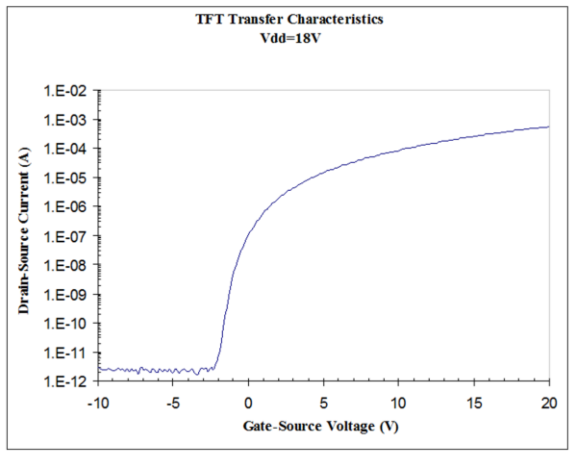


**Figure 1.** Transfer Curve of Backlane 192

From the Figure 1 curve, one can observe that the leakage current is low enough to be insignificant for our use. The maximum current is in excess of what we require. And the steepness of the curve produces an excellent switching transistor

Table 1 shows the other parameters of the TFT's. All of these verifies the high quality of the transistors and are capable of driving the e-paper front plane.

**Table 1.** TFT Characteristics of Panel No. 171

| Panel Summery | Average | St. Dev. |
|---|---|---|
| Vth (V) | 1.52 | 1.03 |
| Mobility (cm2/Vs) | 69 | 29.19 |
| Leakage Current (A) | 2.97E-11 | 1.41E-11 |
| Hysteresis (V) | 4.79 | 1.05 |

The final results are shown in Figure 2 that is a sample scene of a typical display.


**Figure 2.** Completed ESL Display

## 4. Impact

With the quality display we have produced and using the inline system described and in operation now, there is a typical cost saving of 4:1 over traditional photolithography techniques. This is due to improved labor cost because of reduced time to produce the display and reducing material cost with the elimination of gold that has been a past requirement when dealing with CdSe semiconductors. But, our process requires no gold.

This will enable the larger size ESL's, signage, and other larger point-of-sale information displays to be in the economically feasible range with this large cost savings

## 5. References

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