Solving the TFT LCD Yield Problem

Thin film transistor active matrix liquid crystal displays (TFT AM LCDs) are the "state of the art" in high performance color LCDs. Active matrix (AM) refers to an LCD pixel design that utilizes an active element. The active element in most designs is a transistor, deposited on the glass substrate using a thin film process. This process is very similar to semiconductor fabrication, and various materials are used to form the TFTs. By incorporating a switch (the TFT) at each pixel, TFT LCDs offer better contrast ratios and brightness than passive matrix LCDs.

TFT LCDs are currently a critical component of most color portable computers, hand held televisions and other consumer products. By the year 2000, the market for TFT LCDs is expected to grow to greater than $4 billion.

However, the major Japanese electronics companies who have invested billions of yen in TFT LCD development have found that TFT LCDs are very difficult to manufacture. Yields of TFT LCDs have been reported to be as low as 10%. As a result of low yields, today's TFT LCDs are very expensive. For example, an average 10" color TFT LCD used in a laptop computer is priced at about $1,500. Industry observers believe the market demand for TFT LCDs will increase only as a result of decreased prices. The same 10" TFT LCD must sell for less than $500 before it will appeal to a mass market.

The only way manufacturers can decrease their prices is to dramatically increase their yields and reduce their production costs. A major obstacle in the effort to increase yields has been the absence of in-process automatic test equipment (ATE) designed specifically for TFT LCDs.

ATE designed for the final test of LCDs has been available for many years. However, repairing a completed LCD on which faults have been detected is not cost effective because the cost of disassembly, repair, and reassembly exceeds the value of the repaired LCD. A more logical test strategy is to also test the LCD at the substrate stage. At this stage the TFTs and electrodes have been fabricated on the glass but no other materials have been added (see figure 1). If a TFT LCD can be tested at the substrate stage, the manufacturer has the choice of repairing it at a reasonable cost or scrapping it before more value is added. Scrapping LCDs with faults at this stage is a major cost savings since it is estimated that the manufacturer has added less than 50% of the TFT LCD's value. Therefore, an in-process ATE system provides immediate yield and cost improvements to TFT LCD manufacturers.

To address these problems, GenRad and Tokyo Electron Limited (TEL) jointly developed the GTS-1 LCD Test and Measurement System. TEL, the world's leading manufacturer of semiconductor probers, developed the GTS-1 Automatic Prober and Substrate Handling Subsystem. GenRad, the world's leading manufacturer of board test systems, invented a patented transfer admittance test technique and developed the GTS-1 Test and Measurement Subsystem.

The key feature of the GTS-1 System is the ability to precisely measure TFT characteristics and therefore provide extensive pixel data beyond simple pass/fail. This measurement data is critical to manufacturers for three reasons. First, the GTS-1