

## Key Thoughtz:

- Making glass rather than buying it creates competitive advantage for panel producers.
- Margin pressures and capacity shifts to China may alter the glass supply chain.

## Make Glass. Make Money.

### Analysis of recent announcements in China and Korea

The shift of AMLCD fabrication from Japan, Korea and Taiwan to China will change glass substrate supply strategies (for background, read <http://www.bizwitz.com/Downloads/Commentz-20090902.pdf>). Glass cost and size can constrain panel producers' ability to compete in a given AMLCD market segment. Securing supply of certain substrate sizes at affordable prices will be a key success factor for producers as they invest in new Chinese capacity and protect profits in established domestic fabs. Recent announcements by IRICO Group Electronics [HK: 00438] and LG Chem [SEO: 051910] confirm that display companies have started adjusting their glass supply strategies.

AMLCD substrates require electrically neutral glass. Sodium ions in typical flat glass can ruin thin-film transistors (TFT) so inert materials such as borosilicate compounds are used for AMLCD substrates. This creates entry barriers for suppliers of conventional plate glass used for windows and such. For example, Schott (Germany) waited more than ten years to enter the AMLCD glass market and withdrew after a few years of facing more experienced suppliers in Korea. Corning (NYSE: GLW) was an early leader in the formulation and production of glass for AMLCD. Its 50% joint venture in Korea, Samsung Corning Precision, is the major substrate glass supplier there. Also in Korea, Nippon Electric Glass [TYO: 5214] extended its business from float glass to CRT glass to AMLCD glass and formed a joint venture with LG Display [SEO: 034220] to polish panel glass prior to fabrication. The Japan-based company remains a key supplier throughout Asia. Asahi Glass [JP: 5201] is another Japan-based CRT glass maker that extended

its product line to source AMLCD substrates when Japanese ministers fostered formation of the AMLCD industry two decades ago. The three suppliers mentioned here ship about 94% of all AMLCD glass area. A fourth firm, AvanStrate (private equity, formerly NH Techno Glass) supplies smaller producers.

One of the puzzling features of the AMLCD industry has been its willingness to buy glass rather than make it. The three leading glass suppliers obtain prices that sustain pre-tax profit margins of 40% to 90% throughout the business (crystal) cycle while their customers post pretax losses in the 20% to 60% range during cyclical busts (and worse in 2008). As with any commodity industry, panel makers have few ways to sustain long-term growth other than reducing their factor inputs and reducing their cost of capital. They may do both by shifting operations to China where they can restructure their supply base and obtain new sources of funds.

The following commentary places such moves in historical context. The next section reviews lessons learned from the cathode-ray tube (CRT) display industry. It examines plans made by the IRICO Group, a surviving leader in the CRT business, to enter the AMLCD glass business in China. The subsequent section examines plans announced by the LG Group.

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## From CRT to AMLCD Glass

Glass has been an essential element of CRT (a.k.a Braun tube) manufacture since the beginning. In the case of color picture tubes (CPT) used for televisions, three sections of glass are fused together. The front plate is the heaviest component. A thick, lead-free melt is used to withstand the high voltages present in a TV tube. You view the outer face of the plate and see through it to see light emitted from phosphor dots on the inner face. After putting electrical grids in position, the plate is fused with the funnel, the glass envelope that tapers to the rear where the electron gun goes. In many cases, the cylindrical gun is assembled in separate factories then shipped to the CRT plant for attachment.

The cost of glass comprised 30% to 40% of COS (COGS) for CRT producers. That cost contribution increased when production moved to low-overhead regions in general and increased for those purchasing plates or funnels in particular. Making CRT glass was therefore a key competitive advantage for leading producers before their restructure. Videocon Industries may remain viable as a CRT maker in India because of domestic demand for low-priced TV sets and because the company acquired the former CRT glass operations of Thomson (including RCA).

With the exception of Sharp, leading AMLCD producers in Japan had CRT operations before entering the flat display market. It is interesting that they chose to buy display glass rather than make it after learning its importance in the CRT industry. One reason they let suppliers capture such value may have been the way Japanese ministers and business leaders chose to manage risk. They apportioned risks and responsibilities among many companies. Some companies developed color filter technology, some companies developed glass technology, others created new types of optical films, et cetera.

After experiencing the first two crystal cycles, Japanese AMLCD makers slowed their pace of reinvestment in the mid 1990's. It was then that Korean producers piled into the market. The supply chain might have changed more if Japanese producers had remained dominant. We only know that the original supply chain was preserved as Korean and Taiwanese producers took control. After a few years, Korean producers began making their own color filters (on purchased substrates) but Taiwanese producers followed that change only recently. In other respects the supply chain has remained similar in structure with a few changes in the sources of chips or tools.

Regardless of structure, the AMLCD industry has grown to replace the CRT industry. Few if any monitors using color display tubes (CDT) will be sold this year. That was the more profitable portion of the CRT business and it is dead, essentially. The higher-volume, lower-margin CRT business is dying at the rate predicted many years ago based on the

pace of AMLCD investment. As late as 2006, CRT executives remained unconvinced of this demise, which led to unpleasant liquidations in recent years.

Problems in the CRT business were amplified by new entrants while AMLCD producers attacked the TV market. In Xian, China, IRICO Display Devices expanded its CRT capacity aggressively in the mid 2000's. Expansion was good for the province but bad for producers in other regions because intra-industry rivalry added to AMLCD pressures on CRT prices.

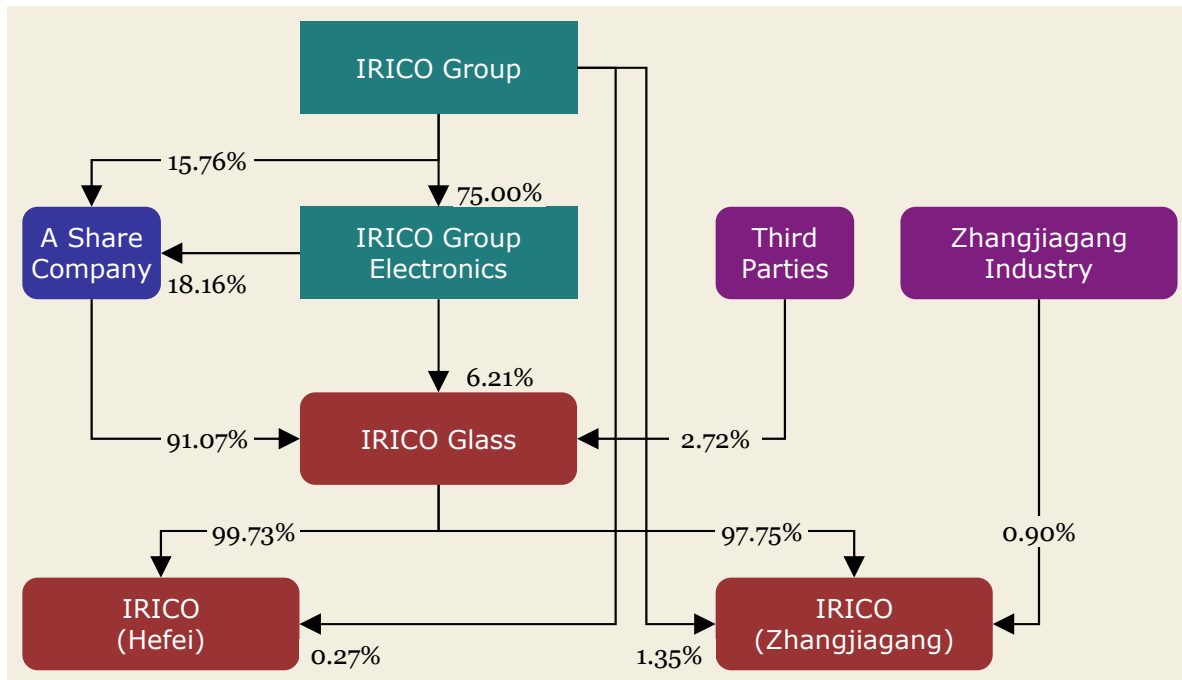
By Q2'09, even IRICO had to admit CRT was a failing business. According to filings, it believed global demand for CRT TV sets fell 31% in 1H'09 compared to 1H'08 while demand for LCD TV sets rose 23%. Chinese domestic demand for CRT TV fell 62% and CRT capacity utilization fell to 30%. IRICO sales fell 59% YoY.

Such conditions have led IRICO to invest in glass substrate capacity for AMLCD and PV (photovoltaic) supply. Phase 1 of IRICO Glass investment for AMLCD substrates became operational this year and the company plans to expand its capacity for fifth-generation sheets to supply domestic panel makers.

Increasing capacity for substrates of this size appears rational given the number of fabs in China already that import glass from Japan. Sheets of that size can be trimmed to serve older plants, such as third or fourth gen fabs, also. In addition, IRICO plans to start its own AMLCD fab in 2011. China's share of AMLCD capacity may rise from 4% in 2010 to 6% or more in 2011.

IRICO has therefore offered shares in a new holding company for its expanding glass business through private placement. The firm expects capital in IRICO Glass may increase from \$57 million to \$639 million as a result of planned share transactions. Two glass facilities are planned at present: one in Hefei east of Shanghai and one in Suzhou north of Shanghai (Zhangjiagang is a manufacturing district of Suzhou). The following figure diagrams the ownership structure that should result from the planned transactions.

FIGURE 1 OWNERSHIP STRUCTURE OF IRICO GLASS



Source: public disclosure (Hong Kong Exchanges)

IRICO Glass may not achieve profit margins anywhere close to those obtained by Corning but investors may find AMLCD substrates a more profitable business than CRT displays. In any event, such transactions signal intent to create a distinctly Chinese supply chain rather than rely on existing suppliers.

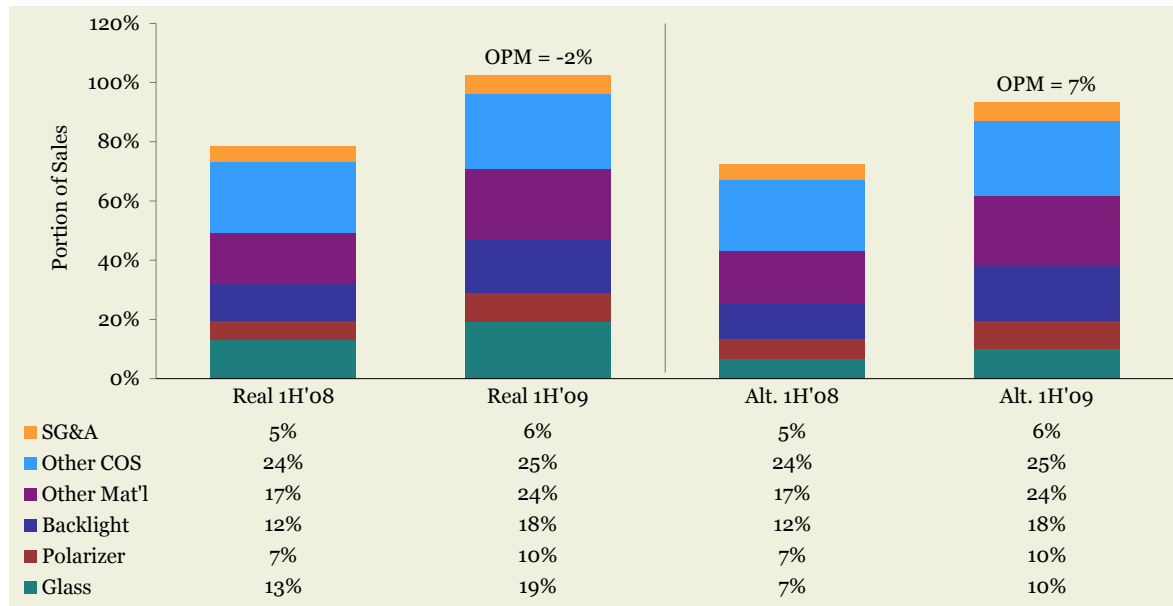
## From Buy to Make Glass

The big three substrate suppliers have faced technical challenges but they seem not to have faced the type of financial challenges their customers have faced. Glass pouring tanks require an order of magnitude less investment than AMLCD fabs do and substrate prices have declined in a more orderly fashion than have panel prices. Advent of domestic glass sources in China implies a challenge to their regime. While I assume the leaders will retain substantial technical advantages over any new entrant, they may find some cost-sensitive customers will defect if the price is right or if Chinese administrative guidance leans that way.

Chinese aspirations are not the only challenge, however. Normal inflationary forces in more developed nations cause fab operating costs to rise. This leads AMLCD producers to take countermeasures such as increasing their fab productivity. Small investments may adjust the operating capacity of existing plants upwards without increasing depreciation proportionally. Such actions tend to yield diminishing returns over time, however. The two primary contributors of fab operating cost are substrates and plant depreciation. Of these, glass material costs are greater. It has been surprising therefore that only Samsung Electronics formed a joint venture for making most of the glass it needs. In comparison, Paju Electric Glass (a joint venture of LG Display and Nippon Electric Glass) only refines glass poured in Japan. That venture provides some benefit in terms of cost and logistics but less than a full glass venture.

Looking at the cost structure of LG Display in more detail, we see that total material cost rose from 49% of sales in 1H'08 to 71% as the average price per square inch of display fell 23%. Purchased glass was 20% of COS and 19% of sales in 1H'09 when the producer posted a 2% operating loss.

FIGURE 2: REAL AND ALTERNATE COST STRUCTURES



Source: BizWitz analysis of LG Display disclosures

Looking at the left side of the figure above, we see that purchased glass comprises about one-fifth of total material cost. Historically, the cost contribution has increased when new, larger substrate fabs came on-line because panel makers paid yield-risk premiums to suppliers of the larger glass substrates. Of course, depreciation charges tend to increase at such times, also, which adds to margin pressure. Combine those factors and it is easy to see why panel makers experience cyclical losses.

In contrast, Samsung Corning Precision had gross profit margins of 69% in 1H'08 and 71% in 1H'09. It supplied about 40% of the glass purchased by LG Display, which recorded gross margins of 27% and 4%. This raises the question, what might LG Display record if its glass supplier demanded less profit?

Using the numbers disclosed by Corning, it appears that LG Display would have recorded a 28% operating profit margin in 1H'08 and a 7% profit in 1H'09 if its glass supplier booked a 10% net profit margin. In other words, the AMLCD producer's operating results depend significantly on the profit margin of its glass suppliers. Such findings are in line with the experience of CRT producers in prior decades, as described previously.

Now, looking at the right side of figure 2, we understand the alternate cost structure that might have occurred if LG Display sourced glass from affiliated companies willing to accept less profit for the sake of group performance. There are legal and moral constraints on such coordination but some benefits seem plausible nonetheless.

For such reasons, LG Display and the group may benefit substantially when LG Chem enters the AMLCD substrate market. The company entered the polarizer film business earlier this decade and became a leading supplier, which benefitted the group. It may take similar effort to develop competitive glass making ability but the benefit could be even greater. In this case, LG Chem will start with IP from Schott, which developed viable substrate technology but which lacked scale.

The plan brings seven glass tanks on-line between 2012 and 2018 with total target capacity of 50 million square meters a year. Assuming tanks of equal size, LG Chem could supply about 15% of the AMLCD fab capacity at the Paju site in 2012. That may be enough to increase LG Display's bargaining power with current suppliers but the total effect on operating profits would be less than that modeled in the figure above. The long-term effect could be more significant. Seven tanks would support capacity increases and cost

decreases in Paju facilities. Moreover, glass productivity may become competitive about the time LG Display hopes to bring a joint-venture fab on-line in China. That would enable LG Chem to establish tanks there as well. Combined with the potential supply from IRICO Glass, this might pose significant challenge to exiting glass companies.

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## Strategic Implications

Announcements by Chinese companies deserve to be read with some skepticism but IRICO Group has demonstrated ability to accomplish substantial capacity expansion in the face of competitive opposition in the past. In addition, the group is an important part of provincial aspirations and politics in Xian. It therefore seems prudent to take the group at its word and assume that it will become a significant supplier of smaller substrates to domestic panel makers in the next five years.

Given the history of accomplishment by the LG Group in display-related markets, it seems prudent to assume significant AMLCD glass capacity will develop in the Paju cluster of facilities. Such capacity could benefit LG Chem and LG Display next decade.

In addition, development of productive glass technology creates a real option for placing such capability near fabs created through joint venture in China. At the least, it creates potential to support such ventures with glass exported from Paju.

Taken together, such developments may alter the glass supply chain that has proven so profitable for a few companies over the past two decades.

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