NanoMarkets Report

Markets and Opportunities for Transparent Displays: 2014 –2021

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SUMMARY

NanoMarkets believes that the market for transparent displays is about to expand dramatically. "Smart glasses," such as Google Glass and Augmented Reality (AR) applications have focused attention on displays that can simultaneously display information and function as windows on the real world.

Display firms have begun to respond to these major trends with novel types of transparent displays. To do so they have had to invent new technologies. Transparent TFTs are especially challenging, with the most likely material solution being ZnO, though other options are possible. Hiding backlighting in transparent LCDs is also an issue, creating opportunities for transparent OLED displays; but these have their own challenges too.

In this report, NanoMarkets identifies where the revenues will be generated by transparent displays over the next eight years. In addition to leading edge applications such as smart glasses and AR, this report also considers near-term applications for transparent displays in more mundane applications such as retail and automotive.

This report is designed to be a guide to how transparent displays will be commercialized and provides both a roadmap to how the transparent display market will evolve and an assessment of the latest transparent display technology.

And in addition to granular eight-year forecasts of the transparent display market, this report also discusses the product/market strategies of transparent display makers, both large and small.

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Chapter One: Introduction

1.1 Background to this Report

Transparent displays have been around for many years, but have enjoyed only partial success. In the military and the automotive industry, heads-up displays (HUDs) have been available for decades. On the retail side, a number of niche suppliers have been providing transparent displays with limited capabilities for almost as long.

One reason why transparent displays have not been a big revenue generator so far is that actual demand for transparent displays is limited. Who in the world really needs a display that one can see through? In addition, for various technical reasons, transparent displays offer limited image capabilities. However, NanoMarkets believes this situation is all about to change:

- On the supply side, the display industry is gradually making a shift to organic light emitting diode (OLED) technology, which is easier to turn into transparent displays than the dominant liquid crystal display (LCD) technology.

- On the demand side, new augmented reality (AR) applications seem to call for new types of hardware platforms with transparent displays. The most obvious example of this kind of platform is Google Glass, but we note that another dozen or so firms are offering products of the Google Glass kind, and both Apple and Microsoft have shown interest in devices with transparent displays.

Most of this technology is only barely on the market. NanoMarkets believes, however, that the growing attention that these futuristic applications and associated transparent displays are getting has proved a call to action for the more conventional sectors of the display industry.

As a result, we are seeing LCD firms coming up with clever ways around the technical problems that have hampered the rise of transparent displays. In a highly competitive economic environment, the retail and advertising sectors are finding these precursor transparent displays useful, and the revenue from transparent displays is already beginning to grow.

As a result, NanoMarkets believes that transparent displays represent a substantial opportunity over the next decade. However, we do caution that both the market and technical risks are quite daunting in our opinion.

The market risks are high because there is not a full understanding of how transparent displays fit into the retail and advertising market going forward. Even more uncertain are the prospects for AR, a primarily software-based technology that is fueling much of the current attention in transparent displays.

1.1.1 The Problem of Invisible Components in LCD Displays

The technical problems of creating transparent displays are equally worrying for display makers, especially for LCD firms. In particular, the need for a transparent display immediately raises the problem of how to create “invisible” backlighting and color filters.

Backlighting: Since most of the transparent displays that will hit the market in the next few years are going to be LCDs, backlighting is an obvious challenge. NanoMarkets sees several theoretical solutions to this issue, but really only one that has much commercial potential.

Backlighting itself could be made transparent using zinc oxide (ZnO) LEDs, but such devices are more an interesting R&D topic than anything else. Another possibility—but an expensive one—is the use of additional optics so that the LEDs are not positioned directly behind the display.

The solution that most transparent LCDs are using—and, we believe will continue to use—is simply to make use of ambient light. Samsung and JNM Display Company—both Korean companies—are already supplying transparent displays using ambient light. The problem, of course, is that when there is no light, the display doesn't work.

As we see it, this limitation is a serious negative for this type of display, and one that is not easily overcome. However, there is still some room for innovation here. For instance, Eyevis' (Germany) transparent LCD technology uses ambient light during the day while it is transparent and changes to a more conventional dark background during the night. However, this type of approach isn't going to save the fortunes of the transparent LCD!

Color filters: A similar set of issues can be found with color filters, which are also not transparent. Again, the typical solution with transparent displays is to remove the color filter. While doing so makes it easier to make the LCD transparent, sacrificing color is a huge backward step for transparent displays.

We think that any transparent display company that sacrifices color thinking that it will not be hurt in the marketplace should take a look at the electrochromic display business, which has been devastated by "retina displays" and the like—in part because it has proved completely unable to provide attractive color.

1.1.2 Enter the TOLED

These are serious limitations, and it is therefore no surprise to see a new and considerable focus on transparent OLEDs (TOLEDs). Small TOLEDs are even being shipped in low volumes. Players worth watching in the TOLED space include Futaba (Japan), Neoview Kolon (South Korea), and Samsung (South Korea).

Because they are emissive and happen to provide excellent color, OLEDs need no backlighting or color filters. So transparency seems easier to achieve; "easier," but still not "easy." Thus, various factors hindered the plans of Samsung in 2010 to launch the world's first TOLED-based device. LG was also unable to make commercially available a prototype of a transparent display-based 15 inch laptop.

Some of the issues that TOLEDs face include:

- The replacement of the usual metallic cathode with indium tin oxide (ITO) or some other transparent conductive oxide (TCO),
- The excessive light loss, and
- The disruption of displayed images caused by light coming from the background.

Gradually these issues are being solved, and NanoMarkets expects progress to accelerate. Indeed, the solutions need not be all that dramatic. For example, light loss can be controlled to some degree by introducing a slight asymmetry in the local transmittance of the electrodes.

And once these problems are solved, we foresee some exciting possibilities, although we also note that most of the really cool stuff here is being sponsored by Samsung in one way or another.

Thus, as a signpost to the future, we note that Samsung's transparent display screens are being used by Microsoft (U.S.) to create 3D-interactive computing systems in the lab. In addition, Samsung might be utilizing a transparent panel with touch capabilities on both sides in its smartphone (Galaxy S5) that is set for commercial release in the first half of 2014.

Samsung's intention is also to enable Google to switch Google Glass to OLEDs, while Toshiba (Japan) already has OLED AR glasses.

1.1.3 Coda: The TFT Factor

All of this news is very exciting. However, NanoMarkets believes that thin-film transistors (TFTs), which are a problem for both transparent LCDs and TOLEDs, may be another challenging factor.

Silicon TFTs aren't a possibility because they could never be transparent, so the most likely solution will be oxide—possibly ZnO—TFTs. The good news is that these TFTs are already in use for OLEDs, but not for TOLEDs. Oxide TFTs don't have to be transparent, but they can be. Serious manufacturing challenges remain, however.

As things stand now, therefore, the transparent display story is a cliffhanger. New applications seem almost ready to turn the transparent display market into a profitable sector within the display industry. But to get there, makers of transparent displays will have to simultaneously reinvent at least the display backplane and possibly—because LCDs will remain dominant for many years—the backlighting unit (BLU) as well.

1.2 Objective and Scope of this Report

This report is the first analysis from NanoMarkets on the market for transparent displays in retail, advertising, consumer electronics, and augmented reality applications. This report is based on NanoMarkets' ongoing industry research in the area of transparent display technologies that leverage the benefits of LCD, OLED, or e-paper technologies.

The report is a comprehensive study of current trends in the market, including industry drivers and technical limitations that are hindering the growth of the industry. The report provides an outline of not only the current technological aspects, but also the potential future applications based on current research and development efforts.

Specifically, the objective of this report is to analyze the potential of the currently available transparent display solutions and evaluate the future opportunities. Market projections for the next eight years are provided along with a brief description of various applications, profiles of major manufacturers, and the prospects for different raw materials.

This report is entirely international in scope. The forecasts are worldwide forecasts and we have not been geographically selective in the firms that we have covered in the report or interviewed in order to collect information.

1.3 Research and Forecasting Methodology

The forecasting approach in this report identifies and quantifies the underlying addressable markets and various applications of transparent displays in leading geographical areas. An attempt has also been made to identify future applications and market penetration of transparent displays in these emerging applications. We also evaluate the stated plans of key firms in the market in our forecasting analysis.

To determine where the opportunities lie, we have relied on both primary and secondary sources of information.

- Ongoing discussions with key players across the transparent display industry form our primary information source.
- We also draw extensive information from secondary resources, including the Internet, commercial databases, trade press articles, press releases, SEC filings, and other corporate literature.

This approach enables us to provide an in-depth analysis of the relevant application markets, including retail, advertising, consumer electronics, and the augmented reality space.

The forecasts are executed based on an inherent technical understanding of the currently used applications that incorporate transparent display technology. We have also relied on various scientific papers from journals and literature from various companies (brochures, annual reports, and articles) in order to identify the future applications of the technology.

The resulting forecasting approach and the assumptions made when preparing the forecasts in this report are explained in more detail in Chapter Three.

1.4 Plan of this Report

Chapter Two reviews the technical factors that are working in favor and against the successful adoption of transparent display technology. In addition, this chapter examines the strategies adopted by the key original equipment manufacturers (OEMs) such as Samsung, LG, and Planar. Significant attention has been paid to ongoing research in the raw material space. Recent technical trends are also pointed out to provide a commercialization roadmap for transparent display technology.

Chapter Three explores existing transparent display-based applications in detail, with specific emphasis on mobile displays, wearable computing, retail applications, and building-related applications. Other potential markets that are highlighted include casinos, museums, and the automotive and military sectors. In addition, this chapter provides detailed forecasts of the transparent display market with breakouts by application, type of material, and geography.