Markets for OLED Materials: 2010-2017

Chapter One

December 2009

About the Report:

This report contains NanoMarkets latest analysis and forecasts of the OLED materials market. Our new appraisal of this market is viewed from the perspective of the world's ongoing economic problems and especially from the shift in the applications space; plans to launch large OLED display panels were put on hold by several suppliers in 2009, while OLED lighting is exciting the attention of both lighting and OLED firms. These changes obviously have a significant impact on what materials are needed in the OLED space and how materials firms can make money.

What hasn't changed, however, is that almost all of the applications in which OLEDs are (or will be) used are badly in need of performance improvements. This typically translates into the need for better materials and with this in mind this report discusses the latest OLED materials and fabrication achievements, what the likely roadmap for OLED materials as a whole is likely to be, and what impact new materials developments are likely to have on the OLED industry.

The report addresses all of the segments of the OLED materials market and covers both polymers and small molecules, including materials for the latest solution processable small molecule approaches to OLED fabrication. It also covers materials for all layers of the OLED from the photoactive materials themselves, through the electrodes and encapsulation materials. Coverage includes the role of newer nanomaterials that appear to have commercial potential in the OLED space.

As with all NanoMarkets reports, this report on OLED materials provides detailed forecasts of the materials covered broken out by type and by application. It also includes strategic profiles of the leading firms who are developing and selling OLED materials of all kinds. The audience to which this report is targeted should be strategic planners and marketing managers at materials firms of all kinds, electronics companies, display and lighting firms and the developers of OLED technology itself.

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1.1 Background to This Report

The OLED materials market is the invisible foundation sitting beneath the more prominent OLED industry. The darling of the technology press for the past decade, OLEDs hold forth the promise of thinner, lighter, brighter, and more efficient displays. Yet the industry remains a vexing contradiction, with well-established applications on the one hand, but on the other hand with applications that seem to remain forever out of sight over the horizon, just tantalizingly out of reach.

There is no disputing the allure of the technology. The emissive nature of OLEDs eliminates problems of viewing angle and the related shifts in hue or contrast. The devices only require a single substrate, unlike the two glass layers required for LCD or plasma displays. The resulting products can be astoundingly energy efficient, with the potential to use one-half to one-third as much power to produce the same amount of light as a compact fluorescent lamp.

In spite of these advantages, OLEDs have only managed to gain a foothold in a couple of applications. Other uses continue to be in a state of development, but progress is slow. The problem, as will be discussed in this chapter as well as throughout this report, is that while the existing OLED industry is well established and relatively mature, many new problems must be solved in order to achieve similar success in other applications. This will require new materials and process technologies, and thus presents important opportunities for materials producers.

To capture the opportunities presented by applications such as solid-state lighting and large-format color displays, it will be important to understand OLED's history, its current state, and where it is headed. In addition, an analysis of the OLED industry would not be complete without considering the role of the worldwide economy, in particular the impact of the recent recession and anticipated recovery.

1.1.1 Making Haste Slowly

The early applications for OLEDs were low-density information displays, such as those on car stereos. Passive matrix elements were used to create single-color icons or segmented alpha-numeric readouts. The small size and energy efficiency were appealing to designers, and the vivid colors and excellent contrast gave the early displays dramatic impact.

After a few feints in other directions—electric razors and digital cameras—OLEDs next moved to mobile phones. The first applications were the secondary displays where passive matrix technology was sufficient to show phone numbers and date-and-time information. Eventually, the performance of active matrix OLED displays was good enough for the primary display, with full-color pixilated panels providing brilliant colors and excellent contrast. The thin form factor and power efficiency are well suited for mobile device applications, and the relatively low duty cycle (compared with a television or room lighting) minimized issues of differential color aging and other problems. (The fact that these displays need a polysilicon backplane does not increase the bill of materials cost as much as it would for a larger display, so they remain affordable.)

On a revenue basis, main displays for mobile phones remain the leader for generating OLED revenue for the near future. So what's the next step for the industry?

The next application that will generate significant business for OLED manufacturers is almost certain to be architectural lighting. While this may not be as sexy as a big-screen television, it has great appeal for its thin form factor and high efficiency. Also, lighting devices are simpler to manufacture than pixilated displays, so it is more likely that they will come to market sooner. Pent-up consumer demand for OLED televisions remains strong, however, so this segment appears to be poised to surge ahead as soon as they can go into production at competitive prices.

1.1.2 Speed Bump: The Effects of the Global Recession

So why haven't these next applications taken off yet? One reason is that there are plenty of material and process challenges to be conquered. Both universities and corporations are investing time and money into improving existing approaches and developing new ones, but progress comes slowly.

The bigger reason, however, may be the global economic environment. Technology research of all sorts suffered under the recent recession, as companies struggled to deal with massive losses by finding ways to slash costs. Even if we have turned that corner, unemployment remains high, which will be a drag on the consumer spending that helps fuel technology advances. The tight credit market is likely to continue, which in turn will make it difficult to get funding for new ventures.

The economics don't look to get much better for OLED in the near future, either. Even without the massive spending undertaken by central governments around the world to speed the recovery from the recent recession, many experts were already talking about significant inflation coming down the line. As a result, we expect that inflation will become the order of the day, forcing companies and consumers alike to struggle to manage rising prices and decreased buying power. The end result is that it will be increasingly difficult and expensive to fund the start up of new segments of the OLED industry, such as lighting and large-format displays.

1.1.3 A Strong Foundation

The existing OLED industry benefits from standing on the shoulders of other giants. For example, manufacturers can use the same high-quality glass produced for the LCD industry as substrates and top encapsulating layers. The existing glass has excellent uniformity and planar characteristics, which is precisely what is needed as substrates for the thin-film layers of OLED devices. Glass also is impervious to oxygen and water vapor, so it is a reliable solution for encapsulation.

The process of using lasers to anneal an amorphous silicon layer on glass is well established, providing the increased electron mobility required for pixilated OLED displays. And glass substrates with ITO coating as a transparent conductor are readily available from many sources. Even the specialized materials required for OLED devices are available from a variety of sources and in sufficient quantities for existing production needs.

The catch is that the next steps require some technological leaps, and there are no shoulders handy to jump on to get there.

For example, glass has characteristics that are less than optimal for OLEDs. It is relatively heavy (on a weight per volume basis), relatively rigid, and relatively fragile. At present, it is not suitable for flexible devices, either as conformable displays, such as curved dashboards in automobiles, or as displays that can be folded or rolled for storage. Various plastics and metals are available, but there is not another industry that needs flexible substrates that are impermeable to water vapor and oxygen (with the exception of organic photovoltaics, but that industry is in its infancy compared with OLEDs).

ITO is broadly used as a transparent conductor, but has its own shortcomings. Planarization of ITO coatings can be a problem for OLED devices, which can require additional layers in order to get reliable performance. ITO can also be brittle, making it less desirable for use in flexible displays. A variety of alternative materials are under investigation as transparent conductors—especially for thin film devices—but there is no existing industry segment that already relies on any of these alternatives.

The use of polysilicon backplanes extends to other segments besides OLED displays, but they all tend to be small devices, with small notebook computer displays being the largest to be mass produced. In order to make any headway in the large-format television market, the OLED industry will need either alternatives for the semiconductor backplane or ways to scale the polysilicon production process to larger screen sizes.

The holy grail for OLED device production is roll-to-roll (R2R) continuous processing. The promise is for greatly increased material use efficiency while greatly reducing the amount of time it takes to manufacture a device. To be sure, various forms of R2R printing are extremely mature at this point, but they have only limited application in products that are even remotely similar to OLEDs. As a result, processes must be developed to support this form of fabrication. Most of the approaches require OLED materials in solution—printable inks—to work, and many believe that this will mean the use of polymer-based OLED materials.

At present, however, practically all the OLEDs are produced using small-molecule materials, applied with traditional vacuum deposition techniques. In short, the current production systems do not have a practical roadmap to get to large format displays.

Some progress is being made, especially in the area of OLEDs for solid-state lighting. A number of organizations have started pilot production lines for R2R OLED manufacturing, including GE and Fraunhofer IPMS, which will presumably lead to further refinements in process and material technology.

Still, there is a long way to go in order to build up the OLED industry beyond its current focus on mobile device displays. This involves considerable risk as research and development take a lot of time and resources with no guarantee of success at the other end. And with risk comes added expense and difficulty in getting funding, which only serves to slow down progress that much more.

And delay can be costly. LED lighting already is progressing rapidly, which may make it more difficult for OLED products to find competitive niches when they become commercially available. And LCD flat panels for televisions have already become astoundingly thin with improved picture quality, even as prices continue to tumble, which will make it that much more difficult for OLED TVs to compete once they go into production.

So while OLED technology continues to capture the imagination of the press, consumers, and even manufacturers, the reality remains that while it has a strong base on which to build, it will take a long time for it to move to the next level. OLED lighting is not likely to hit its stride for at least four years, and while there is even greater uncertainty for OLED televisions, that segment is not likely to have significant market share any earlier than 2015.

1.2 Goal and Scope of This Report

This report analyzes and forecasts the prospects for OLED and related materials in the coming eight years. In the report, we review the range of materials currently utilized or under development for OLED lighting and display applications, including interesting research underway in universities and industrial labs. We also investigate how the OLED materials markets are changing, including the impact of demands for commercially viable mass production processes.

We provide an in-depth review of current commercialization efforts by firms that have focused on the OLED materials, including strategic profiles of the leading suppliers of these materials. In addition, the report contains detailed forecasts of major OLED application categories, in both revenues and volume terms.

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 Methodology and Information Sources for This Report

This report is based on extensive interviews with the movers and shakers throughout the OLED community, as well as extensive secondary research including an analysis of relevant applications markets. To determine where the opportunities are, we have based this report on both primary and secondary research. The secondary research drew on the World Wide Web, commercial databases, trade press articles, SEC filings, and other corporate literature to fill out what is going on in this sector. The forecasting approach taken in this report is explained in more detail in Chapter Two.

1.4 Plan of This Report

Chapter Two of this report provides an in-depth analysis of the major applications where OLEDs are being used now or will be used in the future, from mobile phone displays to flat panel televisions and solid-state lighting. This chapter also includes detailed eight-year forecasts of the materials that have been identified for use in making OLEDs, from the emissive layer all the way out to encapsulation techniques.

Chapter Three provides an overview of the key materials used in OLED devices, and the implications of new developments in material science that could have a major impact in the industry over the forecast period.

In Chapter Four, we profile the major companies involved in the development and supply of the various OLED materials.

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