
OLED Lighting Materials Markets—2011

Nano-433

Published November 2011

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Chapter One: Introduction

1.1 Background to this Report

Development of OLED technology for lighting markets is not as mature as for displays, but NanoMarkets still expects this sector to grow dramatically over the coming decade. And because OLED lighting panels are likely to be a (1) a mass market and (2) consist of panels a lot larger than the average OLED displays, the market for OLED lighting materials should ultimately be a lot larger than those for materials in the display sector. However, much more risk is associated with the lighting sector, for materials suppliers and just about everyone else.

NanoMarkets believes that materials suppliers will play a big role in whether the OLED lighting industry booms or settles into a niche pattern. For real, sustained growth in OLED lighting, new, better materials and processes are needed to enable this growth.

1.1.1 OLED Lighting Manufacturing Capacity Shaping the Need for Materials

The OLED lighting materials business will be shaped initially by the needs and preferences of those pioneer firms that are bringing the first OLED lighting panels to market. At the present time, the manufacturing infrastructure for OLED lighting is still at an early phase of development, but it has moved past the laboratory stage to pilot plants. From at least some of the OLED manufacturing companies, there have also been statements of intent regarding both plans for expansion and the kinds of manufacturing facilities that they plan to deploy. However, these statements have been made over a period of years, and it is hard to know how seriously to treat them, especially in this era of financial instability.

This uncertainly presents a real challenge to the materials firms hoping to supply the OLED lighting industry. The challenge consists of determining how much capacity there is likely to be for OLED lighting over the coming decade, who will be providing that capacity, and where the capacity will be built. It also includes determining which materials will be required. Will the OLED manufacturing continue to largely run classic vapor deposition equipment, or will solution processing take hold? If solution processing succeeds, will it be in the form of small-molecule materials or will polymer OLEDs finally make a play in lighting?

1.1.2 OLED Lighting Materials: Risks and Uncertainties

Some of the OLED materials firms that we have talked with, see exciting possibilities for their businesses in the OLED lighting market, but they also perceive the high risk. For now these materials firms are now supplying relatively small amounts of OLED materials to these first OLED lighting manufacturing plants may well emerge as the materials market leaders later in

the decade. Among the most important current issues that materials firms have to think about in the OLED lighting space are:

- The dominance of phosphorescent emitters from Universal Display Corporation (UDC) in important sectors of the OLED lighting market;
- The increasingly important role of Chinese OLED materials suppliers;
- The significance of solution-processable small molecule OLED technologies; and
- The continuing failure of polymer OLEDs in the OLED lighting market.

The situation of all of these areas is very fluid and in all of them changes could completely reshape the opportunity profile for OLED lighting materials suppliers.

The dominance of UDC: At the moment, UDC holds an essential position with a dominant intellectual property (IP) portfolio focused on small-molecule phosphorescent emitter technologies. And even more importantly, UDC has been very successful in getting OLED lighting manufacturers to employ UDC technology, through partnerships and licensing deals.

However, the recent invalidation of a key UDC PHOLED patent in Japan may mean that the market will open up to other materials firms. This decision is under appeal, and its long term implications have yet to become apparent. In the past, the ability of other materials firms to gain a foothold in emissive technologies for OLED lighting has been hampered by UDC's dominance.

The role of China: There are now several Chinese firms making OLED materials, and there is at least one firm in Mainland China – Visionox – producing OLED lighting panels. Most of the principal OLED materials firms are in the developed world but given the determination of the Chinese government to create more domestically sourced IP and given that OLEDs are a particular topic of its attention, NanoMarkets believes that competition from Chinese companies in the OLED lighting materials space.

Solution-processing of small molecules: This solution processing approach has the potential to deliver the advantages of solution processing to the OLED industry without forcing the industry to shift to an entirely new kind of material (*i.e.*, polymers):

- However, at this time, only GE, in cooperation with DuPont, is planning to use solution-processable small molecules to build OLED lighting panels, and *it not certain whom else DuPont – and any others developing solution processable small molecules like UDC – can persuade to buy into the idea.*

- *At the same time, GE is struggling to commercialize the solution-processed materials, and the current status of the GE pilot line is uncertain. It is not yet entirely clear what this will mean for the future prospects of solution processing in OLEDs, but we think it is safe to say that solution processing – especially printing – has proven much harder than the industry initially expected.*

Polymers in OLED lighting: Sumitomo Chemical with its ownership of CDT controls the nexus of polymer OLED EML material IP. *However, although Sumitomo and other proponents of polymer OLED technologies continue to push for polymers to gain entry into the market, not a single OLED lighting manufacturer is actually using polymers today.* As a result, Sumitomo remains a marginal player in the OLED lighting space.

NanoMarkets believes that polymer OLEDs might have a role for really large lighting panels at some time in the future, but given the lack of activity with polymers in lighting today, we think that it is fair to say that betting on a vibrant market for polymers in lighting is taking a big risk.

1.1.3 How Materials Firms Can Win the OLED Lighting Battle

For now the only serious commercial markets for OLED lighting are to be found in the luxury luminaire market and that is where the OLED lighting business will stay unless costs can be reduced. All projections – including ours – that show OLED lighting reaching revenues in the billions of dollars assume major reductions in OLED lighting costs from where they are now. This is not an entirely materials related issue. Nonetheless, it is closely related to materials and it presents opportunities for the materials makers:

- Economies of scale that will come into being as the OLED business as a whole ramps up. At the moment, pricing for OLED materials sits uncomfortably between the kind of pricing one expects for materials sold largely into R&D environments and ones that apply in commercial specialty chemical markets. *Opportunities exist for materials firms that can shift their pricing structure more towards the latter.*
- Initial costs for OLED lighting – as for other solid-state lighting – will be high and the only way that OLED lighting can be expected to prove in economically will be in terms of a total cost model. *This in turn depends heavily on lifetimes and also on luminance, both of which are heavily materials-dependent challenges. Several different materials in the OLED stack can affect lifetime, including the emissive technology used and the quality of the encapsulation scheme.*

Indeed, cost is not the only factor critical to the success in the OLED lighting space that the materials firms can impact and with which they can achieve a competitive edge. Much of the

raison d'être for OLED lighting in the first place is enhanced efficiency and that is very largely a materials issues.

There are also materials issues that relate to panel itself:

- At the present time, OLED panels are quite small; too small to be competitive in the office lighting market, for example, which is where some observers of the OLED lighting scene, expect OLED lighting to get its big break. Materials – both substrates and active organics – may have a role in taking OLED lighting to the next stage; that is larger panels.
- The stage after that, as many people see it will be flexible – or at least conformable – lighting panels. This transition to flexibility is materials dependent and will rely on the availability of suitable substrates and, most importantly, on high performance/low cost flexible encapsulation materials.

Thus the future of the OLED lighting market is heavily dependent on materials selection, and the maturity—and prices—of available OLED materials remain a challenge to market. However, this should be seen as an opportunity for materials makers, especially since the potential volumes are so high. Assuming for the moment that OLED lighting is able to capture even just a few percent of the lighting market, the square footage of OLED lighting sold will be considerable and will easily outshine the amount of OLED material sold for displays. This makes it a market that OLED materials suppliers cannot afford to miss.

1.2 Goal and Scope of This Report

The goals of this report is to analyze and forecast the prospects for OLED *lighting* materials in the coming eight years. The materials used in OLED lights are similar in most respects to those used in OLED displays. However, some of the cost, manufacturing, commercial and technical requirements for OLED lighting are different than for OLED displays, and this impacts the outlook and opportunities for materials in multiple ways.

It is for this reason that NanoMarkets believes that there is a need for a report specifically geared to the opportunities for materials stemming from the growth of OLED lighting. Although we show how OLED lighting could represent major potential for the materials and specialty chemical industry over the next decade, we pay special attention to how the opportunities for OLED lighting materials will develop over the next 18 months or so.

NanoMarkets has been providing industry analysis of the OLED community for six years, and is the leading supplier of analysis in the OLED lighting space. The objective of this particular report is to examine the OLED lighting materials sector and analyze what we see as the new

directions that OLED materials will be taking in the coming years for lighting. It is also to identify and quantify the opportunities that are emerging in this space.

Scope: Materials are discussed in the report from the perspective of the pioneer OLED lighting manufacturers – from the big three lighting companies Osram, Philips, and GE to the smaller and nontraditional lighting firms making a play in OLED lighting manufacturing like Kaneka, Lumiotec, Visionox, and others. We also take a look at the likely requirements and suppliers from potential major manufacturers of OLED lighting, who have yet to make a full commitment to such products; firms such as NEC and Samsung, for example.

The materials discussed include all the major materials used in the OLED stack as well as substrates and encapsulants. The product development and marketing strategies of the major materials suppliers in this space are covered, ranging from giant chemical firms such as BASF, DuPont and Sumitomo to specialty firms such as UDC, Novaled and Plextronics.

In addition, the report contains detailed forecasts of materials used for major OLED lighting categories, in both revenues and volume terms. The forecasts are developed from our forecasts of both OLED shipments and OLED lighting manufacturing capacity, and we utilize our insider's understanding of what the major OLED lighting firms are likely to need from their materials suppliers.

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. However, we have discussed the special characteristics of regional markets and industry clusters in the OLED lighting space, where this seemed appropriate.

1.3 Methodology and Information Sources for This Report

This report is based on NanoMarkets' ongoing research in the area of OLED lighting and on ongoing discussions with key players throughout the OLED community. We also draw on extensive secondary research including an analysis of relevant applications markets within the OLED lighting space.

Additional research for this report 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 Three.

1.4 Plan of This Report

Chapter Two examines in depth the OLED lighting materials supply chain. In this chapter, we analyze material usages from the perspective of the OLED lighting companies. We pay particular attention to those that already have real pilot lines in place for producing OLED lighting panels, since their decisions will largely shape the rest of the market. Within each discussion of a particular firm, we review the likely materials and key suppliers from the perspective of which materials that firm is using and which materials it plans to use in the future. Wherever possible, we also discuss the ways that materials suppliers are planning to serve the growing OLED lighting market.

In Chapter Three, we provide detailed forecasts of the OLED lighting materials sector with breakouts by layer functionality and by type of material, from the substrate and emissive layer to encapsulation technologies. The forecasts are organized primarily by layer functionality in the OLED materials stack, with consideration given in each layer to the dominant small-molecule vapor-deposition approach, solution processable small molecules, and the polymer approach to making OLEDs.

To obtain a full version of this report please visit us on the web at www.nanomarkets.net or by contacting our offices at 804-270-4370 or sales@nanomarkets.net