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Topics Covered

Background

NanoMarkets is a leading provider of market and technology research and industry analysis services for the thin film, organic and printable electronics businesses (which we refer to as TOP Electronics.) Since the firm's founding, NanoMarkets has published over two dozen comprehensive research reports on emerging technology markets. Topics covered have included sensors, displays, OLEDs, HB-LEDs, e-paper, RFID, photovoltaics, smart packaging, novel battery technologies, printed electronics, organic electronics, emerging memory and storage technologies and other promising technologies. Our client roster is a who's who of companies in specialty chemicals, materials, electronics applications and manufacturing. NanoMarkets also hosts a blog at www.nanotopblog.com where we discuss technology trends, company announcements and the industry's on-going progress.

Conductive Coatings for Printed Electronics

Conductive coatings cover a wide variety of applications and materials. In many cases, applications for conductive coatings are so mature and the materials that are actually used to support these applications so established, that they do not represent an opportunity in any real sense. But there are also other parts of the conductive coatings markets that seem likely to produce new business revenues in the not-too-distant future.

The main driver here is the demand for higher performing and lower-cost conductive materials, in addition to added benefits such as flexibility and compatibility with solution processing via conventional printing techniques. As such, there is considerable research and commercial development of materials to be used as conductive coatings. That such materials are important both strategically for the future development of printed electronics and as revenue generators is shown by the list of firms and research institutes working in this space. These include Agfa, BASF, Bayer MaterialScience, Fraunhofer-ISE, H.C. Starck, Henkel, Northwestern University, and Unidym to name but a few.

Conductive Coatings for Optical Devices and Photovoltaics Panels

The most vibrant part of the conductive coatings market at the present time is focused on contacts and electrodes for new types of electronics, optical devices and photovoltaics panels. But the story is bigger-much bigger-than this. Antistatic coatings for packaging and industrial clothing is likely to see something of a boom as the semiconductor industry moves down the path set for it by Moore's Law. As the node size decreases, the concern about damage from static electricity and vagrant currents becomes more important. With the semiconductor industry about to move beyond the 45 nm node, antistatic devices are increasingly essential. Finally, there are conductive coatings used for EMI/RFI shielding, another area of growing importance as the world of computing and communications becomes increasingly wireless.

These application trends would be of only modest importance as a driver for new business if the materials world was stable technologically. For example, if the inevitable solution to EMI shielding was a layer of copper (a solution widely used in the past), there would be little to talk about in a report such as this. However, the conductive coatings market is dynamic on the supply side as well as on the demand side. New materials-including new nanomaterials-are appearing quite regularly today and promise to improve on traditional materials in what have been largely mature markets for many years. Materials selection for conductive coatings may also be impacted by the current worldwide recession. Where a designer might have been cautious about using an Indium or silver-based coating a year ago because of the high price of such metals, in today's economy these coatings could have acceptable economics.

Materials Selection for Conductive Coatings

It is not possible to cover every material and every application for conductive coatings in a report such as this. Instead we have focused on areas that we expect to provide the greatest opportunities; these areas include the applications already mentioned and three key materials trends. One materials trend is the growing role for conductive polymers. The second is the growing role for nanomaterials, and especially carbon nanotubes. The third is a growing palette of oxides that seems to be available for conductive coating applications.

Conductive Polymers as an Electrode Material for Novel Electronics

The poster boy for the rise of conductive polymers is H.C. Starck's PEDOT:PSS material. This has been used for some time in electrostatic applications, but is now beginning to find a new-and higher value-role as an electrode material for novel electronics applications. It has even been used for OLED lighting electrodes, in the touch-sensitive subsystems of touch screen displays and in fuel cells. Still conductive polymers are not without their issues in the context of high-end conductive coatings. In particular, they have relatively low conductivities. There is hope here, however. For example, Ormecon in conjunction with its partner Nissan Chemical Industries has demonstrated polymer materials that are climbing the conductivity ladder.

As an aside, polymer materials also seem to have a growing opportunity in EMI/RFI shielding; the most commonly used conductive polymers in EMI/RFI are polypyrrole and polyaniline, due to their low cost and good electrical conductivities. Water-based polymer conductive coatings have shown the unique ability to transform surfaces into functional antennae, thereby radically changing the way that communication systems can be linked. Such coatings block external access to wireless signals including WiFi networks and can contain and isolate EMI given off by electronic equipment. These coatings have even proven to provide excellent solutions for Sensitive Compartmented Information Facility (SCIF) buildings, and have been retrofitted for U.S. government agencies and military operations.

Carbon Nanotubes in Conductive Coatings

The use of carbon nanotubes in conductive coatings is interesting in a number of ways. First it illustrates one of the first practical applications for carbon nanotubes in electronics. While some of the more romantic visions of high-performance carbon nanotube transistors have never really panned out, CNT-based conductive coatings seem to have real commercial value here and now. They may even lead to the first transparent conductive coating that can offer a better mix of transparency and conductivity than ITO.

The two companies that have been pushing carbon nanotube coatings in this way are Unidym and Eikos. As an example of what can be done today, one can point to Unidym's collaboration with Samsung Electronics that resulted in the development of an innovative 10.1 inch VGA analog resistive touch screen, and Unidym's carbon nanotube-based color active matrix electrophoretic display which uses a carbon nanotube transparent electrode. Such coating developments are a long way from the CNT transistor, but not so far from nanoscale electrode elements that are plugged into biological molecules. In addition, it is interesting to note that CNTs are not the only nanomaterials that can be used in conductive coatings; firms such as Cambrios are believed to be looking at metallic nanomaterials.

Oxide Materials in Conductive Coatings

The third key direction for conductive coatings that is of special interest in the context of this report is the growing oxide zoo; that is the growing number of oxides that can be used as conductors. Often the opportunity for these materials is as an ITO substitute, but there is a broader range of electrode applications for oxides and in some cases, the role of oxides spill over into the optical coatings field; for example in UV filter applications, and in the case of ZnO also promise a whole new class of semiconductor devices. Among the materials that proven useful in this way are various zinc oxides and tin oxides doped with a wide variety of materials such as antinmony, fluorine, aluminum, indium and gallium.

Summary

Finally, it is worth noting that while current materials innovations for conductive coatings mostly relate to the areas above, the market for these coatings continues to be affected by developments in the area of the first kind of conductive coatings-metals. There are new ways to deposit some kinds of metals. Printing-of silver and copper, in particular-is now a practical alternative to older coating approaches. In addition, metals can be mixed with other materials to form novel conductive coatings of various kinds. For example, Syscom Advanced Materials in conjunction with NASA has developed the AmberStrand metal-clad polymer coating, which produces highly conductive yarn and has effectively replaced the commonly used beryllium copper CS95 wire. AmberStrand is fabricated from silver-PBO fiber, which is less toxic to manufacture than beryllium alloys. The novel material is being used for signal transfer and EMI shielding in wiring and cable applications.

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