Conductive Coatings in Electronics and Energy Markets

Nano-507

Published January 2012

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About the Report:

NanoMarkets believes that the 2012-2013 period will be an important one for conductive coatings manufacturers. Once a staid and stable business, the conductive coatings industry has seen a steady demand for ESD and EMI/RFI coatings and new forms of energy storage, solar, energy-efficient lighting, and the rise of flexible and transparent displays, all with unique and challenging coatings requirements.

The industry is also seeing the emergence of nanomaterials and NanoMarkets is predicting that nanometals, graphene and carbon nanotubes will account for a sizeable part of the conductive coatings market in the not-to-distant future and that metal oxides and organic materials will make a greater impact on the conductive coatings market than ever before.

Clearly the business is changing, forcing companies to become more dynamic and responsive to new forms of energy and electronics.

In this report NanoMarkets examines and quantifies the opportunities for conductive coatings. As with all our reports, this study includes a detailed eight-year forecast of conductive coatings markets by application and material and it also contains a discussion of some of the key conductive coatings materials suppliers and their product/market strategies.

NanoMarkets has been providing analytical coverage of the conductive coatings market for more than four years and has developed an insider's knowledge of the factors that shape it.

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Chapter One: Introduction to Conductive Coatings

1.1 Background to the Report

Much of the conductive coatings business involves mature applications manufactured using equally mature materials. In these mature materials markets, there are few real opportunities as such. At best, these sectors are "cash cows." *The good news, however, is that a few key applications are open to new materials and new suppliers.*

1.1.1 Applications Driving Growth in Conductive Coatings

These key growth areas fall into two categories:

- Fast growing and highly dynamic application areas such as solar panels, emerging electronics, etc., where the needs for conductive coatings are still in a state of flux. NanoMarkets firmly believes that some conductive coatings firms are going to make considerable amounts of money in these sectors, where they will benefit from growth in the underlying addressable markets; but the flip side of this scenario is that these markets are constantly shifting ground, and demand for new materials can disappear here as fast as it appears. Put in economic terms: they are quite risky!

- Legacy applications, where there are still plenty of examples of existing coating technologies that are less than perfect. Electroless copper for electromagnetic interference (EMI) shielding coatings and indium tin oxide (ITO) transparent electrodes for displays could be cited here. There are fewer risks for entering coating manufacturers, but also less opportunity to build a very large new business. Still, we think that it is encouraging that conductive coatings firms that look hard into existing markets are likely to find some new ways to make money.

While in a broad sense the applications for conductive coatings haven't changed much in years, there are some important trends that are shifting demand patterns. In the solar energy sector, NanoMarkets expects to see a growing emphasis on energy conversion efficiency as solar subsidies begin to go away. This shift translates into a need for more effective electrodes and hence for improved electrodes. With energy storage also becoming more important, there are new kinds of batteries and supercapacitors on the market that also need higher performance electrodes. *These demands for better electrodes obviously translate into new opportunities for conductive coatings of various kinds going forward*

Meanwhile, the display industry is itself looking for ways to adjust to the fact that the boom days for LCDs are over. On the one hand, this effort includes trying to squeeze the biggest

possible margins out of the (still gigantic) demand for LCDs that remain. On the other hand, it means looking for entirely new business opportunities outside the mainstream LCD industry. To date, these opportunities have included e-paper, OLED displays, transparent displays and flexible displays. All of these new types of displays have appeared on the market (with varying degrees of success) or are about to do so.

The details of these changes in the display industry are not all that important here, but suffice it to say that all of these new kinds of displays represent a challenge to the dominant transparent conductive coating: indium tin oxide (ITO). *No one – and certainly not NanoMarkets -- believes that ITO is going to be anything other than the dominant transparent conductor for a long time to come. However, it is also impossible to doubt that the trends described above in the display industry will not enhance the opportunities for new conductive coatings of various kinds.*

While these developments in the display and solar panel industries are new – or at least new-ish – and, we think, deserving of immediate attention for market strategists in the conductive coatings industry, it is also important to recognize that trends in the electronics and communications industries *continue* to promote growth in the conductive coatings market. Thus, there is nothing really new in the following items, but they continue to counteract the core maturity in the conductive coatings space:

- The expansion of electronics, especially of electronics that support pervasive wireless computing, is fueling growth in the market for EMI and radio frequency interference (RFI) coatings. Legacy products will continue to do well, but new solutions for shielding are also expected to grow. This application was once considered slow growth, but has transformed into one that has greater potential than ever before.

- Electrostatic dissipation (ESD) and antistatic markets are benefitting from the trend toward pervasive electronics, and are further fueled by the onward march of Moore's Law, which makes errant charges ever more harmful in electronics manufacturing and assembly. Antistatic coatings for packaging and industrial clothing are likely to see a boom as feature sizes decrease.

1.1.2 Satisfying Demand for Conductive Coatings with New Materials

It is important to realize that none of the markets described above are expected to throw off old conductive materials and embrace new ones, and we think that slow penetration should be built into any forecasts of new materials sales in the conductive coatings sector. However, the fact that in the past 1 to 2 years – roughly the period since NanoMarkets last published a conductive coatings report – firms selling transparent coatings made from conductive polymers

and nanosilver have taken a small share of the market away from ITO should be regarded as encouraging.

This example, of course, is just one of many that have changed on the supply side of the conductive coatings market. *More generally, the appearance of new metal oxides, nanomaterials and conductive polymers in commercially available conductive coatings has broadened the choice of materials:*

- Incorporation of nanomaterials is probably the most exciting trend that NanoMarkets can see in the advanced coatings materials space. These materials have a long way to go in terms of product development, but we expect big things from them. *Not only do nanomaterials potentially go a long way to enhance the performance of conductive coatings, they can help reduce manufacturing and/or materials costs – preferably both – in applications.*

- *Given that metallic coatings are always going to be a preference where conductivity is an issue, nanometallic coatings seem to be of particular importance. But carbon nanomaterials are also interesting in the context of conductive coatings,* although they are also deserving of some skepticism in this regard. Carbon nanotube transparent conductive coatings have not done as well as some hoped a few years ago. But new firms are getting into this market, and the costs of CNTs are rapidly declining. Then there is graphene, everyone's favorite material at the present time; which may or may not be the way to go in the conductive coatings market in the future.

- *We also cannot help but note that conductive polymers are now out there in real world products serving as transparent conductive coatings.* Still there is only so far this trend can be pushed. Conductive polymers are not without drawbacks, particularly with respect to their relatively low conductivities and stabilities compared to pure metals and many conductive metal oxides. This performance issue means that despite progress, the addressable markets for conductive polymers are always going to be limited.

1.2 Objectives and Scope of This Report

The objective of this report is to analyze and forecast the growth opportunities for conductive coatings over the next eight years, with a focus on the materials and applications outlined above. It identifies and quantifies the opportunities for emerging conductive coatings in applications including electronics protection, ESD assembly and packaging, energy storage, solar panels, lighting, displays and a variety of other areas.

This report focuses specifically on the applications that are open to novel conductive coating materials. It also identifies and compares the major candidate materials for new conductive coatings and how well each is suited to particular end uses and/or markets. The report discusses the product strategies of major materials firms that are involved in this space, and includes a review of commercialization efforts of conductive coating developers.

Through a review of each of the various market segments, we show where new business revenues will be created in the next eight years. This report also provides detailed eight-year market forecasts for the use of conductive coatings. These forecasts are provided at the end of this report and are broken down by material type and application.

This report is 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.

1.2.1 Applications and Materials Covered

Because the area of conductive coatings is so large, it is not possible to cover the market opportunities presented by every available niche material or application. Instead, we have focused on the areas that we anticipate will provide the greatest opportunities for new and emerging conductive coatings materials. We acknowledge that the focus of the report is primarily toward areas that fall into the *electronics industry* in one form or another.

Our primary interest is in coatings that are used to create electrodes (especially transparent ones) and contacts as well as in coatings used for antistatic and EMI/RFI applications. However, in some cases we go beyond these applications. With regard to materials, our main interest is in metals, conductive metal oxides, conductive polymers, and nanomaterials. While "coatings" can mean almost anything one wants it to, we are generally concerned with roll-to-roll coating or web coating processes. Despite overlap in some areas, we have attempted to draw the line at patterning *vs.* coating as much as possible. We acknowledge, however, that there is a fine line between printing and coating, and we undoubtedly cross that line from time to time in this report.

In this report, we have relatively little to say about several areas that have unique demand/supply patterns and industry structures. These include (1) conductive inks, pastes and adhesives, (2) metallized films, (3) electrolytic, electroless or other direct metallization processes for the deposition of copper, and (4) materials for processes in large-scale integration in the semiconductor industry.

1.3 Methodology of This Report

NanoMarkets has been covering the markets for conductive coatings, in one form or another, for over five years, and this report is our latest on the subject. Our basic forecasting approach is to identify and quantify the underlying application markets for conductive coatings, the materials needs that are or can be served by different kinds of conductive materials, and the technological and market pressures that affect penetration into these markets.

The information for this work is derived from a variety of sources, but principally comes from primary sources, including NanoMarkets' ongoing interview program with entrepreneurs, business development and marketing managers, and technologists involved with conductive coatings of all kinds. We also use information from secondary sources, such as relevant company and industry organization websites, commercial databases, trade press articles, technical literature, SEC filings and other corporate literature.

Some of the applications-related market information in this report comes from our most recent reports on the covered application areas. Where information has been used from another report, it has been reinvestigated, reanalyzed, and reconsidered in light of current information and updated accordingly.

This report forms part of a series of reports published by NanoMarkets covering new directions in the commercialization of materials for electronics applications. Other areas covered by NanoMarkets' reports include analyses of the markets for silver and nanosilver, OLED materials, materials for functional printing, ITO and other transparent conductors, and materials markets for photovoltaics.

1.4 Plan of This Report

In Chapter Two, we examine the different kinds of commercially available existing and novel conductive coatings materials. The analysis is done from the perspective of technology and materials science, both of which influence performance, product design, and manufacturing. As part of this analysis, we briefly examine the focus and strategies of some of the key manufacturers and suppliers of conductive coatings materials. We pay particular attention to innovations and strategies being followed to reduce costs, increase performance, and customize products for particular markets and applications.

In Chapter Three, we discuss the applications and markets for conductive coatings in printed electronics and other industries. The goal of this chapter is to identify the niches and sectors that represent opportunities, as well as the materials and performance requirements for these areas.

In Chapter Four, we present our eight-year forecasts for conductive coatings. Wherever possible, the forecasts are broken out by material type (metal, metal oxide, conductive polymer, or nanomaterial) and by application.