# Smart Coatings and Photovoltaics 2012

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This report is part of NanoMarkets' ongoing coverage of materials and markets in photovoltaics (PV). In this report, NanoMarkets examines the emerging opportunities for selling "smart" coatings into the solar panel industry. In this report we examine the potential for self-cleaning, self-healing, electrochromic and thermochromic coatings in the PV applications over the next eight years. It includes an assessment of where revenue generation will occur and which companies are likely to be the winners and losers in this space. The report also includes a detailed eight-year forecast of smart coating usage in the PV space, broken out by coated area and market value.

NanoMarkets has been covering the markets for PV materials for almost seven years and believes strongly that there are now growing opportunities to sell smart coatings into the PV sector. This report considers how smart coatings can create value for the PV industry under the changed circumstances that PV faces today, in which government subsidies are under threat and there are huge pressures to reduce PV costs across the industry.

In this environment, some PV module makers are seeking ways to differentiate themselves in a rapidly commoditizing market, such as through addition of self-cleaning or self-healing coatings to PV panels that improve performance and/or reduce cost-in-use. Others may seek to add new functionality to PV panels, such as by combining BIPV with an electrochromic smart window that enhances the value proposition of PV for end-users. Among firms discussed in this report are, Bayer MaterialScience, Cardinal Glass, Corning, Gentex, Nippon Sheet Glass, Nissan, PPG, Peer, SAGE Electrochromics, Saint-Gobain, and Soladigm.

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# Chapter One: Introduction to Smart Coatings in PV Applications

## 1.1 Introduction to this Report



### 1.1.1 Changes in the PV Market that May Influence the Adoption of Smart Coatings

NanoMarkets continues to believe that there are opportunities for commercialization of smart coatings in the photovoltaics (PV) sector, even though the PV market is quite different today than it was just a year ago, both from an economic and a political perspective.

Starting in 2012, the PV market is entering a period of reduced growth. This new market is very different from the one of the last several years, in which year-to-year growth in production doubled (or more), even in the midst of a worldwide recession. Today, however, a glut of conventional crystalline silicon (c-Si) PV modules on the market after over-production by the Chinese PV panel makers, along with dropping prices, is expected to significantly slow growth rates in PV production starting in 2012 and for the next few years.

Meanwhile, the political environment has also changed. Lingering fiscal concerns in the United States and the European Union, coupled with slow growth and high unemployment, have led governments around the world to pursue serious cost-cutting measures in an effort to reduce debt. To date, most subsidies, feed-in tariffs, and other tax incentives for PV remain in place. However, their future is uncertain; governments are likely to see these subsidies as targets for the cost-cutting axe. *(At the time of this writing, Germany has just announced a more aggressive FIT reduction of 30% vs the previously targeted 15%)*

But what does all of this mean for smart coatings in PV applications? First of all, it means that suppliers of materials and technologies to the PV market cannot simply rely on high growth rates for organic growth of their products. It also means that the ongoing commoditization of PV, especially in the market-dominant c-Si PV sector, will encourage PV panel makers to do one of two things:

- Look for ways to cut prices in order to stay competitive and keep sales volumes up, or
- Look for ways to add value to their products and create differentiation in the market in order to maximize profit margins.

That portion of the PV sector that opts for the latter strategy—addition of value-added features to their PV products—is where the opportunities can be found for smart coatings suppliers. To capitalize on these opportunities, coating suppliers must actively make the case to their customers, and potential customers, that the additional cost of adding a smart coating to a PV panel or module is worthwhile to the bottom line.

In summary, NanoMarkets believes that there are significant opportunities for smart coatings suppliers in the PV business. The sheer size of the PV market as a whole means that the addressable market for smart coatings in PV is potentially large; even modest penetration in the PV market for smart coatings can lead to significant revenues for coatings and coatings technology suppliers. In addition, the adoption of smart coatings in PV can help PV panel makers accomplish two key goals important to the future success of the PV sector:



- *Integration of smart coatings can cost-effectively increase conversion efficiencies for PV, and/or,*
- *Smart coatings can provide additional functionality that enables PV panel makers to create "premium" products and differentiate themselves in a rapidly commoditizing, and homogenizing, marketplace.*

### 1.1.2 How Smart Coatings Improve the Value Proposition for PV

It is not clear how far the PV industry is willing to go with respect to adoption of smart coatings. The degree of penetration will hinge on two factors. The first question relates to cost; panel makers must be convinced that smart coatings can boost the performance of PV without adding so much cost that the economic benefits of the added coatings are negated. The second, and even more important, question is how well smart coating-enabled PV products will do in the marketplace.

Smart coatings can be broadly divided into two categories:

- Smart coatings that improve the basic performance of the PV panels, thereby helping to create higher performance PV products with better cost-in-use propositions to customers, and
- Smart coatings that add novel functionality to PV panels, thereby creating new types of devices and end-uses for the PV panels and higher profit margins for panel suppliers.

Within these categories, the most obvious opportunities for smart coatings in PV are for coatings that can increase efficiencies. This area is promising because the PV market is very likely to buy into increased efficiencies, as long as the increase in efficiency takes cost into account. For example, self-cleaning coatings may be employed to prevent dirt accumulation, thereby improving panel efficiency. But to be worthwhile in the marketplace, they must be practical solutions for the life of the panel. In other words, coating maintenance must be simple and inexpensive enough so as not to negate their benefits or erode their value below their cost.

At the other end of the scale, smart coatings that add novel functionally could certainly make PV panels stand out in the marketplace, but it is far from certain to what degree customers will care about the added functionality. Using smart coatings to add novel functionality should therefore be regarded as a much riskier proposition than using them to increase efficiency.



### 1.1.3 Smart Coatings for Better Panel Performance

Smart coatings can enable higher performance of PV panels by increasing the light capture in the panels. To that end, NanoMarkets believes that there are roles for both self-cleaning and self-repairing smart coatings in preventing dirt, scratches, and other damage. Such problems are difficult to avoid in outdoor environments where most PV panels are deployed.

Specifically, self-cleaning smart coatings can improve performance by keeping the PV panels clear of dirt and debris, and self-repairing smart coatings can reduce the degradation of optical quality caused by scratches and other minor damage.

- Self-cleaning coatings will be successful if they can reduce the costs associated with manual cleaning. Routine cleaning using manual labor is an inherently expensive process that will only get more expensive in the long run. Thus, there are opportunities to improve the self-cleaning properties of PV panels in order to minimize ongoing maintenance costs.

- Self-repairing coatings that reduce the incidence of scratches and other damage could also improve underlying panel performance, reduce warranty claims related to underperformance, and reduce the incidence of breakage. And here again, routine repair of PV panels is inherently expensive, so self-repairing coatings that reduce the need for repairs and replacement are likely to present opportunities for both coatings companies and panel makers alike.

*The key value proposition that performance-enhancing self-cleaning and self-repairing coatings bring to PV is reduced costs. These sources of value to the panel maker and the customer are quite tangible, and hence may be more easily monetized than the more speculative values of the added functionalities of new products that we discuss below.*

### 1.1.4 Smart Coatings and Added Functionality

Smart coatings can also offer new functionality to PV panels—functionality that can provide new value to end users and better distinguish PV panels in the marketplace. As we have already noted, this latter issue is very important to maintaining margins in the PV marketplace, especially in today's economic environment in which panel prices are dropping and growth prospects are much more moderate than in recent years.



NanoMarkets therefore believes that there are opportunities for coatings and coating systems that can selectively customize PV performance in the hands of the customer. In particular, we believe that smart coatings can enable certain niche PV products that can turn off or dim when required:

- First, *thermochromic coating* systems that dim or shut down panels can help to preserve service lifetimes. This functionality could be of particular use in PV technologies like cadmium telluride (CdTe) PV, which suffers from degradation when under power at high temperature. A thermochromic smart coating could protect such panels from permanent damage if temperatures exceed the limits. The value of preventing record heat from wiping out an otherwise fully functional PV generator should certainly be sufficient to fund some interesting products in this space.
- Both *electrochromic* and *thermochromic coating* systems for the fabrication of *smart windows* could also be used to add tangible, value-added functionality to PV panels. For example, these kinds of smart coatings could be integrated with BIPV glass, in which a transparent or semitransparent PV panel is combined with a smart window to provide controlled shading.

Other, longer-term opportunities may emerge as well, such as the integration of PV panels with OLED lighting or different kinds of displays, or more sophisticated smart window/PV panel combinations with OLED lighting in which an electrochromic shading layer would provide increased reflection of light back through the PV cell or toward the target as necessary.

There are also opportunities for combining PV with electrochromic layers across the portable and/or flexible PV sector, for both on- and off-grid applications, and for combining PV with other kinds of devices.

## 1.2 Objectives and Scope of This Report

The objective of this report is to analyze the opportunities available in the PV market for suppliers of smart coatings. In this analysis, we consider the factors that affect the smart coatings markets and those that shape the PV market. We include an assessment of each of the types of smart coatings that are likely to gain significant penetration into the PV market and the unique aspects of their use with photovoltaics.



We are principally concerned with the smart coating materials themselves, but wherever possible and germane, we also consider the different types of PV as they specifically relate to smart coatings and the companies producing and developing smart coatings for PV.

The classes of smart coatings that we consider as likely to achieve significant penetration into the PV market are as follows:

- Self-cleaning coatings,
- Self-repairing coatings,
- Electrochromic coating systems, and
- Thermochromic coatings.

Antireflection coatings, which are not strictly "smart" or active, are excluded from this analysis.

Through a review of each of the various market segments, we show where new business revenues can be created in the next eight years, and we provide detailed eight-year market forecasts for the use of smart coatings in PV broken out by material type.

The forecasts are in terms of the materials required per square meter of PV panel and in dollars of revenue. This choice of units makes the data meaningful to suppliers of smart coatings materials that may provide bulk materials like inks or coatings, or pre-coated glass and/or plastic substrates, or, in more sophisticated cases, complicated multilayer coating systems and/or devices for integration with PV modules.

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.

### 1.3 Methodology of this Report

This report is the latest from NanoMarkets that looks closely at materials used in the PV industry, which is a key area of expertise of NanoMarkets. The information for this report is derived from a variety of sources, but principally comes from primary sources, including NanoMarkets' ongoing interview program of entrepreneurs, business development and marketing managers, and technologists involved with the PV sector, materials for PV applications, and emerging electronics of all kinds.

We also use information from secondary sources, such as relevant company and industry organization Web sites, commercial databases, trade press articles, technical literature, SEC filings, and other corporate literature.



Some background information for this report has been taken from last year's version of this report, *"Smart Coatings for Photovoltaics"* from March 2011, as well as from *"Smart Coatings Markets 2011,"* from February 2011. Where information has been used in an earlier report, it has been reconsidered in light of current developments and updated accordingly. In addition, information related to the size of the photovoltaics market, which is directly related to the addressable market for smart coatings in PV, is based on NanoMarkets' internal forecasts for the PV sector.

The basic forecasting approach is to identify and quantify the underlying photovoltaics markets, the penetration of various smart coatings into PV markets, and the technological and market pressures that affect the adoption of different types of smart coatings for PV. We also consider broader economic developments that impact PV and materials development and commercialization.

This report on smart coatings for PV forms part of a series of reports published by NanoMarkets covering new directions in the commercialization of PV and materials used in PV applications. Other related areas covered by NanoMarkets' reports include analyses of the markets for different PV technologies, silver and nanosilver, transparent conductors used in PV, and other materials markets for PV applications.

### 1.4 Plan of this Report

In Chapter Two, we examine the smart coatings that improve the performance of PV panels, namely self-cleaning and self-repairing coatings. In Chapter Three, we turn our attention to smart coatings that add value-added functionality to PV panels, such as electrochromic, thermochromic, and other more sophisticated multilayer coatings or devices. In both cases, we examine the market opportunities and value propositions for performance-enhancing or added-functionality smart coatings integrated with PV devices. Finally, Chapter Four contains our eight-year forecasts of smart coating markets for PV.