Brightly colored solar modules for building facades

State of development of MorphoColor® technology

The global photovoltaic market is growing rapidly. In the future, solar module applications will also focus on building facades, where aesthetic aspects are particularly important. The Fraunhofer Institute for Solar Energy Systems ISE has therefore developed a process for solar modules with a homogeneous and brightly colored surface that are sufficiently efficient. This could drive the use of building-integrated photovoltaics (BIPV).

The solar potential of building envelopes is huge

Photovoltaics is already an important pillar of energy supply in many countries. In the future, this will be much more the case. The integration of photovoltaics into building facades, windows and shading solutions is therefore particularly interesting. The potential is huge: in Germany alone, the Leibniz Institute for Ecological Spatial Development and Fraunhofer ISE estimate a theoretical potential area of around 12,000 square kilometers of façade surface, twice as much as on roofs. The solar activation of facades therefore not only represents a intelligent dual use of existing surfaces, but also offers itself as an ideal solution.

BIPV offers many advantages for building owners: the modules not only supply solar power, but also fulfill classic functions such as sound insulation, thermal insulation, and wind and weather protection. In addition, shading and daylight utilization are provided by systems installed in the transparent part of the building envelope. Vertically installed modules also make particularly good use of the low sun in winter. Depending on their orientation, they do not produce peak values at midday like most rooftop systems, but rather in the morning or afternoon hours, depending on the orientation. This enables a high proportion of self-consumption, which increases grid efficiency.

It is surprising that the market share of building-integrated solar modules remains small despite all these advantages. However, interest has grown noticeably in recent years, and experts expect BIPV use to pick up.

Design as important as efficiency

Since design is particularly important in the field of building-integrated photovoltaics, however, architects and owners believe that it is not enough for modules to have a good price-performance ratio. They must also be visually appealing and as free as possible in design. There is a great demand for modules in different colors with high saturation and homogeneity.

Previous approaches for coloring solar cells or cover glasses are limited in the choice of colors and have a decisive disadvantage: they lead to comparatively high performance losses. In order to minimize these, Fraunhofer ISE has developed a new process - inspired by nature - which enables colored modules with minimal transmission losses.

The new photovoltaic modules can be manufactured in the desired color. Photo: Fraunhofer ISE

Innovative coating: Morpho butterfly as model

A phenomenon observed in the morpho butterfly served as the starting point for the development. Its special feature is the strong blue coloration of its wings. However, this is not due to color pigments on the wing surface, as is the case with other butterflies, but to a three-dimensional surface structure with lamellae on a nanometer scale. The lamellae can only be seen under an electron microscope and have the property that they interfere with incident light. Light of a certain wavelength (blue) is reflected by the many lamellae. The reflections reinforce each other, resulting in a bright color impression.

The key feature of such a structure is that it remains transparent to other wavelengths. As a result, it achieves a strong coloration with high light transmission at the same time. By changing the distances between the lamellae, the reflected color can be specifically adjusted.

Fraunhofer ISE has now succeeded in demonstrating the feasibility of a coating with which such color-giving three-dimensional surface structures can be applied to large areas of cover glass for PV modules. The coating consists of a dielectric material and enables high color saturation as well as good viewing angle stability. The color can be customized. Compared to uncoated cover glass, the colored modules have a relative power loss of only 7 percent, i.e. a 150-watt module still delivers about 140 watts with the colored cover glass.

The coating enables high color saturation as well as good viewing angle stability. Photo: Fraunhofer ISE

In collaboration with module and glass manufacturers, the manufacturing process is currently being optimized for industrial production scale. The modules will then undergo the certification process for market approval. We are convinced that this technology will not only enable a more diverse design of solar modules, but also contribute to a broader acceptance of building-integrated photovoltaics.

About the authors:

Thomas Kroyer, Head of Group Coating Technology and Systems, Fraunhofer ISE

Arnulf Dinkel, Project manager Group Building Systems Technology, Fraunhofer ISE

https://www.ise.fraunhofer.de