



1 Semi-transparent BIPV modules integrated in a building of Fraunhofer ISE.

(Photo: Guido Kirsch)

2 Colored solar module with MorphoColor® coating.

COLORED SOLAR MODULES FOR BUILDING INTEGRATION

Buildings account for a high share of total energy demand and greenhouse gas emissions nationwide. Building-integrated PV (BIPV) can significantly improve the CO₂ balance of a building, ideally to the point of a zero-energy or plus-energy building.

The technical potential of BIPV in Germany amounts to at least 800 GW_p. If this potential were used, a large part of our energy needs could be covered without additional land consumption. BIPV modules not only generate electricity, they also fulfill building functions in terms of building physics, design or construction. Therefore, the multifunctional solar modules perform better in economic and ecological terms than conventional building elements.

BIPV modules also offer great potential in terms of design: The bright colors and patterns of the modules, developed at Fraunhofer ISE, make BIPV increasingly attractive for building design. The integration of the modules is very easy, especially

for glass surfaces. BIPV can be used almost anywhere in a building: in the roof or façade, in transparent and non-transparent areas or, for example, as a curtain-type, rear-ventilated façade.

BIPV Development at Fraunhofer ISE

Flexible formats, shapes, colors and designs allow a wide range of architectural integration forms. Our services include:

- support in product design
- prototype production
- technology transfer in production lines
- efficiency analysis and optimization
- yield simulation and monitoring
- cost analysis
- module testing in accredited laboratories
- assessment of aspects relating to building regulations
- further development and upscaling of the processes together with architects, construction companies, module and component manufacturers or glass processors

Fraunhofer Institute for Solar Energy Systems ISE

Heidenhofstr. 2
79110 Freiburg, Germany
Phone +49 761 4588-0

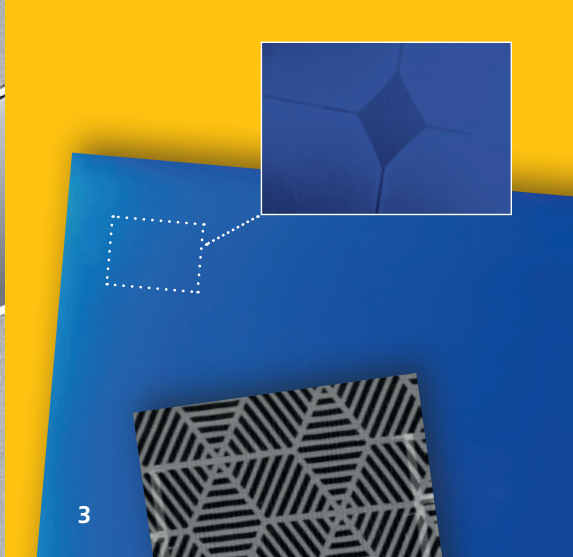
Energy Efficient Buildings – Building Envelope

Dr. Tilmann E. Kuhn
Phone +49 761 4588-5297
building.envelope@ise.fraunhofer.de

Photovoltaics – Module Technology

Dr. Holger Neuhaus
Phone +49 761 4588-5825
pvmod.tech@ise.fraunhofer.de

www.ise.fraunhofer.de



At Fraunhofer ISE we develop efficient and aesthetic module designs using a wide variety of materials and technologies. Individual, multifunctional modules are created by

- the basic technology of PV cells and their electrical interconnection, such as shingling or wire connection
- the optimization of the building physics functions
- the type of constructive integration
- the functional and colored design of the cover glass

Intensive Colors by MorphoColor®

Colored PV modules can add life to the architecture of a building, making it interesting and modern. Together with industrial partners, Fraunhofer ISE is developing the MorphoColor® coating to market maturity. The individually selectable color gives architects and building planners a great deal of creative freedom:

- saturated colors, matte or metallic shiny surfaces
- good angular color stability
- reduced glare
- individual module formats, colors and designs

The layer is a photonic 3D structure inspired by the Morpho butterfly and made of dielectric materials. Due to the special layer structure a very high color saturation and an excellent angular color stability can be achieved. The solar cell technology behind the color layer is not visible.

The high efficiency of MorphoColor® modules is unique in the construction sector. Compared to an uncoated module of the same design, the loss of generated electrical energy is only about 7%_{rel.}

Market Opportunities for European Module Manufacturers and Suppliers

The pressure of competition is enormous, especially for ordinary solar modules. However, for more specific requirements for PV modules, the local industry can operate competitively. Aesthetic and individual requirements can be developed on a project-specific basis and the modules integrated into the building can be manufactured in smaller series.

Standardizing BIPV Modules

For efficient construction and manufacturing processes, standardization of BIPV modules for certain types of buildings can be profitable. The project “Standard BIPV” at Fraunhofer ISE identifies suitable building categories that can be renovated with prefabricated and standardized BIPV façades. For example, the project examines the category “industrial halls”, which in Germany comprises more than 100 million square meters of façade area.

Product data of standardized modular façades can be included at the very beginning of the planning process. The aim is to achieve uncomplicated fastening through simultaneous electrical and mechanical coupling. To facilitate building planning, electrical system configurations are also predefined and standardized.

1 Colored solar module with MorphoColor® coating.

2 BIPV modules integrated in building of Fraunhofer ISE, Freiburg.

3 Reference samples for a MorphoColor® module and a SEFAR module with textile mesh insert for building integration.

Customer-specific size adjustments are often required for solar building products. But even for customized production, automation and digitalization can significantly reduce costs and simplify planning. At Fraunhofer ISE we work with industrial partners on the automated planning and production of customer-specific BIPV modules with type approval.

PV Building Integration – Component of the Energy Transformation

Together with partners from the industry we would like to realize further reference projects. In the Module-TEC – Module Technology Evaluation Center we produce samples and pilot batches on industrial plants. In our TestLabs “Solar Façades” and “PV Modules”, both accredited according to DIN EN ISO IEC 17025, we test the electrical, thermal and optical properties of the multifunctional components as well as the quality and reliability of the modules and systems.