Building integrated photovoltaics in practical use: The 5GSOLAR thin film device perspective

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Fig 1: Traditional PV silicon modules versus specialised BIPV products (rollable PV bitumen felt, PV luxopheres developed by the University of Exeter UK and PV pavement elements, developed by TalTech e-Pavement startup in Estonia).

Maciej Sibiński from Tallinn University of Technology, examines building integrated photovoltaics in practical use, from the 5GSOLAR thin film device perspective

BIPV concept, role and applications

Building-integrated photovoltaics (BIPV) is developing rapidly as more private homes, office buildings, production facilities, and even storage structures are designed with energy neutrality in mind. Achieving sustainability in electric energy has become a crucial objective, especially considering that around 40% of energy consumption in the European Union (EU) comes from buildings. Additionally, emissions from private households account for over one-third of greenhouse gas (GHG) emissions.

In response to these facts, in 2024, the EU Parliament prepared the Energy Performance of Buildings Directive (EU/2024/1275), which defines photovoltaics as one of the critical factors to achieve low- or zero-energy building status. It is essential that in the document, the PV installations combined with energy storage systems in buildings are recognised as beneficial for both the climate and the finances of citizens and businesses.

However, apart from the economic and ecological convenience, the development of BIPV brought about several possible applications for various building types. Evolving from the traditional add-on setup placed on the roof cover, modern PV modules can fulfil the roles of windows, terrace berries, facades, or even integrated roof tiles, bricks, or flagstone products.

Additionally, modern, popular bifacial modules, characterised by double-sided light sensitivity, are the perfect materials for fences or balcony barriers. With these applications, the energy production level may be more equalised during the day, eliminating unnecessary battery costs. Of course, to adjust the PV products to the specific application, proper technology must be adopted. Luckily, several materials and structures are accessible to satisfy these demands today.

Fig 2: Various colours of polycrystalline silicon cells, PV silicon coloured roof tiles and texturised façade panels by ML System S.A Poland and PV sound blocking barrier by Alfabond Kohlhauer A.G Germany.

Various solar module types in BIPV products

Standard silicon solar modules started the adventure in Building integrated photovoltaics in the early eighties, but their rigid, cumbersome construction, necessary metal support, high weight and unpleasant general outlook made the scientists and designers re-think and adjust their concept. In response to these needs, multi-coloured and structured modules, emulating visual roof or façade materials, were elaborated. Also, new types of silicon bifacial modules were successfully employed in specific building applications.

Nevertheless, next-generation photovoltaics offers much more attractive opportunities for module integration with the architectonic elements. Thin film solar cells may be effectively used for the fully flexible, multi-coloured polymorphic or even semi-transparent elements. They can also be easily scalable solutions for both small-scale houses, parking places, or bus stations and huge skyscrapers.

Among these structures, one may distinguish popular inorganic structures like amorphous silicon (a-Si), cadmium telluride (CdS/CdTe) cells and copper-based devices (like CIGS or CuxOx). They are well-known but mostly opaque; some are degradable or based on life-hazardous production technologies or materials. The alternative may be organic or semi-organic colorful dye-sensitised PV (DSSC cells). Unfortunately, their photoconversion efficiency and long–term stability are still significant issues.

The antimuonium-based PV technology ($Sb_2(S,Se)_3$ is an alternative to all those propositions. This new material, developed in the Laboratory for Thin Film Energy Materials at Tallinn University of Technology, is very promising in terms of photovoltaic conversion efficiency. It is also produced using simple, scalable technology and may be semi- transparent, which makes it perfect for future solar glass applications.

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