TAIYO

Darmstadt, Germany

ETFE MEETS OPV

AN INNOVATING MULTIFUNCTIONAL MODULAR CURTAIN WALL FOR THE TRANSFORMER STATION

Figure 1: MERCK Transformer Station, Darmstadt, Germany
1a: appearance of the original brick-façade
1b: appearance of the new curtain wall

Building envelopes offer opportunities for the use of solar energy. Curtain walls are particularly suitable for the application of photovoltaic modules. Considering the fact that curtain walls are arranged separately in front of the building exterior wall, they allow a relatively simple application of photovoltaic modules, without paying particular attention to the aspects of building physics (thermal insulation, heat dissipation). Furthermore, a curtain wall enables the access, the connecting and the maintenance on PV-modules from the back. The presented project shows such a successful application. Here, organic photovoltaic (OPV) was applied to ornamental printed and pre-tensioned ETFE films. In combination with the lightweight profiles of aluminum, this resulted in a transparent and aesthetically appealing curtain wall that additionally generates electricity from renewable energies. The façade, finished at the beginning of 2018, is covering the transformer station, a one-story brick building, on the premises of the company MERCK KgaA in Darmstadt, Germany. The façade can be considered, therefore, as the world's first energy-efficient, digitally printed single-layer ETFE curtain wall equipped with OPV-elements. The innovative example shows where development could lead on this path.

Description of the pilot project

The project shows a modular design for curtain wall façades, which consists of the combination of ETFE- film and organic photovoltaic cells (OPV). Here, three different organic shapes of OPV elements were applied on the mechanically pre-tensioned ETFE film. The 64 membrane modules with aluminum frames form a curtain wall covering four sides of the existing transformer building on the premises of MERCK in Darmstadt in front of a wall made of fired bricks. The selected colours of the digital printing of the ETFE film follow the corporate identity of the company. Due to the relatively small area of the OPV the plant provides only a low power yield.
The small façade is, therefore, a pilot project, that should demonstrate the possibilities of this technology. The direction in which this technology goes is clear: the individual design of modular, aesthetically appealing multifunctional curtain walls. Topics include lightness, transparency, aesthetics, careful use of resources and solar energy generation.
The project uniquely combines aesthetics and multi-functionality. The result is a great architectural work of art with a high innovative standard.

Conclusion

The project shows the possibilities of building integration of photovoltaic (BIPV) in combination with transparent ETFE film, but it also shows the beginning of a construction method that will only mature to a trend-setting technology after going beyond initial teething troubles. However, the combination of PV and ETFE enables, like no other, the realization of modular, individual, multifunctional and aesthetically pleasing façades and roofs. The example also shows that requirements for aesthetics, transparency, lightness, load transfer, weather and fire protection, as well as the careful use of our natural resources and the solar energy production are achievable. Since the example refers to an open curtain wall, building physical requirements due to thermal insulation were not compulsory.

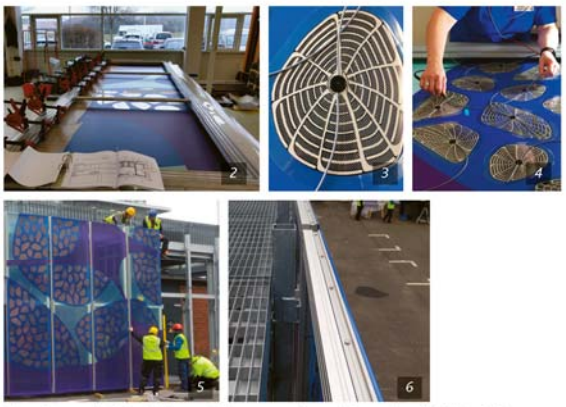

Figure 2: Assembly of the 64 frames in Taiyo Europe's workshop (standard size 4.2x1.3m, as shown here; special size 4.2x0.5m).
Figure 3: OPV-modules glued on the backside.
Figure 4: Connecting the OPV-modules.
Figure 5: Installation of the pre-fabricated façade-modules on site.
Figure 6: Detail of the finished façade, top view.

Currently the membrane construction industry is changing rapidly to the extent that modular constructions with mono- or multi-layered structures and multifunctional uses are now part of it. Due to their low weight per unit area and their multi-functionality, modular constructions also undoubtedly belongs to the field of lightweight structures. Such multifunctional modules are becoming increasingly important for architects and building owners, and, therefore, for the construction industry as well, as they allow very different applications and functional possibilities. However, they also lead to a major challenge for membrane construction companies, architects and structural engineers. This means that suitable production methods with appropriate quality assurance for modular multilayer structures must be present or developed, and the topics of building physics, fire and structural behaviour, but also production and assembly technologies of modular multilayer membrane structures are to consider in design and engineering, including all interactions.
Which membrane construction company is capable of producing a large number of uniform or even different modules economically and in terms of a needed high quality? Which structural engineer is also a specialist in building physics and photovoltaic and knows the element's stress-strain behaviour and its structural limits? Which architect can claim that he masters all relevant topics in such a way that he can present a harmonious execution planning of such modular constructions, without involvement of experts in the early phase of the planning process? The knowledge of all the elementary properties and requirements, but also their interactions, will increasingly determine the success of such modular membrane projects as well as the future of the planners and specialist companies involved in this new technology.

Karsten Moritz
info@taiyo-europe.com
www.taiyo-europe.com

Name of the project:	Merck Transformer Station
Location address:	Darmstadt, Germany
Client (investor):	Merck KGaA, Darmstadt
Year of construction:	2018
Design:	Henn Architects, Berlin
Structural Design:	Leicht, Munich
Contractor:	Taiyo Europe, Sauerlach
Supplier of the membrane material:	Nowofol Kunststoffprodukte, Siegsdorf
Supplier of the steel substructure:	Steelconcept, Chemnitz
Supplier of the OPV:	Opvius, Kitzingen
Manufacture and Installation:	Taiyo Europe, Sauerlach
Covered surface:	300m²
Number of modular frames:	64
Number of PV modules:	1,578 (3 types of organic shapes)