DEVELOPMENT OF COLOURED SOLAR MODULES FOR ARTISTIC EXPRESSION WITH SOLAR FACADE DESIGNS WITHIN THE "BIMODE"-PROJECT

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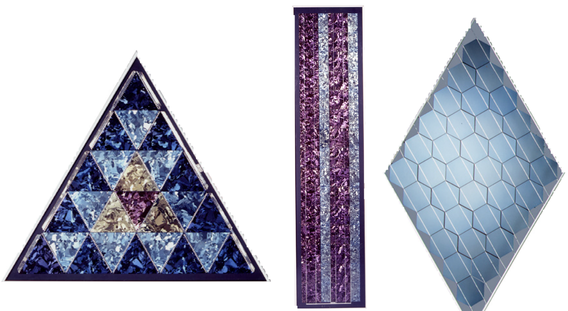
ABSTRACT: The BIMODE-Project was an interdisciplinary research project, funded by the European Commission within the Joule programme. Artists, architects, engeneers, researchers and industry worked together to achieve new forms of artistic expression with crystalline solar cells. The challenge for the artists and designers of the Academy of Media Arts Cologne within the BIMODE-Project group was to use the technology of differently shaped coloured and interconnected crystalline solar cells to design solar facade elements. The solar module was seen as an element of a facade composition. The aim was to enhance the visual appearance of buildings and to show the possible variety of solar aesthetics. On the basis of three generic prototypes, virtual solar facade designs have been made to demonstrate the different possibilities of expression.
Keywords: Facade – 1, Building Integration – 2, Coloured Solar Cells – 3.

1. DESIGN AND PRODUCTION OF DIFFERENTLY COLOURED AND SHAPED PROTOTYPES:

Within the BIMODE-project from a broad variety of designs three generic prototypes were chosen to be produced, using all the technical abilities of the partners: a triangular solar module with triangular multicrystalline solar cells in steelblue, dark blue, gold and magenta (Fig. 1.1) designed by Prof. Jürgen Claus; a striped solar module with full and half multicrystalline solar cells in the colours magenta and steelblue (Fig. 1.2) designed by J.P. Janka and monochrome solar modules produced in the colours steel-blue (Fig. 1.3), titan and dark blue with monocrystalline hexagonal solar cells, designed by Astrid Schneider (for technical details about the modules see reference 1). The prototype cells and modules were manufactured by BP Solarex, the multicrystalline wafers by Bayer AG and the glasses by TFM. The modules have module efficiencies of 6.3 % (Fig.1.1), 7.6 % (Fig. 1.2) and 10.8 % (Fig. 1.3) and 12.1 % for the dark blue hexagonal module (See det. fig. 6).



1.1 1.2 1.3

Figure 1: Three generic prototypes of the BIMODE-project

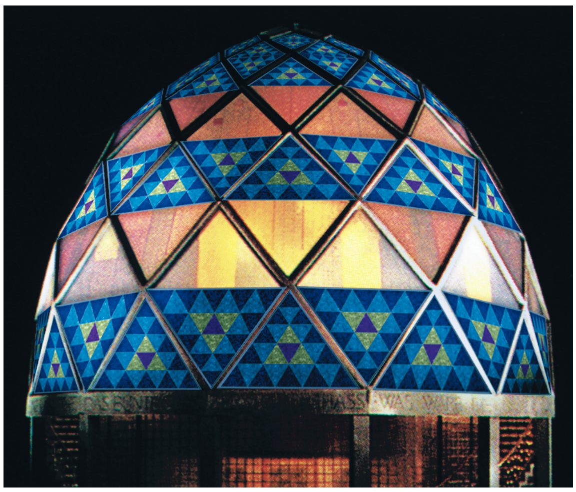


Figure 2: Bruno Taut's 'Glass Pavilion' with imaginated triangular solar modules (Design: J. Claus)

2. VIRTUAL FACADE DESIGNS WITH THE BIMODE PROTOTYPES:

The specific shapes and coloures of the BIMODE-modules open the way for solar facade and roof designs with different geometries and design languages than with standard modules. The triangular solar module allows integration into dome structures (Figure 2). This shape and the rhombic one are as well suitable

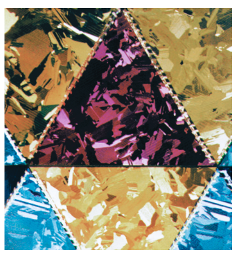


Figure 3: Detail of 1.1

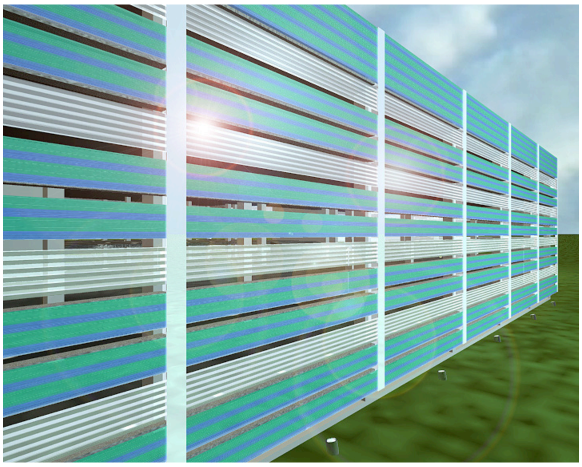


Figure 4: Mannesmann Garage with virtual PV-facade

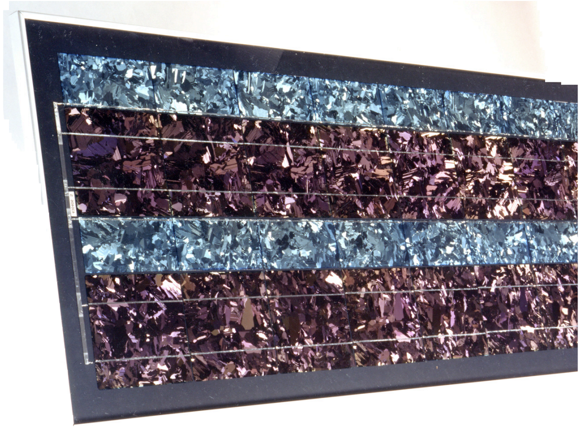


Figure 5: Detail of striped module (1.2) with half and full cells

for inclined roofs with their triangular geometries. The striped module designed by Jörg-Paul Janka (Fig. 1.2 and 5) enhances the cubic form of the Mannesmann Garage in Düsseldorf (Fig. 4), alternated with light directing devices. Figure 7 shows the solar office of the future (designed by Astrid Schneider): in this design green hexagonal solar cells within hexagonal modules give a more natural appearance. The solar cells are interconnected with a wave-formed grid. To cut the round monocrystalline wafer to a hexagonal shape (Fig. 6) instead of a squround shape gives not only aesthetic advantages, but functional ones as well (Fig. 12). The hexagonal cut allows a much better use of the original wafer: less

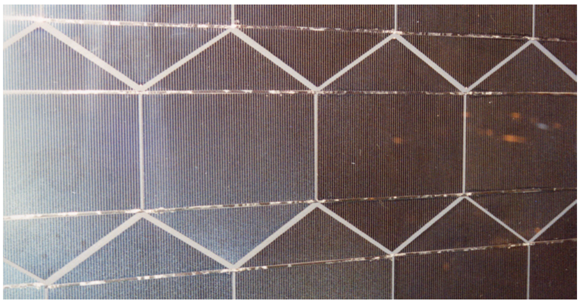


Figure 6: Densely packed hexagonal monocrystalline cells

Figure 7: Office of the future (with the solar filmmaker Hellmuth Costard and the solar researcher Tim Bruton in the background).

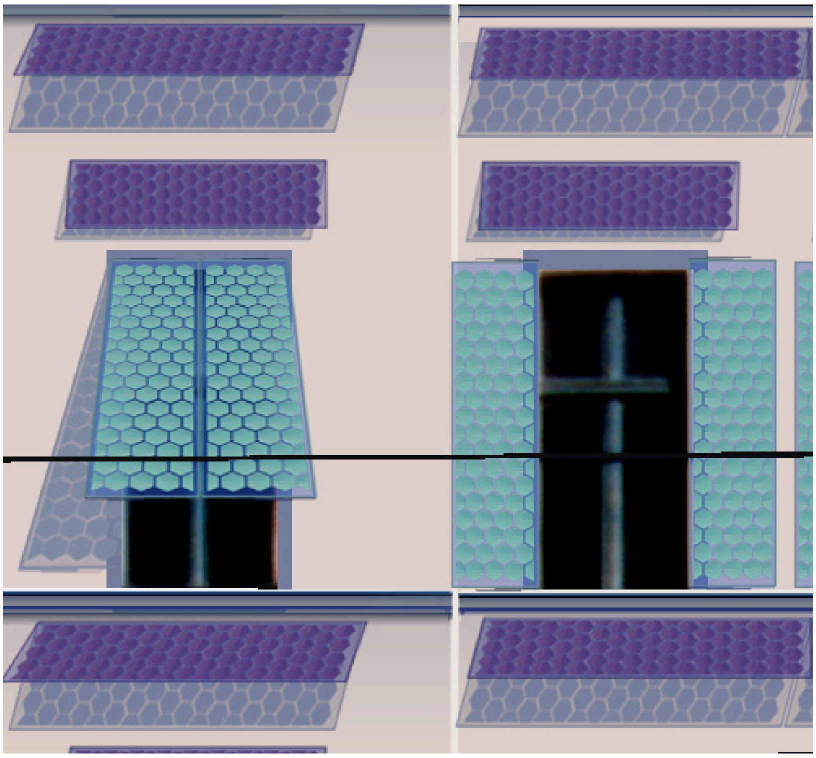


Figure 8: Window with solar shutters and 'stucco' (Design Figure 6-11 Astrid Schneider)

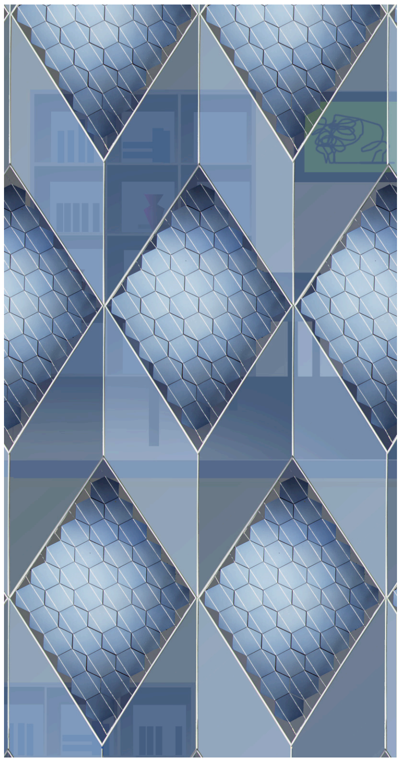


Figure 11: Facade with inclined modules

Figure 9: Apartment house with solar shutters and 'stucco'

Figure 10: Apartment house in Berlin without PV-Integration

wafer is cut away around the future cell. Second advantage: one cell fits exactly to the other. Therefore the module area is filled more densely without gaps. The more homogeneous filling causes again functional and aesthetic progress at once: the module efficiency is higher than with gaps on the one hand and the ugly and visually very dominant gaps of the 'squround' wafers vanish. Instead a more elegant appearance is caused. Figure 11 shows the design of a folded glass facade with inclined rhombic PV-modules. This allows the modules to recieve more solar radiation and to provide shading. The figures 8-10 show an apartment building in Berlin-Prenzlauer Berg. Fig. 10 shows the original situation today, fig. 9 the design of a solar facade, for which solar modules are used as shutters and as stucco. The PV-elements structure the facade in a differentiated way, according to the historic neighbours. The design shows, that PV-elements can enhance the visual appearance of buildings in historic environments. The PV-module design adapts to residential and historic constructions with stone facades and can be used easily for restauration. Multifunctionally the solar elements protect the facade as well by rain and weather influences. Inclination and free airing of the modules allow a higher solar gain than usual PV-facades with vertical elements have. The PV-modules are designed in a lighter colour (green-blue) for the shutters and

Figure 12: To cut the monocrystalline round wafer hexagonally provides more efficiency in material use and module lay-out

in a darker colour (dark blue) for the ‘stucco’. The different colours help to structure the facade horizontally. The module design demonstrates that hexagonal solar cells fit to rectangular forms.

3. SPECIAL DESIGN PROTOTYPES COMBINING COLOURED GLASSES AND SOLAR CELLS:

Special artistic research has been carried out within the BIMODE-project: Jürgen Claus and Hellmuth Costard both designed and produced prototypes, in which the rich tradtion of glass windows and handicrafted coloured glasses is combined with solar cells.

3.1 Solar Cells in Combination with Stained Glass Windows

J. Claus worked together with the glass studio of Dr. Oidtmann for the realisation of a stained glass window, consisting of four parts (Fig. 13). Small solar modules are integrated in the window structure, using coloured mound blown

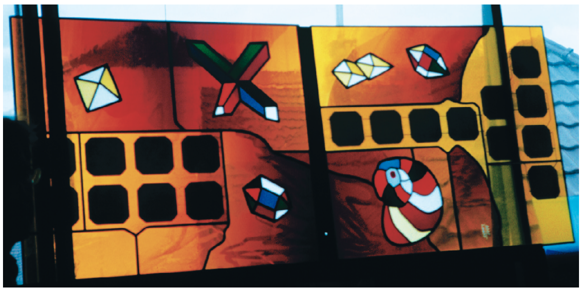


Figure 13: Stained glass window with PV-module integration

glass as a backside sheet for the modules. This type of solar stained glass window could especially be used for church-windows, castles etc, where already stained glass windows exist and should be renovated or added with a more modern type of it. The stained glass solar window combines the traditional glass art, which has been carried out for centuries by artists for representative buildings with PV-design. The PV here is seen as another material for window design.

3.2 Solar Cells in Combination with Fused Glasses

Hellmuth Costard’s idea was to combine dark blue standard solar cells with fused glasses (Fig. 14 and 15). For this purpose he worked together with an glass-workshop to pro-

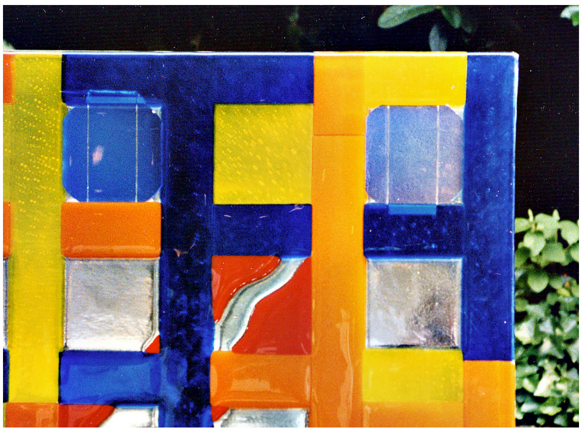


Figure 14: Solar module with stripes of fused coloured glass and with dark blue solar cells filling the gaps (Det. of Fig. 15)

Figure 15: Hellmuth Costard explaining the fused glass solar module in the Garden of the Academy of Media Arts Cologne during the BIMODE expert seminar in June 12th 1999

duce clear glass panes with stripes of mound-blown coloured glasses on top of it. The sandwich goes to an oven, where the coloured glasses melt and fuse to the clear glass pane. The gap between the grid of coloured glasses belongs to the solar cell in this design. As a window the backside sheet would be made from clear glass, as a facade element Hellmuth proposed a mirror as a backside sheet (See Fig. 15). This causes reflected light through the coloured glasses and gives them a bright and shining colour effect. Hellmuth’s idea was that it could be much more easy and efficient to add coloured glasses to standard solar cells, than to produce coloured solar cells to get coloured solar modules. Another advantage was that the fused glasses would allow to combine glass elements with and without solar cells without braking the overall composition or harmony of a facade. So for shaded parts of facades, borders to windows etc. modules without solar cells could be used.

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