ADVANCES AND PROBLEMS OF TRANSPARENT INSULATION IN THE MARKET
Professionalization and Diversification

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1. INTRODUCTION

For now more than 15 years transparent insulation is subject to research and development. In spite of promising experimental results and demonstration projects only a small market is currently visible. Fully developed products of several companies have been on the market for about two years. A large thermal resistance combined with high solar gain factors characterize these different systems.

Reflecting the past and future developments in their wide variety, the state of the art in combination with current problems shall be presented here.

2. STATE-OF-THE-ART AND RECENT DEVELOPMENTS

Amongst TI-components a wide diversification has taken place. Although at first hand contradictory, even non-transparent products are on the market, e.g. the SOLFAS-module of Schweizer with integrated absorber plate. Table 1 gives a classification. Most elements today are open and air-filled.

Table 1: Classification of TI-Components

T	Transparent Elements	O	Opaque non-transparent Elements
	1 - open ventilated		1 - open elements with integrated absorber
	2 - pressure exchange		2 - pressure exchange with integr. absorber
	3 - closed air-filled		3 - closed air-filled with integr. absorber
	4 - closed gas-filled		4 - closed gas-filled with integr. absorber

2.1 PLASTIC FILM TI

Absorber-perpendicular TI-structures are still the most efficient material group judged on the basis of thermal resistance and solar energy transmittance. The usual extrusion or spinning procedures for fabrication are suboptimal with respect to small quantity production and flexibility in material choice. Structures based on commercial plastic films were investigated in an Austrian research project by Joanneum Research, Leoben [2]. Slit structures were discarded because of electrostatic and tension problems. However, the prototype production of honeycomb-slit structures yielded promising results.

Hemispherical total solar energy transmittances between 55% and 60% with thermal resistance well above 1 m²K/W were achieved for material of PC, PMMA and CA between two low-iron glasses. Due to the optimized structure the mass density was below 3%.

2.2 HLB MODULAR FACADE ELEMENTS

Within the development of modular TI for demonstration projects constructional improvements led to a decrease in cost. The small modules of Holz- und Leichtmetallbau Leipzig may be fixed even on walls with lower static stability by a simple technique. Including the external shading device the costs reduced from 1370 DM/m² to 985 DM/m² in a real project.

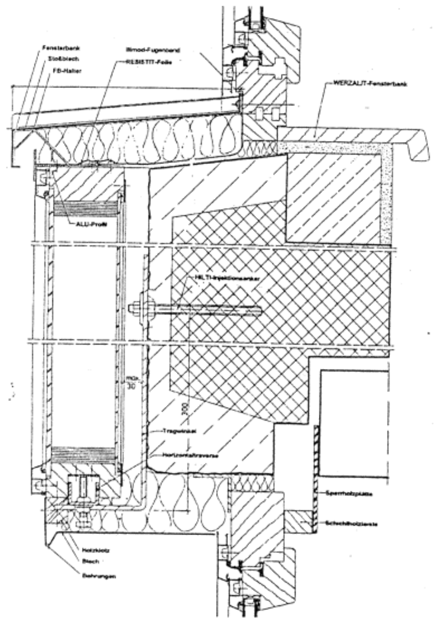

Figure 1: Sketch of improved construction including window detail

2.3 SEMITRANSPARENT MODULES

Although traditional TI-products emphasize the high solar gains possible with this technology, a series of recent developments aim at very low solar gains just to offset the remaining thermal losses of opaque insulation. The motivation is on the one hand to present a cheaper system - prices range in the order of 400 - 600 DM/m2 - and on the other hand to have no need for a costly solar shading.

2.3.1 ESA

The cardboard TI by ESA was the first system presented already in the last conference. The cardboard honeycomb facade has a g_h of 13% for diffuse radiation due almost entirely to radiation absorbed within the cardboard structure. Thus the system approximately reaches a net energy balance of zero - the solar gains over the heating season offset the thermal losses. This is true if the massive wall behind the cardboard facade is able to take up the solar gains.

However, some projects have been argued with solar gains while having an insulating light-weight construction behind the system. In this case obviously the solar gains become negligible and the system effectively is a conventional insulation.

2.3.2 G+H

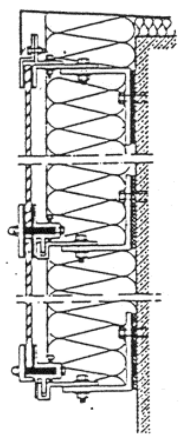

Figure 2: Optratrec system construction (from inside to ambient: thermally optimized cantilever beam, special mineral wool with coloured lining, 4cm ventilated gap with safety glass)

Based on their mineral fibre insulation products the companies G+H Montage, VEGLA and G+H Isover developed the so-called Optratec system, where a coloured mineral fibre mat is placed behind a vented safety glass pane. The characteristic performance parameters have been determined by a student diploma thesis [5]. The results show that a large part of the thermal losses is due to heat bridges of the construction (around 30%). The solar radiation is absorbed in the front part of the fibre insulation and reduces the thermal losses. However, a positive heat gain over the heating period could not be observed.

2.3.3 Other similar approaches

Similar to the G+H concept the Pilkington Solar Wall PSW utilizes the solar absorption within a glass fibre insulation behind a vented low-e glass cover. Although the solar gains are relatively low, they similar to the G+H system improve the insulation noticeably and approach the zero loss envelope. Printing on the exterior glass which is fixed with a simple bolt construction to the wall reduces solar gains in order to prevent overheating. If not used for huge areas this precaution seems to be unnecessary. The Wicona WICTEC panel is based on the same idea, but is designed to be used as an element with a transom-mullion facade, either with or without a massive wall behind.

2.4 INSULATING GLAZING TI (KARLSRUHE)

In order to increase both, construction thickness and cost, the University of Karlsruhe, Germany, develops a TI-system based on insulating glass technology. Low-e coated glazings filled with Xenon are coated with a black absorber (a black film). Thermal contact to the massive wall (in order to prevent thermal breakage) is provided by a layer of metallic flukes. The system has to be evaluated in near future.[3]

2.5 PRISMATIC STATIC SHADING

Seasonal shading with prismatic glazing is being investigated by ISFH, Hameln/Emmerthal, and the Fraunhofer ISE, Freiburg. Whereas the ISFH investigates a saw-tooth type surface, ISE looks into tilted prisms and compound parabolic profiles. Whereas the first type reflects direct solar radiation in a certain solar altitude downwards, the second type retroreflects and the third may be designed to reflect more diffusely. [6,[7]

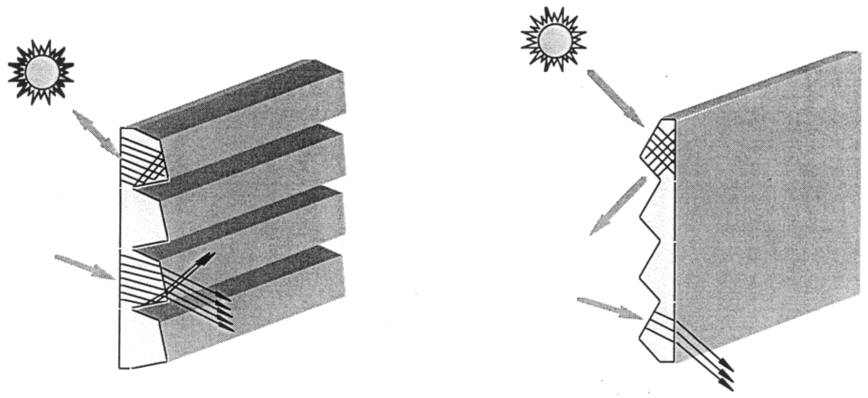

Figure 3: Tilted prismatic and saw-tooth type

3. SELECTED PROJECTS

3.1 RENOVATION OF SCHOOLS

Within the Eastern federal states of Germany at the end of the sixties schools had been built in an industrialized building method. Large heating consumption well above 200 kWh/m^2a as well as old-fashioned heating systems and bad status quo leads to a need for renovation. Apart from better insulation (0.2 W/m^2K roof and 0.4 W/m^2K in the facade), low-e windows (U_{cg}=1.4 W/m^2K) transparent insulation seemed to have a good application potential.

3.1.1 Paul-Robeson-School, Leipzig

One of the first renovated projects was the Paul-Robeson school in Leizig. 4 storeys in light concrete plate construction with 60% window area at the South- and North -facade characterizes this building. Before renovation 225 kWh/m^2a heating energy was needed. A local company developed wooden TI-modules filled with PMMA capillaries of size 2.5m x 1.24m. Weight and a resulting wooden construction led to special precautions with fire resistance. Integrated roller blinds proved to be problematic for necessary maintenance. The heating energy consumption in the years 94/96 was around 70 kWh/m^2a. The cost of the TI-construction raised till 1370 DM/m^2.

3.1.2 School Wurzen

Improving the system design and the manual production led to much reduced costs (reduction 40%) in the case of a second project, the Wurzen School with a heating energy consumption of 300 kWh/m2a before renovation. The shading devices this time were placed outside the modules. Size as well as thickness was decreased consequently. A simple fixing construction became possible (see Figure 1). The roller blinds may first shade the transparent insulation spandrel and then the windows. The commercial control unit is capable to distinguish two shading states (Figure 4).

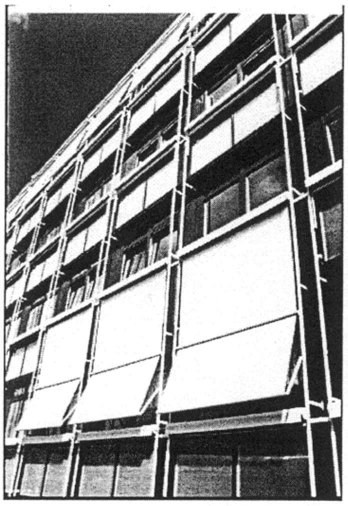

Figure 4:
View of the TI-facade with shading systems (Wurzen)

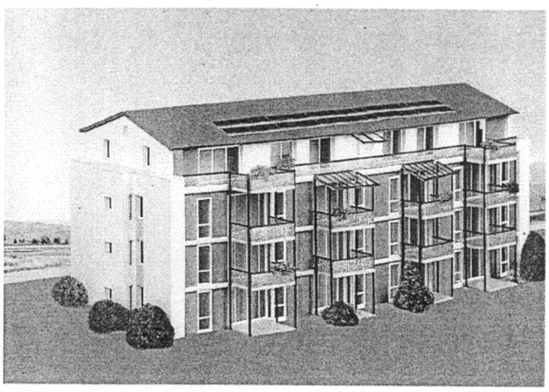

Figure 5:
View of building model (South facade with TI and solar water collectors)

3.2 MULTIFAMILY-HOUSE GUNDELFINGEN

The multifamily house Gundelfingen is a newly built demonstration project combining the different new technologies of water heating by solar collectors and air heat recovery with a heat pump, transparent insulation and advanced windows. Individual flats are sold on the building market with the promotion of solar energy. The targeted heating energy consumption is 30 kWh/m^2a.

4. RESTRICTIONS AND PROBLEMS

A number of reasons can be given why TI although being one of the most promising solar facade types for new architecture and building renovation has a relatively small economical success up to now. A few of them shall be identified here.

4.1 PERFORMANCE ASSESSMENT

With a larger number of product variations and systems designs an easy method to compare and assess the energetic performance is needed. Architects and consultants should be able to quickly assess the benefits and restrictions of a certain project, especially with respect to solar protection. While sometimes being necessary, due to partial coverage and natural or static shading no extra costs may be due.

4.2 BUILDING REGULATIONS

This leads to the second field: In order to consider the solar gains of TI in the building codes, first one needs defined product values. Second there must be a way to feed that into the current code. The situation there will improve rather soon with the new European standard prEN832 for heating requirements of dwellings and consequent national translations. In this standard TI is considered in a generic form. A precise and detailed methodology to deal with that structure has been elaborated and discussed with German bodies by the manufacturer association FV TWD e.V., Gundelfingen, Germany, and is presented also in this conference.

An important problem still is the slow progress with building product certification. Being no regular building product, every variant of TI-system has to apply for an admission to the building market or to ask for permission to use the product in every single case. The product then should be in certifiable compliance with certain quality standards e.g. with respect to fire resistance, static performance. However, these regulations have to be discussed first. This is a time-consuming and costly process. SME´s and companies with steadily improving products have difficulties with that procedure.

4.3 COSTS

Due to the small niche market the costs of TI-systems are too high. Production and mounting is labour dominated. The complexity of the systems in combination with new customers creates a need for extensive work in planning, consulting and modifying. The prefabrication and preplanning potential is certainly big although progress has been certainly made. Unnecessary provisions using an unknown new technology is creating extra costs sometime, e.g. for movable solar protection.

Table 2: Cost estimation for different TI-systems

System	Solar protection	Price range [ECU/m2]
Transom-Mullion-System	mechanical	450 - 750
Prefabricated TI-modules	mechanical	400-500
Transparent Exterior Insulation Finish System	none	200-250
Semitransparent TI	none	200-300
Industrial glazing with TI	none	150-200

4.4 INFORMATION

Information on the different systems available is not widespread amongst builders and planners. Only a small percentage have heard about this technology and even less are able to integrate it into a building project. Planning tools and planning information should be widely available. The FVTWD has dedicated itself to produce and provide information independent on individual manufacturers. Having started recently the information material has to be structured first.

4.5 REGIONAL COVERAGE

As building is in many fields a regional market, the local or regional presence of distribution and know-how is mandatory. Only large companies may provide up to now this service, although even there in practice the regional representatives have to be educated first. The TI business is very much concentrating in a few areas. Demonstration effects are missing!

5. MARKET

With almost every demonstration project being finished the market is growing slowly but steadily. The sponsored projects started up the technology in the first years. Afterwards usually a professionalization and slow uptake from private initiative can be seen without much change in installed area per year. This seems to be typical in a transformation phase for a innovative solar technology.

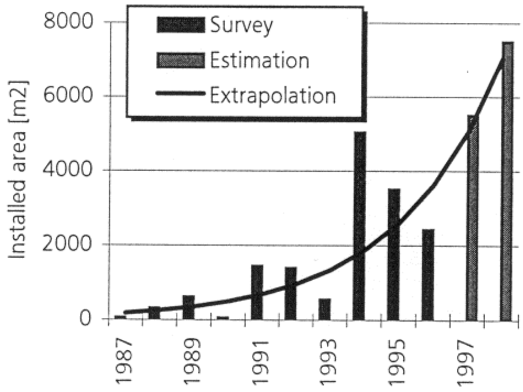

Figure 6: Cumulated installed area of TI-systems (1997 and 1998 approximated numbers from interviews of manufacturers)

6. OUTLOOK AND CONCLUSIONS

Coming from ideas and concepts we have reached a state of commercialization and well-developed products. Although research and development cannot be disregarded in the field of TI, the primary demands are in the fields of standardization, information dissemination to the planning professions and marketing. The recently founded manufacturers association shall try to meet these challenges. Cost reduction is mainly a function of production size.

7. LITERATURE

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