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Solar Collectors from Ultra-High Performance Concrete Combine Energy Efficiency and Aesthetics

When integrating renewable energy into the building envelope, solar thermal plays a significant role. So far, solar thermal products were generally based on metal components that conduct heat, absorb a high fraction of solar radiation and emit little infrared radiation to prevent thermal loss. Using this state of the art technology, building integration and architectural aspects are however often neglected. In the »TABSOLAR II« project, Fraunhofer ISE, together with partners, is following the new approach to produce solar-thermal collectors made from ultra-high performance concrete. Suitable procedures have already been tested. The project team is now working on the next steps for later product manufacture and connection concepts for building integration. The current developments will be presented at the BAU 2017 trade fair.

In the "TABSOLAR II" project, Fraunhofer ISE together with five partners from the industry and research, is investigating the development of resource-efficient and cost-efficient products based on fluid-guiding components made of **Ultra-High Performance Concrete (UHPC)** that can be installed into the façade, making building envelopes suitable for the application of renewable energy. Special compositions were developed for UHPC for the new components. Using UHPC, very finely structured, material-saving yet at the same time extremely strong concrete components can be molded. The channel structures of the UHPC collectors are developed with the bionic **FracTherm®** procedure, developed and patented by Fraunhofer ISE. Based on an algorithm this procedure creates multiple branch structures, like in leaves for example. Using this procedure, a channel network leading to a uniform flow distribution can be achieved for almost any form. This has already been successfully applied to other concepts and manufacturing processes, for example for solar absorbers or for cooling of tools.

"Having developed a manufacturing process for UHPC collectors at laboratory scale in a previous project, we are now pursuing the necessary steps with regard to later products", explains Dr.-Ing. Michael Hermann, responsible project manager and coordinator of innovation processes in the area of heating and cooling technologies. "In TABSOLAR II we are focusing on utilizing UHPC collectors for façades." Researchers at Fraunhofer ISE and their project partners are currently concentrating on two fundamental aspects. Firstly, the aim is to scale the **membrane vacuum deep-drawing process** – developed by Fraunhofer ISE and tested – in a size suitable for practical use and to realize this with regard to production-like plants. In this process the outer contours of subsequent fluid channels are milled into a tool block. Holes are drilled into the block, which is then covered with a membrane. With the help of a

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vacuum, a half-shell of the UHPC component is then deep-drawn and assembled with a sheet of fresh UHPC prior to hardening. The manufacture of components using the **membrane vacuum deep-drawing process** has already been successfully implemented for formats of 340 mm x 460 mm. Now the intention is to implement formats suitable for practical use in the construction sector.

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Secondly, the project team aims to provide different types of UHPC collectors depending on the requirements for the target markets. Featuring a spectrally selective coating and anti-reflective glass, the **»TABSOLAR Premium«** is intended to be comparable to existing solar collectors with regard to efficiency. **»TABSOLAR Economy«** comprises coated or dyed UHPC collectors with low-emissivity glass and somewhat lower yields. The **»TABSOLAR Design«** category focusses on well-designed panels. These collectors do not feature a glass cover and can be equipped with different surface structures and colors. The first two categories are designed for direct solar applications, for example for domestic hot water preparation or for use in solar combisystems. The third category features a variety of architectural design options. Since it reaches significantly lower temperature levels and efficiencies, it is suitable, for example, as a low-temperature heat source for heat pumps. »System simulations, analysis of cost-effectiveness and life cycle assessments will be carried out for all three variations of collector“, explains Hermann. “Only this way the collectors can be optimized by us for later building façade-integration and purposefully further developed into a competitive product on the market.”

In order to illustrate the later products to experts, architects or installers, an **exhibition building** shall be created, with a façade comprising UHPC prefabricated elements. The exhibition building shall be equipped with simple measurement technology, enabling a visualization of the thermal behavior of the elements. »An exhibition building with real-life operation provides us with important information for the further development of the product categories“, Hermann explains. “Furthermore, it provides us with the opportunity to present our results on site and obtain the direct reactions of potential clients.“ Moreover, the partners involved are already considering the future. They would also like to use the exhibition building to evaluate the first applications of UHPC components for interior use, for example, for thermally activated building systems (TABS), this way displaying the further potential of the developed technology.

The **project “TABSOLAR II – Solar absorbers and other thermally active components made of ultra-high performance concrete (UHPC)”** is coordinated by Fraunhofer ISE. Project partners involved include G.tecz Engineering UG, Betonfertigteile Spürgin GmbH & Co. KG, Facade-Lab und Priedemann Fassadenberatung GmbH, as well as Karlsruhe Institute for Technology (KIT). TABSOLAR II is funded by the German Federal Ministry of Economics and Technology (BMWi). Further information regarding the project and previous results can be found here: <http://www.enob.info/en/new-technologies/projects/details/thermo-active-components-produced-from-uhpc-concrete/>

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At the BAU trade fair from 16 to 21 January 2017 in Munich, Fraunhofer ISE will present its new developments within the scope of the “TABSOLAR II” project. Visit us at the Fraunhofer-Allianz BAU stand in Hall C2, stand 538.

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TABSOLAR component made of Ultra-High Performance Concrete (UHPC), manufactured via the membrane vacuum deep-drawing process. ©G.tecz Engineering GmbH