SCOOP Novel materials, ideas and designs for Solar COllectors made Of Polymers

NEWS

Starting Shot for Innovative Collector Designs

What is going on in the world's solar thermal market? How can these developments be taken into account for the design of polymeric solar thermal systems? This newsletter presents the latest results of SCOOP's work on market costs and scale effects and provides an update on the progress of the development of collector concepts and analytical tools.

SCOOP's market study paves the way for concept evaluation

SCOOP's market studies (p. 2) yielded a big share of results upon which the concept evaluation phase will now be started. 12 collector concepts were designed for evaluation (p. 3-4). The most promising collector concepts will be selected in the weeks to come, upon this date the development of novel polymeric collector designs can finally begin.

Analytics follows suit

In order to improve established analytical techniques, new materials were tested parallel to the concept evaluation phase (p. 4-5). To account for the diversity of materials in SCOOP, a cluster of three different methods will ensure a thorough and reliable testing and enable the application of reliable and cost-effective polymers.

News & Events

The progress in SCOOP was presented and discussed at the second project meeting in Linz, Austria on 11th + 12th, October 2012. A visit to the Polytec plant in Ebensee and the Institute of Polymeric Engineering and Testing at the Johannes-Kepler University of Linz (host) completed the stay and provided fruitful insights into the possibilities for the work that lies ahead.

Figure 1: SCOOP partners in front of the Danube in Linz, Austria.

The next meeting will take place in Rapperswil, Switzerland on **May 2nd + 3rd, 2013**. It is hosted by the Institut für Solartechnik SPF.

Brand new

Check out volume 1 of the Solar Heating and Cooling Series on page 5!

From World's Solar Thermal Market to Polymeric Materials

The world's solar thermal marketplace is rapidly growing. In the year 2010, a total capacity of 42.2 GWth corresponding to 60.2 million square meters of solar collectors was installed worldwide.

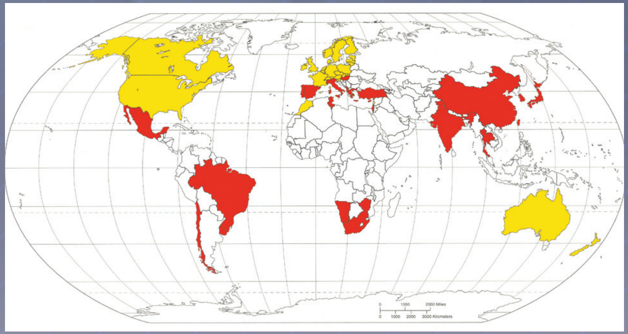

Figure 2: World's solar thermal marketplace (AEE INTEC, 2012).

This means an increase in new collector installations of 13.9 % compared to the year 2009. The installed capacity in 55 countries is estimated to represent over 95 % of the solar thermal market worldwide. These countries represent 4.2 billion people, which is about 61 % of the world's population.

A closer look onto the worldwide solar thermal map in figure 2 highlights the countries where solar thermal systems significantly contribute to the heat-energy consumption. The red marked areas are countries where solar thermal systems with natural circulation known as thermosiphon systems or integral collectors storages play an important role.

One fact is that worldwide the majority of solar thermal systems for domestic hot water preparation (75 % of the totally installed capacity and 89 % of the newly installed capacity) work with natural circulation (thermosiphon). When focusing on the distribution of solar thermal systems in different regions, it shows that the fraction of thermosiphon systems has been rising during the period from 2008 to 2010 (compare chart in figure 3).

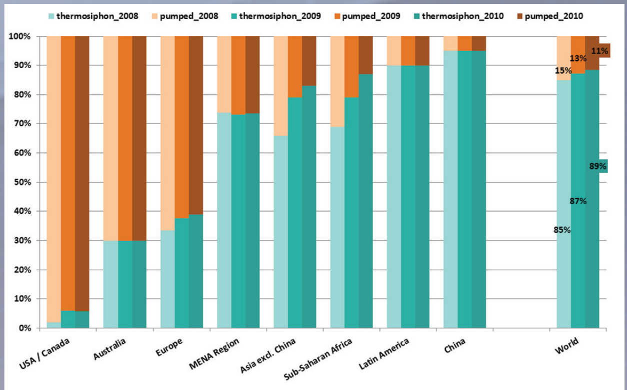

Figure 3: Newly installed collector capacity per region (AEE INTEC, 2012).

In several well-established markets in Europe as well as in some Latin American (Brazil, Mexico) and Asian (China, India, Japan) countries, the market penetration of solar combi-systems, solar supported district heating networks, industrial applications and solar cooling systems is increasing.

How can polymeric materials influence market trends?

The typical solar thermal customer is the end-user. The economical factor is certainly of importance, but also other aspects, like e.g. the question how easy products can be installed and integrated in the building. The use of polymers is one way to solve these questions, as Jay Burch from the National Renewable Energy Laboratory (NREL), explains:

"Polymer-based solar domestic water heating tends to be innovative in design compared to conventional solar domestic water heating, perhaps in part because of the formable nature of polymers. There is a significant opportunity for further innovation to produce highly profitable polymer-based solar thermal systems for residential, commercial and industrial markets" (Burch J.; NREL, USA; 2006).

Michaela Meir from the University of Oslo agrees. Against the backdrop of a rapidly increasing installation in overseas countries she sees a great potential for the implementation of novel polymeric solar thermal systems:

"The growing market of solar thermal systems makes the application of polymeric materials feasible, which reveal a large cost-reduction potential due to mass production, reduction in weight, freedom in structural and functional design and the potential to lead to a breakthrough for solar thermal energy production. New materials can only be applied if the service-life is comparable to those in conventional products" (Meir M. et al; Uio; 2008).

The introduction of solar collectors and other components made in plastics can open new opportunities in terms of closer interaction between solar thermal actors and building and construction industries. In addition to the market potential of low-cost, well designed and high quality polymer based thermosiphon systems and integral collector storages, the possibility of designing solar collectors with additional functions, i.e. functions that are presently performed by the building skin, makes replacements of conventional facade plasters or roof tails with solar collectors a realistic option.

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Why Trust in Plastics?

Polymeric materials in the solar thermal industry are well-known from the pool absorber technique. In most cases the temperature level in this application is too low for domestic hot water preparation and space heating.
Unpredictable raw material prices like for example the rise of the copper price within the last decade lead to the use of alternative materials in applications for higher temperature levels. If the demand for glazed water collectors will rise in the future, the availability of resources can be questionable. Other advantages of polymeric absorbers are the design freedom, the nearly holohedral flow with low pressure head and the impossibility of metal corrosion in maritime climates. One of the important research and development issues will be the overheating protection and the freezing protection. The latter can be overcome by an appropriate system design.

Building integration should be a fixed part of the building envelope. Both the lower weight and the variety in dimension and shape make polymeric solar collectors more attractive than conventional collectors as regular building elements for the building and construction industries. The possibility of making solar collectors with additional functions, presently performed by the building skin, renders replacements of conventional facade plasters or roof tails with solar collectors a realistic option.

The outcome of work package 2 is a portfolio of the most promising concepts and system designs.

From concepts to production design

If one considers the number of developed concepts, the most important factors for promising investigations are durability and combined thermal and flow calculations. These calculations are the basic instruments to evaluate the variety of concepts to form a portfolio of the most promising ones. With polymer-production techniques like injection molding and extrusion it is possible to realize nearly every collector shape. The following pictures show three promising concepts that have been investigated within the SCOOP project so far.

The first concept design in figure 4 is the absorber of an open loop / pressurized integrated collector storage (ICS).

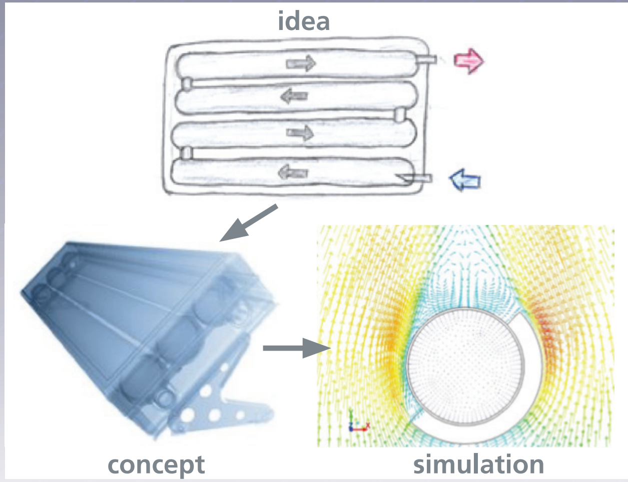

Figure 4: Steps from the ICS concept to first thermal calculations (GoT and HTCO, 2012).

The aim is to find the right geometry-dimensions like wall thickness and shape and to support the material choice.

Another concept is very similar to a traditional thermosiphon system (TSS). The system consists of an extruded absorber sheet with a polymeric tank at the top. The evaluation of the thermosiphon effect can be derived from CFD calculations.

Figure 5 shows the flow speed, caused by solar radiation between the downstream and the upstream channels at the end cap of the absorber sheet.

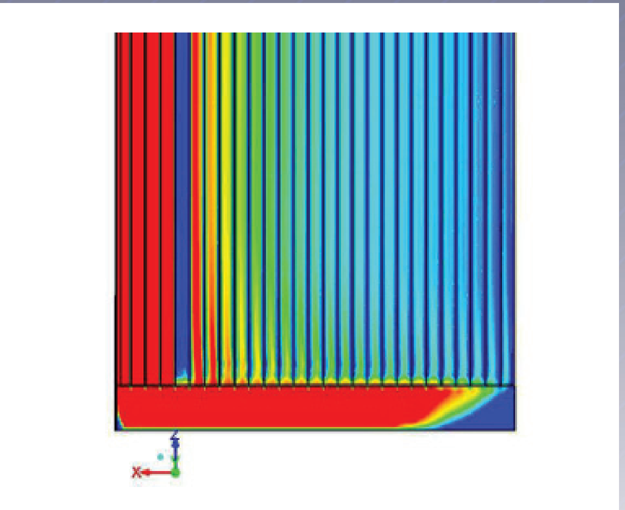

Figure 5: First results of CFD calculations (flow speed) (by HTCO, 2012).

The third path of investigation is the development of pumped systems for building integration (figure 6).

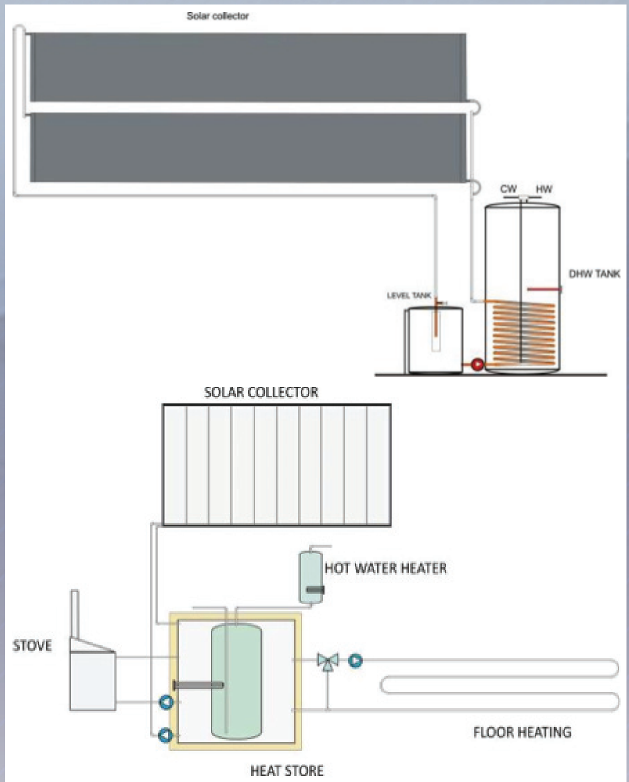

Figure 6: Drain back system for domestic hot water preparation where the collectors and flow stream are at a horizontal position (upper picture). Combi system for building integration (bottom) where the flow channels are in a vertical or tilted position (Aventa 2012).

The concepts above are currently in the evaluation process. As a next development step, test patterns will be manufactured. Extended material testing and research will be done in parallel to ensure the highest level of product quality.

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Setting the Standard Test Procedures

Since June 2012 the first routine screening tests on standard polymeric materials have been performed at the Fraunhofer Institute for Solar Energy Systems ISE. The goal is to establish a common standard in material testing with the partners Aventa AS, the Institute for Physics at Humboldt University Berlin, the Institut für Solartechnik at the University for Applied Science Rapperswil, Fraunhofer ISE and the Institute of Polymeric Materials and Testing of the Johannes-Kepler University of Linz.

Analytical approach

Polymeric material samples underwent long-term UV and heat exposure to simulate outdoor weathering and were exchanged among the mentioned partners to establish a common analytical standard test procedure. A major objective is to ensure direct comparability of scientific data for the most effective information exchange between the partners.

The spectrum of non-destructive analytical methods is supplemented by Humboldt University Berlin. Paired with Fraunhofer ISE, new spectroscopic methods for the testing of polymeric materials based on combined data gained from destructive and non-destructive testing are being developed. Work on the testing of coatings to protect the polymeric materials from UV-radiation and heat damage has been done by the University for Applied Science Rapperswil.

Broad analytical line-up

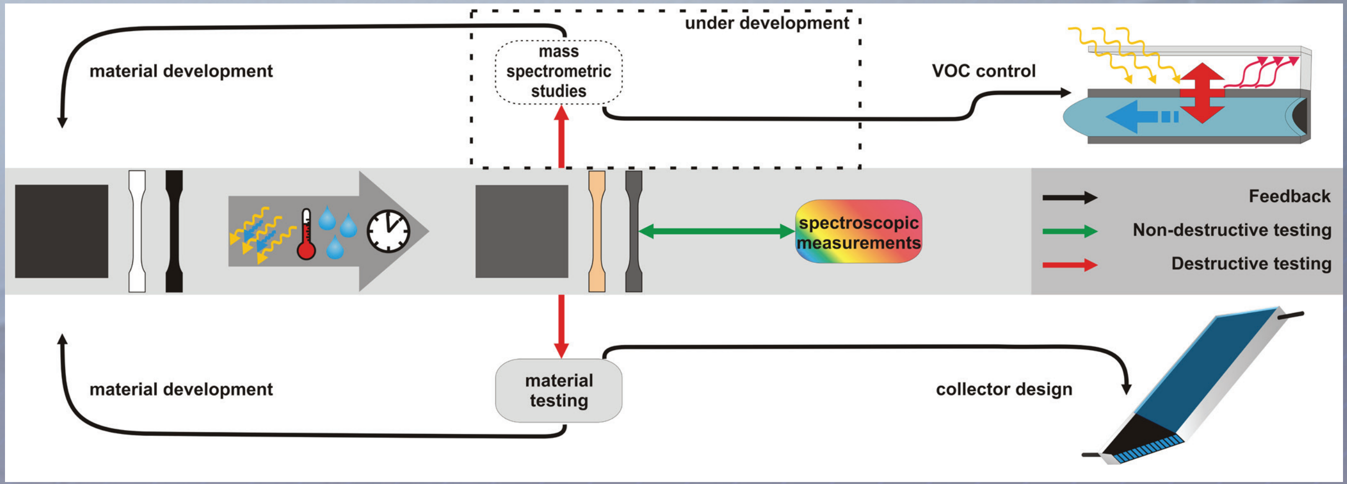

Figure 7: Overview of the envisaged test sequences.

Established methods of simulating outdoor ageing conditions require the exposure of the polymeric samples to the three main aging factors: UV-radiation, heat and humidity.

Samples that were exposed to these factors in different stress levels and combinations are characterized by spectroscopic methods and destructive material testing. Currently under construction is the evaluation of a third characterization technique using mass spectrometry.

These methods will provide comprehensive information about the degradation mechanism of the polymeric materials on the component level.

Changes in material properties and the chemical composition provide essential information both for the development of new materials and prototypes. The trace analysis of volatile components will be one step forward limiting the environmental impact of polymeric materials in solar thermal application.

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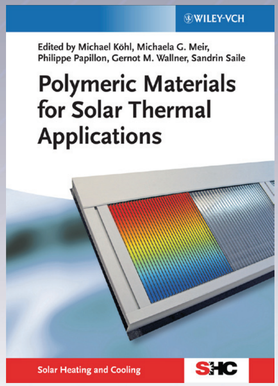
Out Now!

More information on the topic can be found in the newly published *Polymeric Materials for Solar Thermal Applications*.

Volume 1 of the Solar Heating and Cooling Series is the first of its kind to discuss how the use of polymers makes solar thermal applications more economically attractive. The application-oriented handbook bridges the gap between basic science and technological applications. It is relevant for researchers, scientists, engineers and technicians active in the solar thermal field and/or polymer sector and a useful companion to everyone who is interested in working his/her way into this promising field of research.

Polymeric Materials for Solar Thermal Applications is available on wiley-vch.de and amazon.com. Check it out!



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