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Task 39 exhibition – Assembly of polymeric components for a new generation of solar thermal energy systems

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Abstract

IEA SHC Task 39 is dedicated to the development, optimization and deployment of materials and designs for polymer based solar thermal systems and components. To increase the confidence in polymeric solar thermal applications, Task 39 actively supports international research activities and seeks to promote successful applications and state-of-the-art products. For the SHC conference 2013, different polymeric components suitable for domestic hot water preparation and space heating were singled out for an exhibition. Promising polymeric collectors, air collectors, thermosiphons, storage tanks and other components from industrial partners all over the world were brought to Freiburg and assembled at the Fraunhofer-Institute for Solar Energy Systems ISE. The resulting SHC Task 39 Exhibition of polymeric components shows the feasibility of all-polymeric solar thermal systems and highlights their potential, especially as scalable and modular applications for building integration or as export products to sunny regions.

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1. Polymeric solar thermal systems as future oriented design elements

The international solar thermal market has progressed strongly over the last years. The most rapid growth of the manufacturing and commissioning of solar thermal systems has been recorded in China but also in the United States and Europe solar thermal systems have been installed on a grand scale. In 2012, about 70 million households were equipped with a solar hot water supply and market studies forecast even more installations in the years to come [1]. The potential for solar thermal energy is immense. Yet, it runs counter to the relatively high priced metal based solar thermal collectors and components that are still comparatively expensive in acquisition and installation. In order to

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secure a worldwide installation of solar thermal systems and a continuously positive development of solar thermal technologies new solutions for a cost-efficient and sustainable hot water supply are called for. In order to meet these goals polymers are one practicable way to pursue. The possibility to create an almost inexhaustible number of polymeric material combinations allows the development of specially formulated polymeric compounds that meet the requirements of a variety of solar thermal applications. Freedom in the design enables the development of completely new products that are easy to install and suitable for mass-production. This leads to a significant reduction of costs and carries the potential to establish efficient and affordable solar thermal energy systems in all climatic and demographic regions.

The Solar Heating and Cooling Programme's Task 39 of the International Energy Agency (IEA SHC) researches the applicability of polymeric solar thermal components and systems and promotes increased confidence in the use of these products by developing and applying appropriate methods for the assessment of durability and reliability. In the frame of a workshop in spring 2013, Task 39 selected different polymeric components that carry a high potential to shape the next generation of solar thermal systems and elaborated suitable system configurations. The Task 39 Exhibition showcases the most promising components for these system concepts and gives fresh impetus for the development all-polymeric solar thermal systems. Figure 1 shows the Task 39 exhibition presented during the SHC conference 2013 in Freiburg, Germany.

Fig. 1. Total view of the Task 39 Exhibition (a) front (b) rear side, 23 September 2013. (Source: Fraunhofer ISE)

2. State of the art of system concepts – which concepts, which components, which market?

A snap-shot of the state of the art and the ongoing R&D is shown in the Task39 exhibition. The aim of the exhibition project is to show components for three typical system types of polymeric components that are already available on the market:

1.) Thermosiphon concept (all polymeric thermosiphon system for domestic hot water preparation)
2.) Typical domestic hot water system with forced circulation
3.) Scalable solar thermal system with a suitable storage tanks

The following sections present the most important components shown during the exhibition.

2.1 Scalable collectors for building integration

The Norwegian Task 39 partner company Aventa developed an all-polymeric solar collector for building integration. The collector is based on extruded PPS and PC and can be produced sizes from 205 to 580 cm length with a width 60 cm. The scalable collector is adjustable to any roof or façade structure. Its quality further lies in the aesthetics of the collector as the polymeric base also allows for variations in color. With the aim to fashion their collectors as appealing and architecturally interesting building elements, Aventa strikes a new path in terms of collector design and aesthetical quality (fig. 2).

Fig. 2. Façade integrated polymeric collectors, passive house in Rudshagen, Oslo. (Source: Aventa)

2.2 Cost-efficient solutions for sunny regions

Another concept for polymeric solutions is presented by the Israelian company Magen Eco-Energy. The company's solar thermal collectors by the name eco-Spark® and eco-Flare PRO® are successfully marketed and installed. Both consist of specially formulated polymeric compounds that allow the sustainable and effective operation in sunny and Mediterranean regions and show a range of distinctive features that set them apart from their standard competitors. Magen's eco-Flare PRO®, for example, eliminates the need for antifreeze liquid and heat exchangers as its design utilizes a specially formulated Polyolefin-Polymer with extreme heat stabilization and pressure resistance to dry and wet stagnation. The collector of 100 x 215 cm dimension is suitable for large commercial installations and has four quick connection points for a unified water flow down to -10°C (fig. 3).

Magen's eco-Spark® is a low temperature collector of 125 x 232 cm for swimming pool heating and domestic hot water. The design is based on PP and PC, stabilized against UV-irradiation. Its innovative design comprises single collector "panels" that are encased in a partitioned polymeric glazing to create an internal greenhouse effect enhancing the collector's performance. The light weight collector of 13kg is suitable for pre-heating systems, areas with high winds and ideal for low income housing energy saving processes (fig. 3).

Fig. 3. Magen eco-Energy's all-polymeric collectors Eco-FLARE PRO®, left, eco-SPARK®, right. Mounting: Wood Plastic Composites (WPC profiles) (Source: Fraunhofer ISE)

A novel concept is presented by the consortium of the European funded project Solar Collectors Made of Polymers (SCOOP) which developed an all-polymeric thermosiphon system based on extruded PP twin wall sheets. The prototype of the collector design (patent pending) as shown in figure 4 was specifically built for the Task 39 Exhibition and provides first insights into one of the most cost-effective and simple solutions for sunny regions. The material is suitable for mass-production and allows the easy and automated extrusion of any desired absorber length. The showcased collector has an exemplary collector area of 1.2 m^2 and a storage capacity of 65 l.

Fig. 4: Prototype of an all-polymeric thermosiphon system based on extruded twin wall sheets.
(Design: EU FP 7 SCOOP, www.eu-scoop.org; Source: Fraunhofer ISE)

2.3 *Solar air collector for space heating*

A polymer based space heating solution is showcased by the Canadian company Enerconcept (fig. 5). The Lubi^{TM} air heater wall with a performance of up to 80 % efficiency is suitable for all solar air heating applications such as building space heating, coupling to heat pumps, industrial or drying processes and preheating of outside air. Its design is based on UV-treated PC and Al as well as a special perforated glazing technology (PGT, patented). The solar air collector weighs 0,9 kg per panel with a dimension of 32 x 90 cm. It's air flow is lower than 100 m³/h/m² and shows a temperature increase as high as 45K above ambient temperature.

Fig. 5: Exhibition piece of Enerconcept's LubiTM air heater wall, provided by GoGas at the Task 39 Exhibition.
(Source: Fraunhofer ISE)

2.4 Light -weight storage tanks with space-saving capacity

The above described all-polymeric collectors are compatible with a range of new polymeric storage tanks. In respect to efficient all-polymeric systems Roth's Thermotank Quadroline promises an interesting component (fig. 6). The storage tank is encased with fibre/plastic composites and EPS. It therefore only weighs a third of the weight of a compatible storage tank made of steel and is corrosion-free. Thermotank Quadroline is available as separation storage, buffer storage, solar storage, combination storage tank or domestic hot water heater with a storage capacity of 325 l, 500 l or 1000 l. The size of the exhibited storage tank is 325 l.

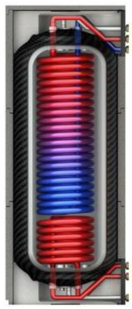

Fig. 6: Roth's Thermotank Quadroline (a) outer view, (b) system view. (Source: Roth)

2.5 Innovative material combinations for framing and mounting

For a holistic development of novel solar thermal systems, Task 39 also considers alternative materials for mounting and framing elements. Especially with regard to this application, wood polymer composites are promising cost-efficient and environmentally-friendly construction elements. The mixture of 65 % wood and 35 % PP and additives is processable like thermoplastics. Profile extrusion and injection molding are typical shaping processes. WPC profiles, as showcased in the frames used in the Task 39 exhibition, are promising constructional elements for the mounting and framing of solar thermal systems (see figures 3 and 7).

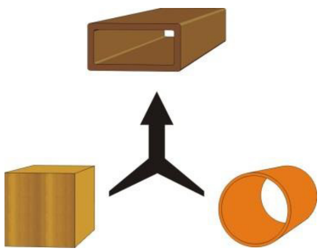

Fig. 7: Schematic representation of a WPC profile as used for the Task 39 Exhibition (see fig. 3). (Source: Fraunhofer ISE)

3. Current research activities within IEA SHC Task 39

The IEA SHC Task 39 brings together numerous research institutes and researchers all over the world which work in the field of polymeric materials in different projects. Table 1 gives an overview of some of the projects conducted in the frame work of Task 39.

Table 1: Overview of products conducted in the framework of Task 39

	Project	Period	Funding agency	Partner countries
1	Bio4Sol - Bioplastics for solar applications (2013-15)	2013-2015	Austrian Klima- und Energiefonds	AT
2	Poly2Facade – Innovative thermal self-regulating solar facades by means of functional polymers Coordinator: University of Leoben; Partners: PCCL, ÖFPZ Arsenal GesmbH, Forschungszentrum für integrales Bauwesen AG	2012-15	Forschungsförderungsgesellschaft (FFG), Programmlinie Haus der Zukunft	AT
3	Untersuchungen zur Fertigungstechnik und Kollektorkonstruktion für Vollkunststoff-Kollektoren Partners: HAW Ingolstadt, Roth Werke GmbH	2012-15	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit	DE
4	SCOOP - Solar Collectors of Polymers Coordinator: Fraunhofer Institute for Solar Energy Systems - ISE Partners: http://eu-scoop.org/partners.html Website: http://eu-scoop.org/	2011-15	EU FP7-ENERGY-2011-1	DE, AT, FR, NO, CH
5	Participation in Phase II of IEA-SHC Task 39 Coordinator: JKU-Linz; Partner: AEE-INTEC Subcontractors: AIT, PCCL, UIBK-EGEE	2011-14	Bundesministerium für Verkehr, Innovation und Technologie; FFG	AT
6	ISOlar - Screening of insulation materials for solar thermal collectors and thermal storages and analysis of their long-term-properties Coordinator: Austrian Institute of Technology Partners: TiSUN GmbH, EuroFoam GmbH Website: http://www.ait.ac.at/~isolar	2011-14	Österreichische Forschungsförderungsgesellschaft (Neue Energien 2020 - Programm)	AT
7	SILVER - Solar Energy in Living Environments Coordinator: Aventa AS; Partners: OBOS, University of Oslo, Linnæus University, CHCP, DSSK Website: http://www.forskningsradet.no/~silver	2011-14	Research Council of Norway	NO, SE, BE, FR
8	PISA - Polymers in solar thermal applications University of Oslo: Leitung, Subtask A	2011-14	Enova	NO
9	UNISOL - Sistema Solar Termico Universal Coordinator: Fabrica de Plasticos, Lda (Pt) Partners: Aveiro University, Oslo University, Aventa AS; Website: http://projectos.adi.pt/actions/project?id=C16/2011/21507&search=global&actionbean=actions/project	2011-14	Portuguese Agency for Development and Innovation	PT, NO
10	POLYSOL - Development of a modular, all-POLYmer SOLarthermal collector for DHW preparation and space heating Coordinator: Energias Renovables Aplicadas S.L. Website and Partners:	2011-13	EU FP7-SME Research area: SME-1	UK, DE, MK, ES

	http://cordis.europa.eu/projects/rcn/98108_en.html			
11	Smart Windows-Smart Collectors Partners: PCCL, University of Leoben, A-P-C	2010-13	Land Steiermark, Zukunftsfonds Partners	AT
12	SOLPOL-1/2 - Solar Thermal Systems based on Polymeric Materials Coordinator: Johannes Kepler University - JKU Partners: http://www.solpol.at/partners Website: http://www.solpol.at/	2009-13	Klima- und Energiefonds. Management: Österreichische Forschungsförderungsgesells chaft	AT

Further information is available from the IEA-SHC-Task39 Web-site: http://task39.iea-shc.org

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Acknowledgements

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References

[1] Koehl. et. Al. *Polymeric Materials for Solar Thermal Applications*. Weinheim: Wiley-VCH, 2012.
[2] www.magen-ecoenergy.com/
[3] www.aventa.no/
[4] http://www.enerconcept.com/
[5] http://www.gogas.com/
[6] www.wood-kplus.at
[7] www.roth-werke.de/