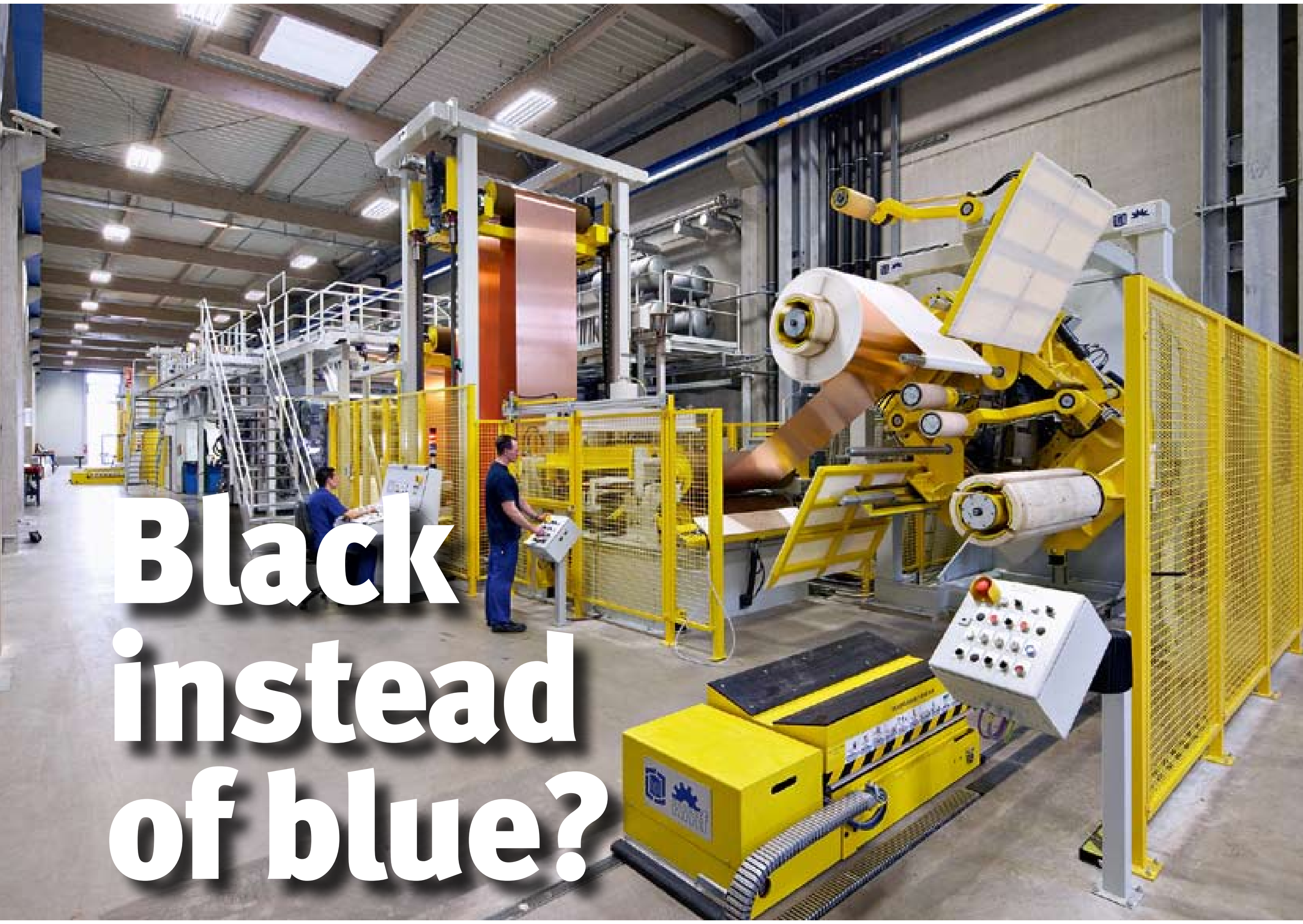


Black instead of blue?

Alanod has dominated the market for highly selective coatings since its takeover of Bluetec in 2014.

Photo: Alanod

Blue PVD absorber coatings have prevailed so far on collectors. Given the domination of just one manufacturer, new players are developing alternatives. Black coatings could once again gain in importance.

What we are talking about is thin: wafer thin. The coating on the collector is just a few nanometres thick, and ensures that as much sunlight as possible is converted into heat. Most collectors in use today are coated with highly selective layers, which are applied in a vacuum vapour deposition process. In the market overview of flat-plate collectors on the SUN & WIND ENERGY homepage (see www.sunwindenergy.com/solar-thermal/market-overview-flat-plate-collectors), 93 % of the 250 collector models receive an absorber with such a coating. Paint coatings or galvanised black chrome are only found in a small minority of products.

To manufacture the highly selective layers you need large vapour deposition machines, which can be over a hundred metres long. There are thus only a few companies which have specialised in such processes. Somewhat over a year ago the market leader Alanod from Germany took over the then number two, Bluetec, also from Germany. A merger with the third large player, the Almeco Group from Italy, was also briefly being considered. Together this monopoly would have controlled approximately 80 % of the selective absorber coating market, according to sector experts. Even though this did not come about, Alanod does still dominate the market today.

There is a second manufacturer active here, namely Arceo Engineering from Belgium, a subsidiary of the steel giant ArcelorMittal, but so far Arceo has not really been able to make its mark. The company had planned to put a steel-based absorber onto the market, but is currently still limiting itself to copper and aluminium as substrates (see table). Those wishing to use steel today must resort to using stainless steel. Galvanised stainless steel plates are made by Energie Solaire from Switzerland and Alternate Energy Technologies from the U.S. Alanod-

Xxentria, a joint venture between Alanod and the Taiwanese company Xxentria Technology Materials, also coats stainless steel using the physical vapour deposition process (PVD).

Apart from the large manufacturers with the ability to perform vapour deposition in a vacuum, there are also newcomers on the market. In 2010, Finnish coatings experts set up the company Savo-Solar. Their MEMO 4 coating, which is manufactured using a combination of PVD and plasma-enhanced chemical vapour deposition (PECVD), achieves an excellent absorption rate of 97 %. Highly selective PVD coatings reach absorption rates between 95 and 97 %. These are values which galvanised coatings can also attain. The difference lies in the emissions rate, that is the loss of heat in the form of infra-red radiation. PVD coatings, with losses of 4 to 5 %, do better here than galvanised coatings, which re-emit between 5 and 15 % of the heat collected.

The Austrian company Calus is even fresher on the scene; it presented its pure.black coating one year ago. The coating is based on a patented thermoelectric process developed by researchers at the National Academy of Sciences in Minsk (Belarus) and at Wels Technical College (Austria). While PVD coatings generally have a blue sheen, the Calus coating is jet black. The company is marketing this with claims that the coating process gives the surface an unmatched ability to withstand any manner of environmental influences. Even the harshest conditions, such as salty air or smog have no negative effects on the high quality of pure.black.

Absorber coatings hardly age at all

Independent tests have shown, however, that ageing processes on the common PVD coatings also have practically no negative effects. In the SpeedColl project, supported by the German Ministry of Economics, researchers from the Fraunhofer ISE and the University of Stuttgart are currently testing collectors for three years at various sites around the world to see how they cope with environmental influences such as temperature, humidity, solar irradiation and salt exposure, but without extracting heat from them. This includes a site in salty air on the Spanish island of Gran Canaria, a site on Germany's highest mountain at a height of almost 3,000 m and a site in the tropical climate of India. After 2.5 years of exposure so far, the researchers can only make out small changes to the collectors. One collector that was on Gran Canaria for 2.5 years did show an approximately 5 % reduction in efficiency back on the test stand, but after sand had been cleaned off the glass cover of the collector, the efficiency across a range of temperatures rose back to the levels from before the exposure.

On other absorbers the researchers did find changes, however. "A spectral analysis of the test objects did show changes in emissions of up to 4 %," it says in a publication by the project group. To what extent the new Calus coating could have advantages in its long-term behaviour is something which must be

Overview of absorber coatings

Manufacturer	Product name	Start of production	Absorptivity [%]	Emissivity [%]	Coating	Coating process	Absorber plate material	Absorber plate thickness [mm]	Absorber plate width [mm]
Alanod GmbH & Co. KG, Germany	Mirotherm	2001	95 ± 1	5 ± 2	ceramic-metal-structure	PVD	aluminium	0.3 to 0.8	max. 1,250
	Mirosol TS	2010	90 ± 2	20 ± 3	selective nano-composite	coil coating	aluminium	0.3 to 0.5	
	Mirosol TSS	2015	> 93	< 45	selective nano-composite	coil coating	copper	0.3 bis 0.5	
	Eta plus Al	2005	95 ± 2	5 ± 2	ceramic-metal-structure	PVD	aluminium	0.3 to 0.5	
	Eta plus Cu	2005	95 ± 2	5 ± 2	ceramic-metal-structure	PVD	copper	0.12 to 0.5	
Alanod-Xxentria Technology Materials Co., Taiwan	Sungain Al	2012	95 ± 2	5 ± 2	ceramic-metal-structure	PVD	aluminium	0.3 to 0.6	max. 1,250
	Sungain Cu						copper	0.12 to 0.5	
	Sungain SS						stainless steel	0.3 to 0.5	
Almeco GmbH, Germany/Italy	TiNOX energy Al	2008	95 ± 2	4 ± 2	ceramic-metal-structure	PVD	aluminium	0.3 to 0.75	max. 1,250
	TiNOX energy Cu	2008	95 ± 2	4 ± 2	ceramic-metal-structure	PVD	copper	0.12 to 0.5	
	TiNOX artline	2011	90 ± 2	5 ± 2	ceramic-metal-structure	PVD	aluminium	0.3 to 0.75	
							copper	0.12 to 0.5	
	TiNOX nano	2011	90 ± 2	5 ± 2	ceramic-metal-structure	PVD	aluminium	0.3 to 0.75	
							copper	0.12 to 0.5	
Alternate Energy Technologies, U.S.	Crystal Clear	1995	97 ± 2	7 ± 2	bimetallic alloy	galvanic	stainless steel, copper, steel	0.2	90 to 152
Arceo Engineering, Belgium	Solarceo	2009	95 ± 2	5 ± 2	ceramic-metal-structure	PVD	aluminium	0.3 to 1	max. 1,250
							copper	0.18 to 0.2	max. 1,300
Calus GmbH, Austria	pure.black	2014	92 ± 2	11 ± 2	ceramic-metal-structure	electro-thermal (ETH)	aluminium	0.3 to 1.0	max. 1,250
	future.black	2015	93 ± 1	8 ± 1			aluminium foil	0.01 to 0.02	n/a
Energie Solaire S.A., Switzerland	AS [1]	1980	96	15	black chrome	galvanic	stainless steel	0.4 to 6 [2]	max. 1,000
	AS+	1998	95	5					
Materials Technology, U.S.	Krosol	1977	95 ± 2	8 ± 2	black chrome	galvanic	copper	0.12 to 0.3	max. 1,200
Savo-Solar Oy, Finland	MEMO	2011	96 ± 2	5 ± 2	TiAlSiN/NO + SiOx	PVD + PECVD	aluminium, copper	0.3 to 65 [2]	max. 3,000 [3]
	MEMO 4	2013	97 ± 1	5 ± 2					
Solec-Solar Energy Corp., U.S.	Solkote HI/ Sorb-II	1982	90 ± 2 [4]	25 ± 5 [4]	silicone/calcined oxide	spray-application	metals, plastics, masonry	any	any
Viessmann Werke GmbH & Co., Germany	n/a [5]	2009	95 ± 1	5 ± 1	ceramic-metal-structure	PVD	aluminium	0.4	max. 1,000

[1] The AS coating can also be used in coverless absorbers and receiver tubes; [2] coating of entire, full-flow absorbers; [3] max. absorber plate length: 6,000 mm; [4] dependent of thickness and substrate; [5] Viessmann only coats its own absorbers

PVD coatings are the most efficient at converting solar irradiation to heat. Galvanised coatings and selective solar paints lose more heat through re-emission.

Source: manufacturers' information

determined in further tests. You do have to make compromises in the absorption rate when compared to PVD coatings, however, as the rate here only reaches 92 %.

New coating for aluminium foil

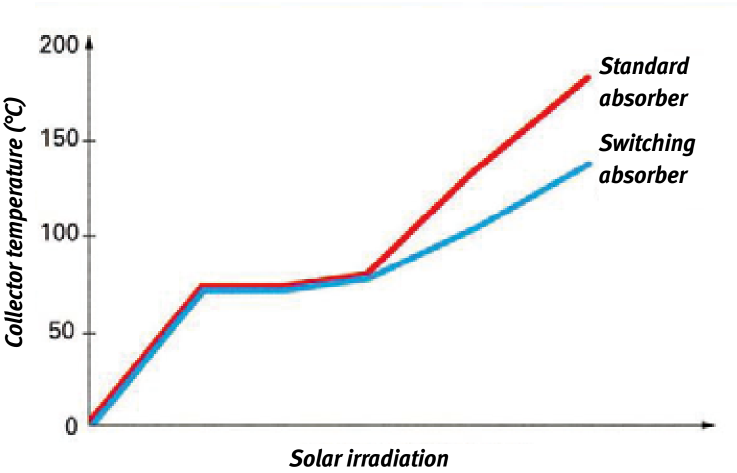
A brand new coating from Calus is future.black. What is special here is that the coating is not applied to aluminium sheets 0.3 to 1 mm thick, but to aluminium foil just 0.01 to 0.02 mm thick. If powerful collectors could successfully be designed using this foil, then the reduction in material use would be huge.

Paint coatings have so far achieved an absorption rate of 90 %. Their disadvantage is an emissions rate of 20 to 25 %. At the Intersolar Europe 2015 in June, Alanod presented the new Mirosol solar paint with the suffix TSS for copper plates. With this paint coating Alanod achieves an absorption rate of 93 %. The coatings company had already been supplying a paint coating on aluminium plates under the name Mirosol TS since 2011. Marketing and Sales Director Frank Schoonen explained that the reason for introducing this new offer was the fact that some absorber manufacturers could only work with copper.

Alanod-Solar had developed the Mirosol coating especially for Southern European countries, where for pricing reasons it is easier to enter the market with cheaper qualities. With its high emissions rate of approximately 45 % it has a lower stagnation temperature and thus offers overheating protection. Alanod-Solar applies the solar paint using an industrial coating process. A low stagnation temperature of the collector was also the development aim for a new coating applied in a vacuum, presented by the German heating technology and collector manufacturer Viessmann in the spring at the International Heating Technology Exhibition ISH. Together with the Institute for Solar Energy Research Hamelin (ISFH), the coating was developed in a joint project supported by the German Ministry of Economics. It lowers the stagnation temperature of the absorber to 150 °C, without any significant affect on the performance across the normal operating range of a solar system. This works because the layer structure changes above approximately 75 °C, thus increasing the emissions. The re-emission becomes particularly high above an absorber temperature of 100 °C. “The special challenge was the optical design of the coating system, so that the technical values of efficient selective coatings with a low rate of thermal emissions could be achieved across the normal working range of a collector on the one hand, whilst obtaining a high rise in the emissions rate above that on the other,” says ISFH working group leader Rolf Reineke-Koch. The big advantage of the new coating is that at an appropriate pressure, vapour formation can be completely prevented in the collector loop during periods of stagnation.

Joachim Berner, Jens-Peter Meyer

Ensuring the prevention of vapour formation



In normal collector operation, the new absorber coating from Viessmann behaves like a regular one. Above a collector temperature of 75 °C, however, the re-emissions change dramatically. This provides protection against vapour formation in the case of stagnation.

Source: Viessmann