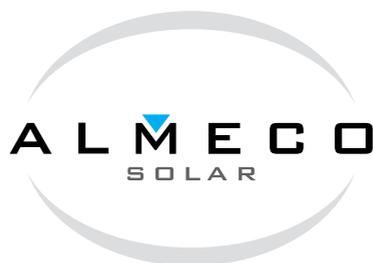


TiNOX[®] energy



Solar absorber coatings





Maximum output Solar thermal collectors use energy from the sun to generate heat for heating and hot water. This energy is free, environmentally friendly and reliable. The heart of flat-plate, air and evacuated-tube collectors is the absorber. It collects the energy in sunlight and converts it into heat. The more efficient the absorber, the greater the collector's output.

Almeco sets an industry benchmark with its TiNOX absorbers: these products absorb 95% of incident sunlight. At the same time, depending on the absorber, they only lose around 4% through heat radiation. In this way, manufacturers of collectors can ensure the highest quality and maximum yield for their customers. Almeco applies its highly selective absorber layers both to aluminium and copper substrates. Collector manufacturers are therefore able to offer a wide range of high-quality products with TiNOX absorbers.

Absorbers for every requirement With their highly selective absorber coatings in the TiNOX product range, Almeco can provide the right absorber for every application.

TiNOX_{energy} is characterised by outstanding absorption and emissivity rates. The highly selective blue coating guarantees the customer the best possible collector performance.

TiNOX_{nano} has a highly selective, environmentally friendly coating, and with its reduced absorption rate is designed especially for regions with very high levels of sunlight.

TiNOX_{artline} comes in a wide range of colours and is therefore perfect for customers who wish to match it aesthetically with their building, especially, for example, in Mediterranean countries.

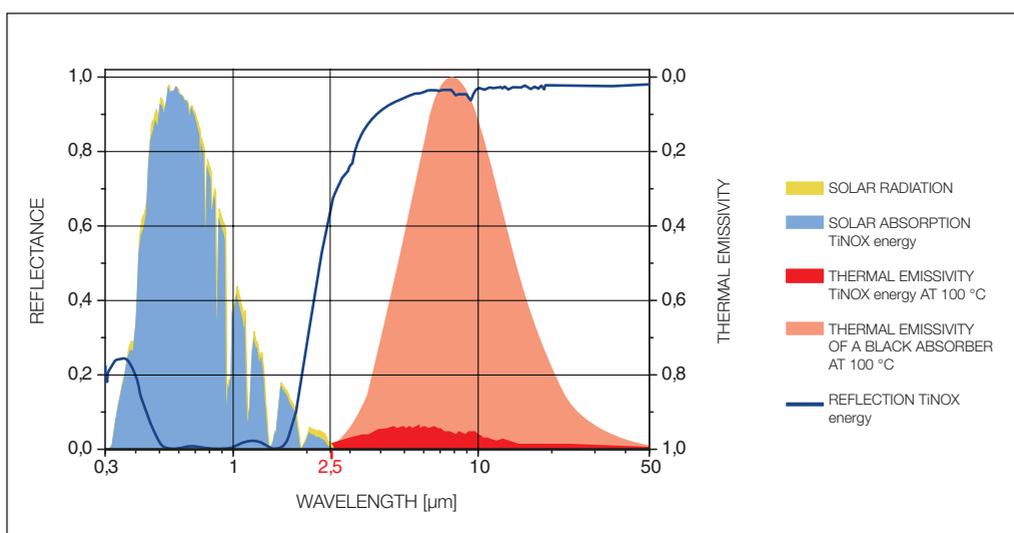
All **TiNOX_{energy}** products are made in Germany in modern production lines in Bernburg.

Service and consulting Almeco is a competent, dedicated partner for its customers with a wide international service network. Collector manufacturers can therefore rely on experienced and knowledgeable experts worldwide for all technical questions, such as product development and production-planning or training, market research and strategy development. A high-performance global distribution network also ensures that the absorbers are always delivered reliably, safely, and on time to our customers – regardless of the manufacturing location. Almeco also believes that good service includes the quick and flexible handling of individual customer requirements, such as special formats or small series production runs. To this end, Almeco has high precision cutting and prefabrication facilities in a number of service centres spread across the globe.



The TiNOX absorbers are energy traps. They collect almost all available solar radiation and convert **The energy trap** it into heat. Unlike black chrome or black-coated absorbers, almost none of this energy is lost again as heat radiation. The energy is directly transferred into the heating-support and water heating systems by the TiNOX absorbers.

How is that possible? TiNOX absorbers make use of the fact that solar radiation energy irradiates **Selective reflection** at wavelengths below 2.5 μm , while the characteristic wavelength range for heat radiation from a 100°C surface (maximum operational temperature of a hot water collector) is above 2.5 μm . The absorbers are therefore capable of reacting differently to wavelengths above and below 2.5 μm – they are selective. This significantly reduces losses from heat radiation, as the following graph depicting the performance data of **TiNOX^{energy}** shows.

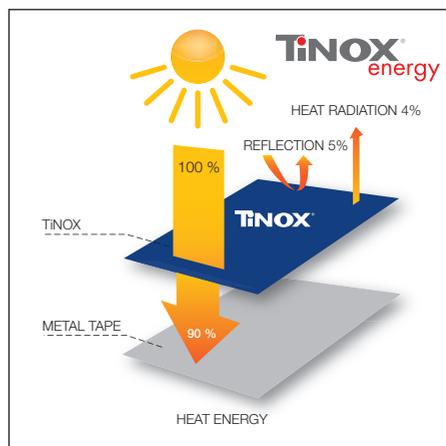


The blue area shows how well **TiNOX^{energy}** absorbs solar radiation. The pale red area depicts heat radiation emissions from a black absorber with non-selective coating. The contrasting low heat radiation emissions of **TiNOX^{energy}** are shown in dark red. The blue curve shows the reflective properties of **TiNOX^{energy}**. In the range of solar radiation, reflection is very low because the absorber is designed to take up as much energy as possible. In comparison, the coating reflects infrared light very well, resulting in very low heat radiation emissions – the maximum amount of energy stays in the absorber.



TiNOX energy TiNOX^{energy} is the premium product in the TiNOX product range: with its outstanding absorption and emissivity performance, the highly selective, blue absorber is the first choice for collector manufacturers who wish to guarantee their customers the highest output even when less sunlight is available.

TiNOX^{energy} is capable of absorbing 95% of incident solar radiation and converting it into heat. Like an "energy trap," the highly selective blue TiNOX coating only loses approx. 4% of the captured solar energy as heat radiation.



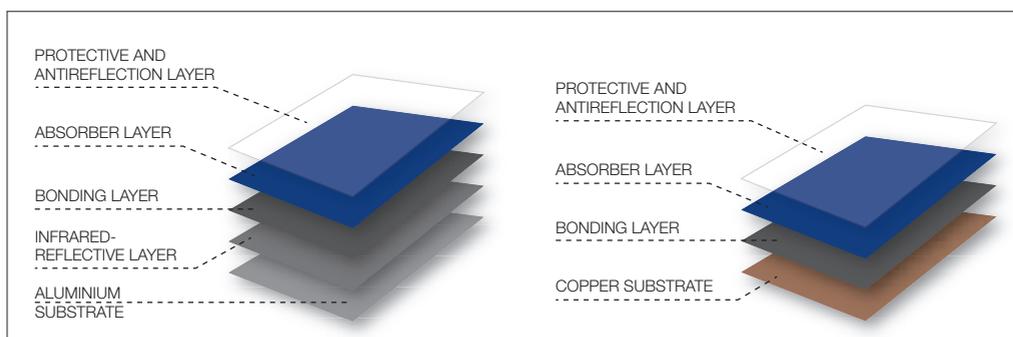
Solar absorption: $\alpha \sim 95 \%$

Thermal emissivity: $\epsilon \sim 4 \%$

All TiNOX^{energy} absorbers are available with both copper and aluminium substrates. Both substrate materials have excellent thermal conductivity properties. On request, Almeco can also coat other materials.

Version	TiNOX energy Al	TiNOX energy Cu
Width	Max. 1,250 mm	Max. 1,250 mm
Thickness	0.20 – 0.75 mm	0.12 – 0.50 mm

TiNOX^{energy} absorbers consist of a number of layers, carefully designed to work together. The substrate material is a highly infrared-reflective metal sheet that conducts heat well. A diffusion barrier is applied to the adhesive layer. This prevents metal atoms from entering the absorber layer at high temperatures and changing the optical properties. This is followed by the absorber layer consisting of a multilayer cermet structure. Finally, the top layer is an anti-reflective, protective layer made of fused quartz. This material is extremely hard and also scratch-resistant. The absorber is therefore very well protected from damage during handling. By minimising surface reflection, the absorption of solar radiation is further optimised.





An optimum balance between efficiency, costs and environmentally friendly manufacture: the **TiNOX nano**. This absorber is suitable for regions with high levels of sunshine and provides an extremely cost-effective, environmentally friendly solutions in those regions.

In contrast to black chrome absorber layers, which have a high level of emissivity in heat radiation, **TiNOX nano** still delivers the best possible output even at high temperatures in the collector, thanks to a low emissivity level of only 5%. The absorption level is especially designed for high levels of solar radiation, keeping the stagnation temperature low and thus reducing the thermal stress on the collector. Thanks to a top-quality protective layer, **TiNOX nano** absorbers are extremely robust and resistant to environmental damage.

Almeco produces **TiNOX nano** – like all its other absorbers – exclusively in cutting-edge PVD coating facilities in Bernburg, Germany. Unlike in the manufacture of black chrome, no toxic waste is produced in the process. The coating procedure is also completely emissions-free. With **TiNOX nano**, collector manufacturers are capable of providing their customers in very sunny countries in Southern Europe, Latin America, Asia or Africa with a reliable and high-performance product, which is designed especially for the unique conditions in these regions.

Solar absorption: $\alpha \sim 90 \%$

Thermal emissivity: $\varepsilon \sim 5 \%$

TiNOX artline combines efficiency and aesthetic appeal in a unique way because of its individual colour scheme, **TiNOX artline** is the ideal product for those looking for an alternative to conventional blue absorbers – but who do not want to compromise on heat output.

TiNOX artline is particularly suited for use in Mediterranean countries, as collectors with **TiNOX artline** inconspicuously fit in with the rooftop landscapes of this region. **TiNOX artline** is also the perfect choice for many facades. With **TiNOX artline** absorbers, collector manufacturers can expand their product range with a high-performance product that also meets special requirements of property owners and architects.

TiNOX artline still achieves an especially high output whatever colour is chosen. With its exceptionally low emissivity levels, the product is particularly powerful when collectors are required to deliver high-temperature results.

Solar absorption: $\alpha \sim 90 \%$

Thermal emissivity: $\varepsilon \sim 5 \%$



When it comes to high-quality coatings for solar applications, Almeco is a renowned partner thanks to its cutting-edge production facilities, meticulous quality processes, many years of experience and comprehensive expertise.

Pre-handling of metal High-performance absorber layers require very pure, highly reflective metal surfaces. After all, there must be as much infrared reflection as possible to achieve the characteristic extremely low emissions of these highly selective absorbers. The laws of physics also stipulate that the mirror used should be completely flawless.

For **TINOX^{energy}** absorber strip, Almeco uses only the purest copper with a special pre-cleaned surface and works with reliable, premium suppliers for this product. The aluminium used for TINOX absorber strip is electrochemically treated in Almeco's strip processing plants to provide the optimum finish before being vacuum coated.

Multilayer PVD coating The coating is applied in high-tech plant in Bernburg. In this process, multiple thin layers of metal and ceramics are applied to the metal substrates in a vacuum. Environmentally friendly PVD (physical vapour deposition) technology is used, in which both electron beam vapour deposition and sputtering are applied.

The whole process is controlled by computer and monitored throughout with optical sensors. In addition, experienced quality engineers carefully visually inspect all absorbers.

Cutting and packaging Almeco runs a number of service centres with cutting facilities so that absorbers can be tailored exactly to customer needs. To protect the coating, the substrates are supplied with an intermediate foil or paper layer. Almeco uses protective foils from the market leader, which are especially developed for our high-quality absorber surfaces.

Environmental impact **TINOX^{energy}** absorbers are green products. Very few resources are consumed during the production process at Bernburg. Almeco GmbH only needs about one kilowatt-hour of energy to vacuum coat and manufacture a square meter of absorber substrate. Some sunny days are enough to get back the energy invested.

The coating procedure is completely emissions-free and, unlike conventional black chrome coating, produces no toxic waste. Furthermore, there is no adverse "end of life" environmental impact as the copper and aluminium substrate materials are very easily and efficiently recycled.



For more than fifty years the Almecco Group has devoted itself to making aluminium products with **The company** reflective and decorative surface finishes. This specialization has led to the Group becoming one of the world's largest producers of components for the lighting and solar energy industries.

All **TiNOX^{energy}** products are manufactured in Germany at Almecco GmbH, which incorporates the Solar Business Division of Almecco Group. With modern, high technology vacuum coating and manufacturing lines, Almecco GmbH specializes in high-tech reflector and absorber coatings that convert sunlight into heat energy in an efficient, reliable and environmentally friendly manner.

Almecco has close, long-term partnerships with its customers. But for Almecco, collaboration **Service and consulting** is not limited to the supply of high-quality, high-yield products. As a competent service partner, the company looks after all of its customers with a wide range of services, including individual consulting, training sessions and other special services.

Almecco works continuously to further improve the efficiency of high-tech solar coatings. To this end, **Research and development** the company has its own research and development department in Bernburg, and collaborates with prestigious research institutes all over the world.

Almecco offers a 10-year guarantee on the performance of its TiNOX absorber products. The high **Guarantees and certificates** quality of **TiNOX^{energy}** absorbers has been confirmed by a number of renowned testing institutes. A key element in the product approval is the "Task X" test, which simulates the effect of years of temperature fluctuations and exposure to the environment on the absorber's selective layers. Absorbers that pass this test are guaranteed to provide 95% of their original output even after 25 years.

TiNOX absorbers have certificates of approval from the following institutes:

- ▼ Fraunhofer Institute for Solar Energy Systems, Freiburg (ISE)
- ▼ Institute of Solar Technology, Rapperswill College (SPF).

Almecco GmbH fulfills the quality standards required for compliance with DIN EN ISO 9001:2000; Environmental Management Standard ISO 14001 and Occupational Health and Safety management standard OHSAS 18001.

Milan, Italy - Bernburg, Germany
Goncelin, France - Atlanta, USA - Shenzhen, China



Almecco GmbH - Claude Breda Strasse, 3
D-06406 Bernburg - Germany
Amtsgericht Stendal HRB 5020 / DE 245852413
T +49 3471 34655 00 - F +49 3471 34655 09
info@almecosolar.com - www.almecosolar.com