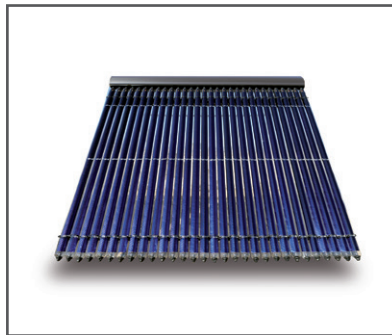
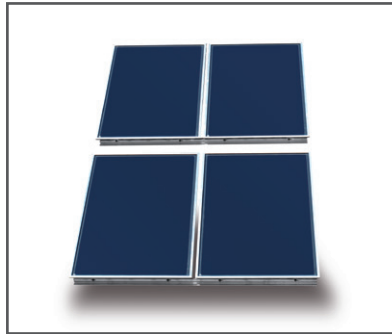
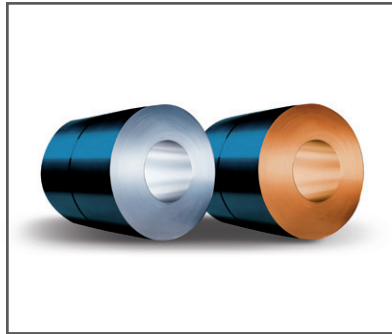


TiNOX[®] energy



Solar absorber coatings





Solar thermal collectors use energy from the sun to generate heat for heating, hot water and solar cooling. 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.

Solar district heating As the combination of several collectors lead to systems which are far more efficient than systems at individual houses, solar district heating (DH) plants are getting more and more popular. They consist of large fields of solar thermal collectors installed on free ground or integrated into building-roofs, feeding up to 50% of the heating/cooling requested by urban quarters, smaller communities, or large cities. The more efficient the absorber coating, the greater the collector's output.

Industry benchmark Almeco sets an industry benchmark with its TiNOX absorbers: these products absorb 95% of incoming sunlight. At the same time, 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.

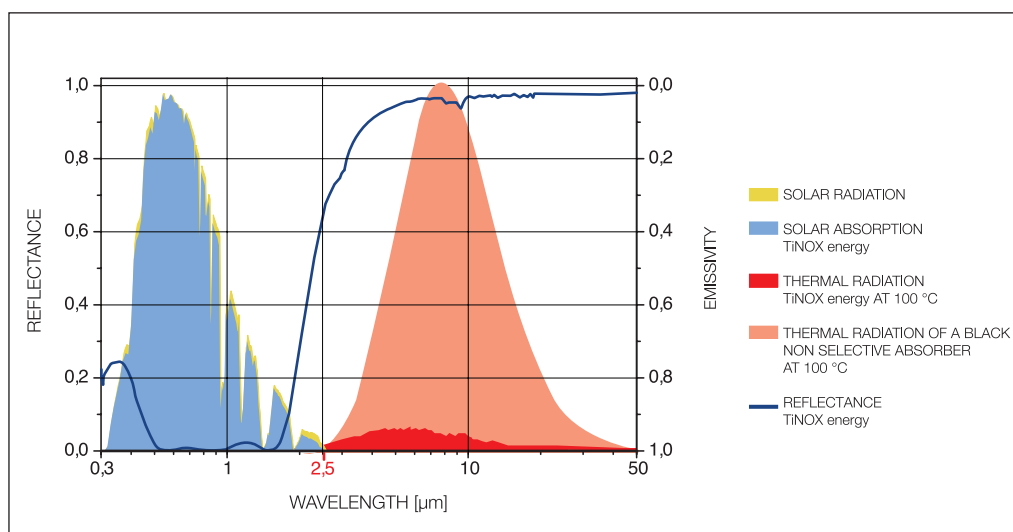
TiNOX_{robust} is an highly selective coating designed especially for harsh environmental conditions.

All TiNOX products are made in Germany in modern production lines in Bernburg.

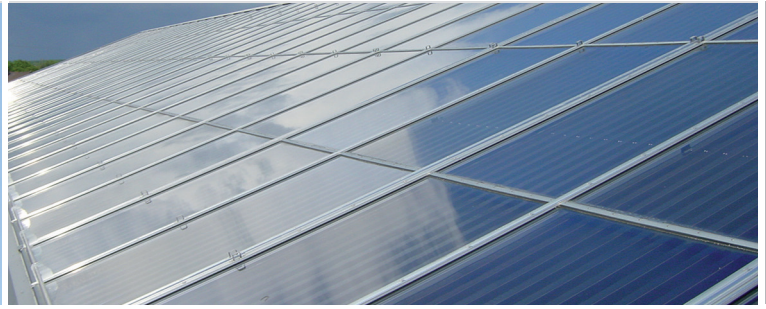


The TiNOX absorbers are energy traps. They collect almost all available solar radiation and convert **The energy trap** it into heat. Unlike black chrome or black-coated absorbers, almost none of this energy is lost again as heat radiation. The energy is directly transferred into the heating-support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

How is that possible? TiNOX absorbers make use of the fact that the sun radiates most energy **Selective reflection** at wavelengths below 2.5 μm , while the characteristic wavelength range for heat radiation from a 100°C hot 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.

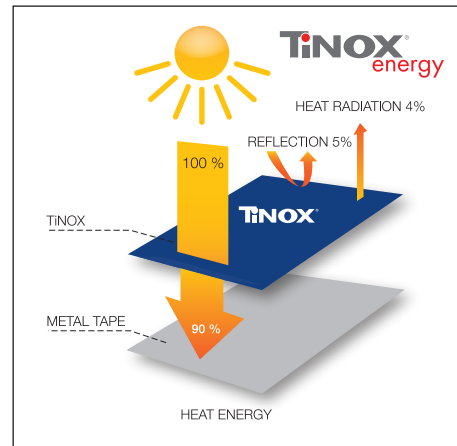


The blue area shows how well **TiNOX^{energy}** absorbs solar radiation. The pale red area depicts the emission of heat radiation from a black absorber with non-selective coating. The contrasting low heat radiation of **TiNOX^{energy}** are shown in dark red. The blue curve shows the reflective properties of **TiNOX^{energy}**. In the range of solar radiation, reflectance is very low to absorb as much solar radiation as possible. In comparison, the coating has a high reflectance in the infrared wavelength range, resulting in very low emission of heat radiation according to the laws of physics – 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.



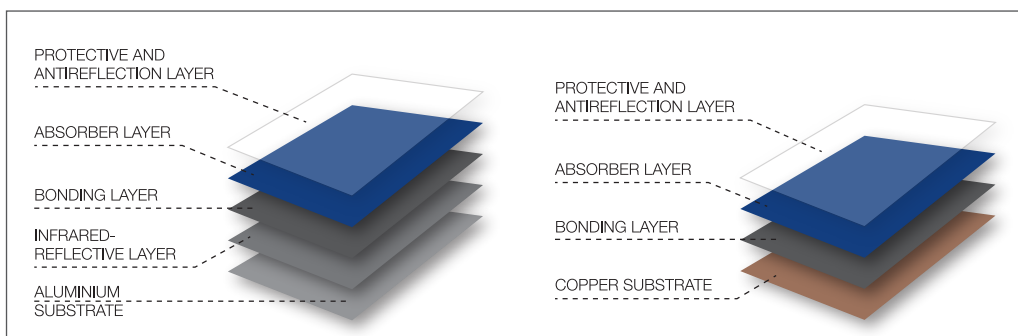
Solar absorption $\alpha_{\text{sol } 100^\circ\text{C}} : 95 \% \pm 2 \%$

Thermal emissivity $\epsilon_{\text{sol } 100^\circ\text{C}} : 4 \% \pm 2 \%$

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, environmentally friendly manufacture and costs: **Tinox robust**

TiNOX
robust

TiNOX
robust is a highly selective absorber coating designed for harsh environmental conditions as found in flat plate solar collectors mounted near seaside or in industrial environment.

Compared to other absorber coatings designed for harsh environmental conditions based on black chromium or lacquer **TiNOX**
robust features nearly the same optical properties as the well-established **TiNOX**
energy coating due to a complex multilayer structure applied by PVD coating process. Due to the special ceramic top layer the material has good corrosion resistance and fingerprints are nearly not visible. In humid conditions, optical stability is maintained.

Solar absorption $\alpha_{\text{sol } 100^{\circ}\text{C}}$: 94 % \pm 2 %

Thermal emissivity $\epsilon_{\text{sol } 100^{\circ}\text{C}}$: 4 % \pm 2 %

TiNOX
robust is deposited on aluminum substrates up to 1,250 mm width (copper or stainless steel are available on request).

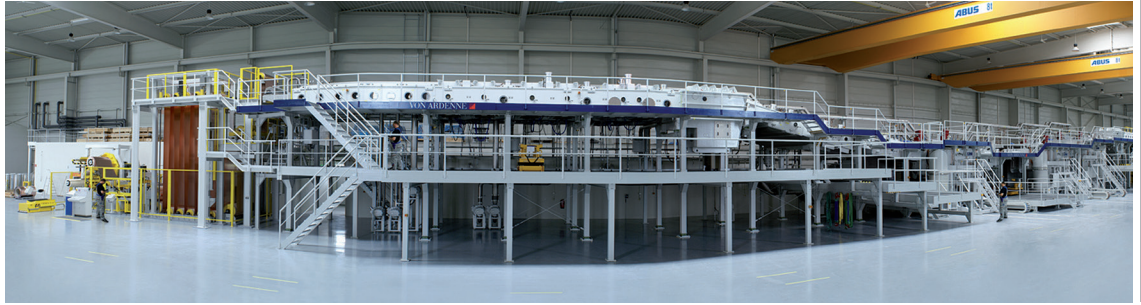
TiNOX
robust absorbers are the heart of solar thermal collectors. **TiNOX**
robust absorbers can be used equally well in glass covered flat-plate and -air collectors.

TiNOX absorber substrates can be further processed using all common industry methods:

- ▼ Laser welding
- ▼ Ultrasonic welding
- ▼ Plasma welding
- ▼ Soft soldering
- ▼ Forming

Deep drawing and embossing are also possible. We recommend contacting us beforehand for such processing.

Optionally the TiNOX absorber material can be delivered with protection film.



When absorber coatings with the highest performance for solar applications are required, 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 emissivity of these highly selective absorbers.

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 a 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 used.

The whole process is computer controlled and monitored throughout with optical sensors. In addition, experienced quality engineers carefully inspect and test all produced absorber material before the material leaves the factory.

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 film 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 Almeco 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, architectural and solar energy industries. All **TiNOX_{energy}** products are manufactured in Germany. With modern, high technology vacuum coating and manufacturing lines, Almeco GmbH specializes in high-tech reflector and absorber coatings that convert sunlight into heat energy in an efficient, reliable and environmentally friendly manner.

Almeco is a competent, dedicated Partner for its customers with a wide international service **Service and consulting** 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.

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

Almeco 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 ("Qualification of solar absorber surface durability" International Energy Agency DIN ISO 22975-3), 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 are certified by external institutes:

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

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Atlanta, USA



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