Solar: Scientific milestones are the result of good ideas, courage, perseverance and conviction. WACKER was one of the very first to manufacture hyperpure silicon and innovative silicone products- and, with its comprehensive network of expertise, is currently one of the leaders in the solar industry. Products and services of the highest quality guarantee our customers a long-term competitive edge in a future-oriented growth market.
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For additional information, see: www.wacker.com ► Products & Markets ► Solar

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High growth potential

In the 21st century, we are faced with the global challenges of climate protection and resource conservation while supplying the world’s ever-increasing population with energy in an environmentally sound and sustainable manner. Conventional energy sources have now reached their environmental and economic limits. Based on climate considerations, an increasing number of industrialized countries are focusing on government-sponsored solar incentive programs and plans for converting their energy systems to renewable energies.

The use of solar energy as a virtually inexhaustible, free resource is the most significant energy source of our time with regard to climate protection. Because photovoltaics allow direct utilization of solar energy, this technology is the key to supplying energy after the age of fossil fuels, with a high potential for global growth. After the dynamic development of the solar and photovoltaic industry in Europe, the focus is now on new key markets in the solar industry such as China, India, Japan and the United States.
For additional information, see: www.wacker.com > Products & Markets > Solar > Market Survey
For additional information, see: www.wacker.com ➤ Products & Markets ➤ Solar ➤ Market Survey
Innovation & expertise
Solar cells made of crystalline silicon convert sunlight directly into electrical energy, thus conserving valuable resources and protecting the environment. Solar modules do not require fossil fuels, and produce no waste gas emissions. WACKER has been at the forefront of the future-oriented solar technology since its very inception. As early as 1959, WACKER laboratories were the first to produce polysilicon on an industrial scale, in collaboration with Siemens. WACKER has since become a leading supplier of ultrapure silicon to the global semiconductor electronics industry. This expertise enabled WACKER to also become one of the key suppliers to the solar industry early on. In addition to polysilicon, our silicone products also play a central role in the manufacture of solar modules with low-environmental impact. WACKER has responded to the growing worldwide demand for polysilicon and silicones by continuously expanding its production capacity. A high level of customer benefits and first-class quality are our top priority. Hyperpure polysilicon gives our customers a crucial competitive edge across the entire solar value chain, and serves as a starting point for the value chain in the field of electronics.

Production of a solar module
The heart of a solar module is its cell, which converts sunlight into electrical power. The cells are manufactured by first melting the polysilicon in a quartz crucible. The silicon is then cooled to form solid crystalline blocks of ultra-high quality. Wafers are sawed from the blocks and further processed to form solar cells, using methods from semiconductor technology. To ensure decades of service with no reduction in solar power, a number of solar cells must be interconnected and embedded by shrink-wrapping in a transparent film. With TECTOSIL®, a new type of silicone gel, WACKER offers a high-quality product line for encapsulation and sealing (see "One problem, two solutions" on Page 14). The cells are then mounted between two glass sheets in an aluminum frame, and all joints are adhesively bonded and sealed using innovative silicone solutions. The result is a completed solar module made of highly crystalline silicon.

Questions about our products and services? Contact us directly at: info.polysilicon@wacker.com
Amortizing energy
It takes one year for a solar system to re-coup the energy expended to produce it; this is referred to as “energy payback time” (EPBT). Compared to a life span of more than 30 years, this is an excellent return. WACKER has contributed decisively to this success by continuously reducing the power requirements for polysilicon production.

Optimal products & processes
In order for the solar cell to convert the most sunlight possible into electrical energy, the polysilicon starting material must have extremely high purity. This is all the more important since the solar module manufacturer cannot guarantee consistently high performance of the system over a period of decades unless a dependable starting material is used. Highly consistent polysilicon purity is a must for the manufacturers of solar wafers and solar cells if they are to achieve short production times and high production yields. Thus, WACKER’s polysilicon meets all demanding market requirements, and provides its customers with significant competitive advantages.
Excellent prospects: Ongoing development of crystalline silicon technology in the WACKER laboratories has consistently lowered the cost of photovoltaics and continuously improved their competitive position compared to conventional power generation sources.
Polysilicon production at WACKER – where quality is of utmost priority

What exactly is polysilicon? Polysilicon refers to incredibly pure silicon containing a maximum of one contaminant atom per billion silicon atoms. This makes polysilicon by far the purest material that can be manufactured.

Polysilicon is produced in a refinement of the four-step Siemens process, using comparatively “dirty” silicon of 99% purity. Since ultrahigh purity is best achieved by distillation, the metallurgical grade silicon is first converted to liquid trichlorosilane (TCS). After purification by distillation, the TCS is introduced into reactors at approximately 1000 °C, where it is reduced to ultrapure silicon, which then deposits in the form of bars. Mechanical grinding of the bars produces size fractions corresponding to those required by our customers for the subsequent crystallization processes.

WACKER produces ultrapure polysilicon according to high quality standards and a continuous quality management system. WACKER is applying its decades of experience in polysilicon production for the semiconductor electronics industry to the emerging field of solar power.

This comprehensive material expertise, ranging from analysis to production to logistics, provides our customers with premium quality for all products and processes. Key areas include complex analytical processes based on state-of-the-art technology and extensive monitoring systems and routine random sampling. In addition, all procedures, duties and responsibilities are controlled by systems certified under ISO Standards 9001 and 14001 as well as OHRIS and OHSAS. Taking quality, productivity, safety, environment and health protection into account is our top priority.

One starting material, two technologies: Polysilicon is produced in a four-step process developed by Siemens. The state-of-the-art TCS process, a proven technology with a fast ramp-up for silicon bars and polysilicon, as well as the innovative FBR process with its extremely low energy consumption for the production of granular silicon, form the underlying technologies for efficient, sustainable polysilicon production.
Encapsulation, sealing and adhesive bonding
Whether for encapsulation material for solar cells, or silicones for sealing technology and high-tech adhesive bonding, premium quality products perform many tasks in the manufacture of photovoltaic modules, and provide proper functioning for climate-protecting energy systems. A number of unique properties make ELASTOSIL® solar silicone rubbers ideal for use in photovoltaics:
- Excellent resistance to high and low temperatures
- High transmission in the UV-VIS range between 250 and 1100 nm
- Unsurpassed UV resistance without addition of stabilizers
- Low content of ionic impurities
- Low moisture absorption
- Low relative permittivity
- High dielectric strength
- High volume resistivity
- Good environmental compatibility
For additional information, see: www.wacker.com ► Products & Markets ► Solar ► Portfolio
One problem, two solutions

Encapsulation material
WACKER offers the solar industry two outstanding approaches for encapsulating photovoltaic cells securely: TECTOSIL® films for established lamination processes, and a novel type of silicone gel which represents a new product generation.

TECTOSIL® film
Supplying energy using renewable energy sources represents the wave of the future. Having the proper encapsulation material for the sophisticated photovoltaic modules is crucial to ensuring high product quality and low process costs. TECTOSIL®, the innovative encapsulation material from WACKER, meets both requirements. TECTOSIL® is based on a new type of thermoplastic silicone elastomer which was developed for the purpose of replacing existing organic encapsulation materials. Its extraordinary property profile ensures defect-free encapsulation of the module and consistently high module efficiency:
– Reliable sealing and insulating properties
– No delamination or corrosive by-products
– High laminate stability and reliability
– Uniform module properties, even at low temperatures
– No abrasive by-products, low maintenance
– High process flexibility
– Stress-free encapsulation of the cells

For additional information, see: www.wacker.com ► Products & Markets ► Solar ► Portfolio
Next Generation
An innovative silicone gel is enabling the adoption of alternative processes for advanced solar applications and novel architectural design concepts. In one development project, WACKER is actively promoting this new gel to become the industry standard. It is highly transparent and cures to form an elastic, very flexible and supple compound, making it very well suited for reducing mechanical stresses in material composites. This even allows production of curved plastic modules as used, for example, for bus stop roofs and solar boats.

TECTOSIL® films crosslink without undergoing a chemical reaction, thus providing major advantages to module manufacturers. The lamination time is greatly reduced, the process is more reliable, and there is less waste. This reduces the cost for quality control, and simplifies storage. The physical crosslinking also makes the modules recyclable. TECTOSIL® films are supplied ready to use, and may be processed in customary vacuum laminators and roll-to-roll processes, in a similar way to organic encapsulation materials. They are likewise ideal for crystalline modules such as thin layer modules, and also suited for other fields of application.

High performance on the field as well as on the roof: A star player in Bremen’s Weser Stadium is its new photovoltaic system. Not only are solar modules mounted on the roof of the stadium, they are also integrated into a semitransparent inner ring of the roof.
Customized portfolio for perfect solutions

Frame bonding
Requirement:
Durable sealing and edge protection, compensation for thermal stresses, good adhesion to both frame and glass-foil laminate
Processing:
Automatic application, rapid curing
Solution:
Quick-crosslinking, stable RTV-1 or RTV-2 silicone rubbers

Sealing the junction box
Requirement:
High elasticity, low modulus of elasticity, very good electrical insulation, good adhesion to junction box and backside foil
Processing:
Automatic application, rapid curing
Solution:
Quick-crosslinking, low-viscosity RTV-2 silicone rubbers

Attachment of junction boxes
Requirement:
Durable attachment of junction boxes, excellent adhesion to junction box and backside foil
Processing:
Automatic application, rapid curing
Solution:
Quick-crosslinking, stable RTV-1 or RTV-2 silicone rubbers

Back rail attachment
Requirement:
Durable, strong bond of mounting unit to module, even under dynamic loads and severe climate conditions, good adhesion to fastening rails and backside foil
Processing:
Automatic application, rapid curing
Solution:
Quick-crosslinking, stable RTV-1 or RTV-2 silicone rubbers
We can offer you customized solutions for various applications in the photovoltaic module field that reflect the versatility of the material properties and processing characteristics.

Applications
Encapsulation
Sealing technology
Adhesive bonding

Products
ELASTOSIL® S
ELASTOSIL® Solar
TECTOSIL®

For additional information, see: www.wacker.com ➤ Products & Markets ➤ Solar ➤ Portfolio
Into space with WACKER

Questions about our products and services? Contact us at: info.silicones@wacker.com
Special applications

Solar modules using WACKER technology have been in use in the aerospace industry since the 1990s, and represent high quality and reliable functionality. With the ELASTOSIL® S series, we offer ESA-compliant specialty products which are reliable at withstanding vacuum, radiation and extreme temperature changes. Furthermore, these silicones also meet very exacting requirements with regard to material properties, processing and service life.

Concentration on the essential

Concentrated photovoltaics (CPV) systems represent an ideal alternative to conventional photovoltaics technology in power plant construction. These systems use specialized optical elements to focus sunlight on small high-performance cells, such as triple junction cells, which are based on III-V semiconductors and have an efficiency of > 40%. By concentrating the sunlight, the active solar cell surface area may be reduced to a fraction of that required in a conventional solar module. In highly concentrated photovoltaic modules, Fresnel lenses focus the sunlight onto the cells underneath, increasing its intensity by a factor greater than 500. A highly transparent dual-component silicone rubber which meets the extremely stringent requirements for high transmission and UV stability has been developed specifically for the cost-efficient manufacture of Fresnel lenses.

Crosslinking on command

As an innovative company, WACKER is continually developing new and even better solutions for its customers and partners. One example is from the field of UV technology: UV-activatable silicone elastomers allow highly efficient processing in mass production with very short cycle times, which represents a quantum leap in manufacturing speed and production efficiency:

- Long pot lives of several hours in the absence of light
- Crosslinking within a few seconds after UV activation at room temperature

For additional information, see: www.wacker.com ➤ Products & Markets ➤ Solar ➤ Portfolio
Integrated sustainability
Sustainable business management is indispensable for long-term success. For WACKER, this means that we re-examine our operations on a daily basis. As the result of continuously expanding production, we are one of the major employers in regions where we have a presence. At our production facilities, we optimize existing systems and initiate new structures so that we can conserve resources and minimize energy and raw material use, as well as solid waste generation and CO₂ emissions. This allows us to offer our customers environmentally compatible solutions. Modules produced using the materials we manufacture are recyclable. Polysilicon from WACKER is cadmium-free and produced in an "intelligent" integrated silicon-based production system.

The consistent use of integrated production systems requires maximum utilization of energy and materials coupled with product optimization during the production process. In highly complex material cycles, the by-products and resulting energy are returned to production and used as the starting point for adding further value. We are increasing energy efficiency by using a heat integration system. High-efficiency cogeneration of heat and power as well as the utilization of waste heat and steam have resulted in an energy utilization rate of greater than 85%.

Carbon Footprint: Climate change is the greatest challenge facing us and our ecosystem. By use of ideas, innovations and targeted life cycle assessment, WACKER is committed to further reducing greenhouse gas emissions and efficiently producing energy for our products and processes.
Sustainability in research and development

For approximately the past 100 years, the company’s corporate research center founded by Alexander Wacker, the “Consor-
tium für elektrochemische Industrie” in Munich, has been an innovative forum for sci-
entists, nurturing their creativity and inventive spirit. Our technical centers throughout the world supplement this re-
search expertise with regional focus. In both cases, the materials and processes we develop are highly beneficial to both the economy and the individual. Our success can be seen in the impressive number of patents we have acquired.

This has produced groundbreaking innovations, such as the development of a pro-
cess for manufacturing granular polysilicon that simplifies the production of hyperpure silicon suitable for photovoltaics. WACKER has also demonstrated sustainability in re-
search and teaching, as evidenced by the Institute for Silicon Chemistry, opened in 2006, as part of the WACKER Chair of Macromolecular Chemistry at the Technical University of Munich and the Garching/ Oberbayern Research Center.

For additional information, see: www.wacker.com

Solar Sustainability
WACKER is one of the world’s leading and most research-intensive chemical companies, with total annual revenues of €4.75 billion. Products range from silicones to binders and polymeric additives for diverse industrial sectors to bio-engineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer a high value-added potential to ensure that current and future generations enjoy a better quality of life based on energy efficiency and protection of the climate and environment.

Spanning the globe via five business divisions, 26 production sites and over 100 subsidiaries and sales offices, we have established a presence in all key economic regions and growth markets. With a 16,300-strong workforce, WACKER sees itself as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, its customers. WACKER also helps them boost their own success. Our technical centers employ local specialists, who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required.

WACKER E-Solutions are online services which we offer in our customer portal and also as an integrated process solution. For our customers and partners, this means comprehensive information and reliable services for quick, reliable and highly efficient management of projects and sales orders. This service is available worldwide at any time or place at www.wacker.com

All figures are based on fiscal year 2010.
WACKER Technical Centers: The Technical Centers are designed according to current technological standards. Their worldwide focus is on finding the best possible solutions to meet your needs. WACKER has 17 Technical Centers in the following cities: Adrian, Akino, Allentown, Beijing, Burghausen, Dubai, Hikari, Hsinchu, Jandira, Calcutta, Melbourne, Moscow, Nünchritz, Portland, Shanghai, Singapore and Suwon.
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