

Photovoltaics Business Unit
Metallization Pastes for Solar Cells

Heraeus. Family owned. Internationally respected.

Heraeus, the precious metals and technology group headquartered in Hanau, Germany, is a global, family-owned company with over 160 years of tradition. Since 1851, Heraeus has built a reputation on innovation and advancements in areas such as precious metals, materials and technologies, sensors, biomaterials and medical products, as well as dental products, quartz glass and specialty light sources. With revenues matching those of Fortune Global 500 companies, Heraeus holds leading positions in its global markets.

Today, that tradition of product innovation still holds true. Of the over 12,000 employees working in 120 locations around the world, over 400 are dedicated to research and development. Because of their hard work, generation after generation, there are currently more than 6,000 patents under the Heraeus name.

Heraeus Precious Metals

With the original process for melting platinum in 1856, Wilhelm Carl Heraeus laid the foundation for Heraeus as the "First German Platinum Melting House." Today, the Heraeus Precious Metals business group produces innovative, technologically demanding products, in areas with great future potential: environment, mobility, communications, energy and health.

Heraeus has over four decades of experience in manufacturing high volumes of thick film pastes for some of the most prominent companies in the industry. We offer a broad range of pastes used for the manufacturing of electronic circuits, passive components, sensors, fuel cells and photovoltaic cells. Combining our paste manufacturing experience and innovation, allowed us to develop the first HeraSol[®] silver paste for the photovoltaic industry.



“From our very first HeraSol silver paste, our goal has always been to formulate metallization pastes for our customers to produce the highest efficiency cells. Because of our commitment to innovation and our customers, we release at least two to three new products each year.”

- Andy London
Global Business Manager
Photovoltaics Business Unit



From the quartz glass developed in 1899 that is currently used in the high-temperature production of solar cells, to our industry leading front-side and new back-side photovoltaic silver pastes with significantly reduced silver content, Heraeus continues to be a global leader in product innovation.





Carrying on a Legacy of Innovation

The PV Business Unit—Market of the Future

Photovoltaic applications—one of the most important markets of the future—make rigorous demands on materials. Conductive pastes must reliably transmit the current created by solar cells, while remaining stable over many years under all weather conditions.

Leveraging 40 years of manufacturing thick film pastes for a multitude of applications, the Photovoltaics Business Unit in 2008 debuted with the first HeraSol silver paste. Within a few years, Heraeus PV quickly gained significant market share thanks to the paste's exceptional printing properties for the finger lines and busbars of first generation photovoltaic cells. After firing, the contact lines are extremely conductive and distinguish themselves by their high efficiency.

New Technologies, New Formulations


The first line of HeraSol paste was only the beginning. Today, Heraeus is introducing at least two to three new formulations each year in multiple technology areas. These include pastes for advanced cell designs such as double printing, metal wrap

through and N-Type cells. The PV R&D and Technical Service Centers support the further development of conductive paste technologies worldwide and encourage the exchange of ideas with customers.

Due to the continual efforts of Heraeus PV to research, create and develop environmentally friendly technologies, many of our silver-base conductive pastes are now available in cadmium-free and also lead-free versions.

Truly Customized Solutions

Heraeus is renowned for true product customization, developing metallization pastes for companies located around the world. Using the latest technologies, Heraeus continues to develop products that take full advantage of customers' unique wafer designs and processes. Experienced research engineers continually formulate pastes to optimize any solar cell's performance, allowing customers to meet production goals and introduce new products.

A person wearing safety glasses and a blue lab coat is working in a cleanroom. They are holding a small white jar with a green label that says "ACCEPTED". The background shows various pieces of equipment, including a digital display showing "23.52" and a warning sign. The scene is lit with bright, cool-toned lights.

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Regional Technical Service Centers— Always Ready, Always Close

Historically, innovation and service have been cited by customers as the top benefits provided by Heraeus. With Technical Service Centers in China, Singapore, Taiwan, Germany and the USA, Heraeus provides an expanded local technical service platform, along with immediate response in key regional markets worldwide.

These fully functioning labs offer full-service testing of new cell designs and materials, providing an extension of customer's engineering capabilities, without disrupting existing production processes. Heraeus engineers also use a wide range of testing equipment to provide meaningful data, allowing customers to duplicate results on-site.

Capacity Across the Globe

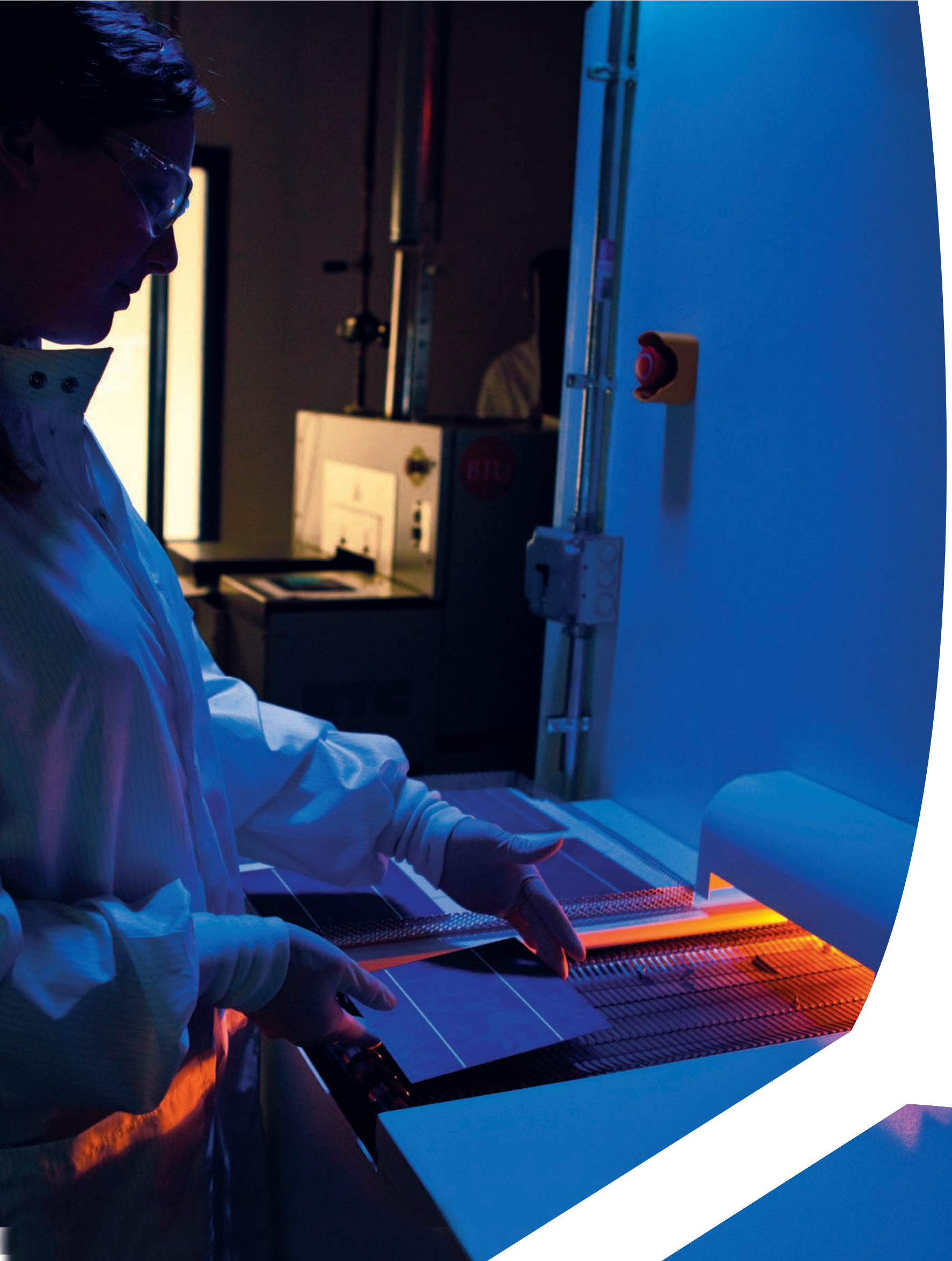
Heraeus produces PV silver paste in the USA, Germany, China, Taiwan and Singapore. With batch sizes as high as 500 kilos, Heraeus consistently delivers the highest quality pastes, uniformly consistent from batch to batch. And with products manufactured all over the globe, customers can quickly get their Heraeus PV

materials—whenever and wherever they are needed.

Committed to Customer Success

The Heraeus Photovoltaics Business Unit focuses our innovations toward our customers' technology platforms. While specialty technology areas include N-Type cell production, metal wrap through, double printing and other advanced cell designs, no two projects are the same. Along with developing numerous new products every year, Heraeus' skilled teams can customize products for customers, changing material properties to meet the most unique customer specifications.

The customization of Heraeus' products is just one part of a commitment to our customers' success. There is also immense pride in being reliable and efficient to ensure faster turnaround times. Employee training and education is critical to ensure employees have the skills and expertise needed to handle any problem or concern that arises.



Metallization Pastes



Front-side Pastes for Conventional Cell Designs

The Heraeus SOL Series of front-side silver pastes are screen-printable conductors for crystalline solar cells, specially formulated to provide higher efficiencies, lower contact resistance and wider processing windows. The result is better yields and higher output for cell manufacturers. Heraeus compositions are all cadmium-free and tailored for either SiN_x or TiO_x anti-reflective coatings. Lead-free formulations are also available. All Heraeus front-side silver pastes are co-fireable with commercial back-side Ag/Al pastes.

The SOL9410 and SOL9411 Series is Heraeus' 4th generation front-side silver paste, which is formulated for lightly doped emitter and optimized for high throughput processing. These pastes provide excellent contact formation and fine line resolution for advanced cell designs, and Heraeus continues to improve upon these industry-leading pastes.



Front-side Pastes for Advanced and Novel Cell Designs

In the race to improve cell efficiencies, cell manufacturers are developing advanced cell designs, and Heraeus is here to assist in improving the performance of solar cells. With Heraeus' line of metallization pastes for advanced and novel cell designs, customers can take advantage of our new innovations for double printing, MWT, N-Type cells and other break-through technologies. Heraeus' scientists and engineering staff are continuing to work with customers to stay on the forefront of paste technology for new cell designs.



Back-side Pastes

Heraeus' line of back-side pastes are specially formulated to provide high coverage for reduced usage on wafers, while also maintaining excellent adhesion to the silicon cell. Heraeus' back-side pastes offer excellent solderability in both leaded and no-lead solders. All back-side pastes are co-fireable and lead-free and cadmium-free.

Starting with the introduction of SOL230, Heraeus has continued to integrate an innovative spirit with our technology to address customers' needs in the market. Included in our SOL200 Series of back-side pastes are new products with significantly reduced silver content. Combined with the higher coverage, customers can achieve lower costs while maintaining higher performance. These products have demonstrated this cost savings at our customers' facilities, while Heraeus R&D continues to improve upon these formulations.

The Sun Always Shines on Heraeus

From Asia and Europe, to the Americas, Heraeus facilities are spread out throughout the world, providing more localized service, faster response times and more direct channels for communication.



Americas

Services offered:

- Manufacturing
- Technical Services
- R&D
- Sales



Europe

Services offered:

- Manufacturing
- Technical Services
- R&D
- Sales



Asia - Singapore

Services offered:

- Manufacturing
- Technical Services
- R&D
- Sales



Asia - China

Services offered:

- Manufacturing
- Technical Services
- Sales



Asia - Taiwan

Services offered:

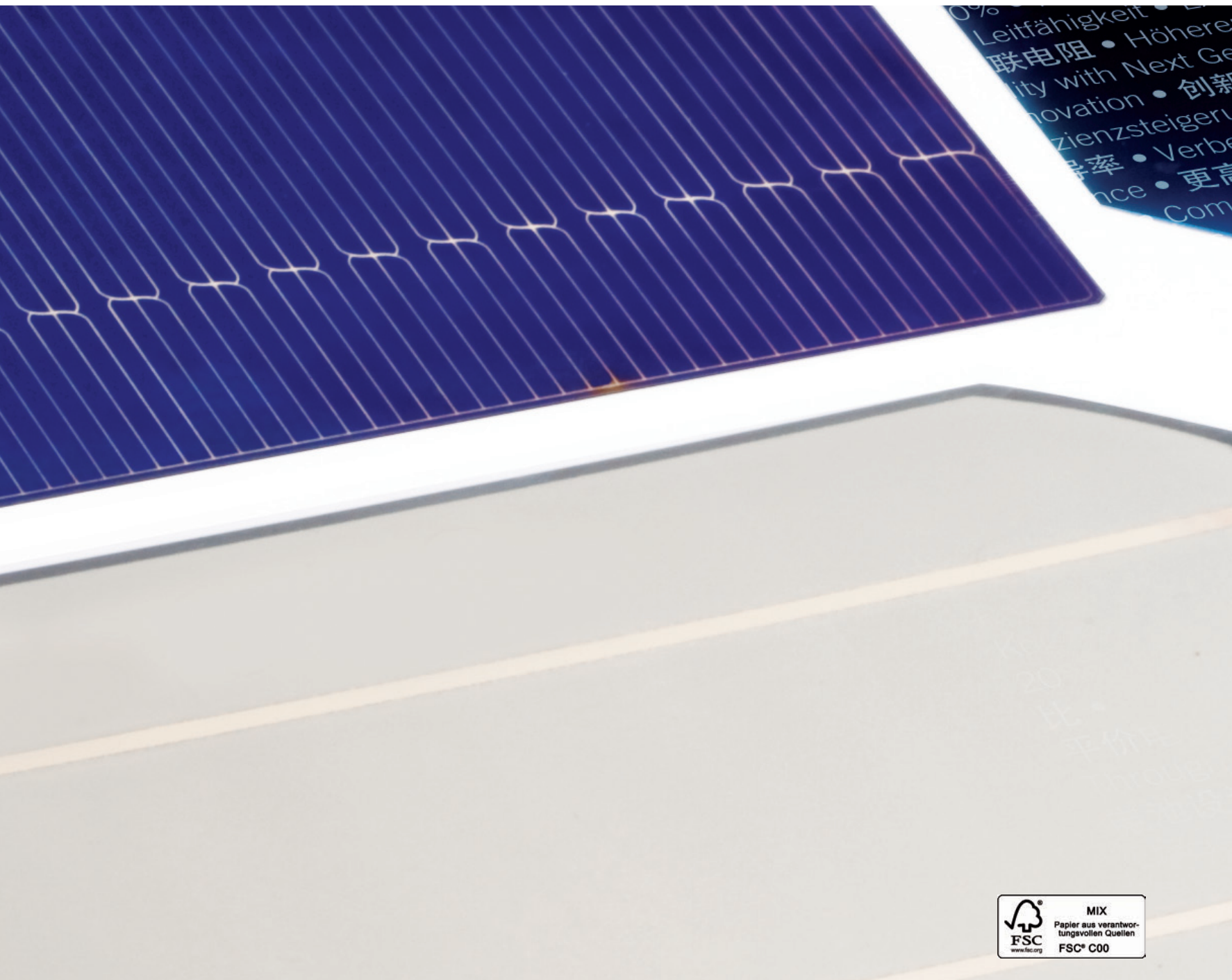
- Manufacturing
- Technical Services
- Sales

- Full Service Site
- ▲ Sales Office

The Heraeus Photovoltaics Business Unit

An innovative Research and Development staff developing new products. A strong Technical Service team focused on customers' needs. These are the fundamental principles that drive our activities. Talk to a Heraeus salesperson today to put over 160 years of insights and innovation to work for you.





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