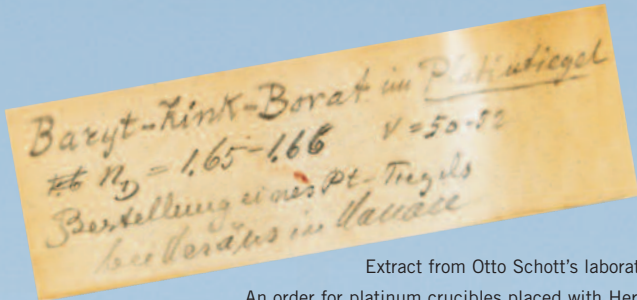


**Engineered Components
for High Quality Glass**

Heraeus – Advanced Materials Technologies

Heraeus platinum products have been at the forefront of glass development and manufacture for 150 years. Otto Schott, the father of modern glass making, specified platinum crucibles from Heraeus for his experiments to develop optical glasses in the second half of the 19th century.



Extract from Otto Schott's laboratory note book:
An order for platinum crucibles placed with Heraeus in Hanau

Throughout the 20th century Heraeus supported the development and manufacture of high grade glass products by providing new and improved platinum materials and fabricated components for every conceivable application in industry and research laboratories.

Heraeus is now a leading global supplier of platinum systems and engineered components for all aspects of glass making. Our products include large electrically heated feeder systems, stirrers, plungers, gob feeders and electrodes for soda-lime, borosilicate and LCD glasses with working temperatures up to more than 1600°C. Further products are glass fiber bushings, linings for refractory components, orifices, thermocouple thimbles and a wide range of crucibles and special devices for the analytical and research laboratory.

We are pleased to assist our customers with the design of fully engineered systems and components. Heraeus platinum materials, including the full range of alloys with rhodium, iridium and gold, are complemented by the oxide dispersion hardened Pt DPH materials which are ideal for use at high temperatures*.

To aid the design of components, we apply Finite Element Modeling (FEM) and have, we believe, the world's most comprehensive database of high temperature mechanical properties of platinum materials**.

Heraeus has state-of-the-art equipment for melting, forming, welding and fabricating all platinum materials. Quality assurance, materials development and applications technology are supported by modern analytical and testing laboratories with highly skilled operatives.

The Business Unit Precious Metals Technology offers complete precious metals competence from one hand:

- Dedicated R & D by highly innovative staff
- Superior manufacturing skills supported by best-in-class equipment
- Recycling of precious metals
- Precious metals management

Heraeus: Your advanced material supplier

*You will find detailed information about these materials in our brochure "Dispersion Hardened Platinum Materials".

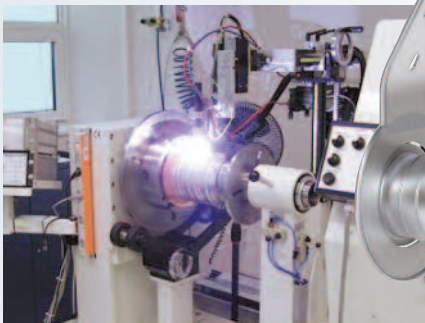
**For a comprehensive review of the high temperature mechanical properties of the platinum group metals, see: Platinum Metals Rev., 1999, 43(1), 18-28 and Platinum Metals Rev., 2001 45(2), 74-82



Sophisticated Manufacturing Processes

The melting furnace is the starting point for the production of every platinum component. At Heraeus we employ modern metallurgical processes such as vacuum induction melting and electron beam melting.

Besides the conventional techniques of rolling, tube and wire drawing, a number of advanced processes are available for forming these materials to semi-finished products such as sheets, seamless tubes, wires and formed parts. The variety of forming and machining processes at Heraeus ranges from CNC spinning and deep drawing to the most modern CNC turning and milling equipment.

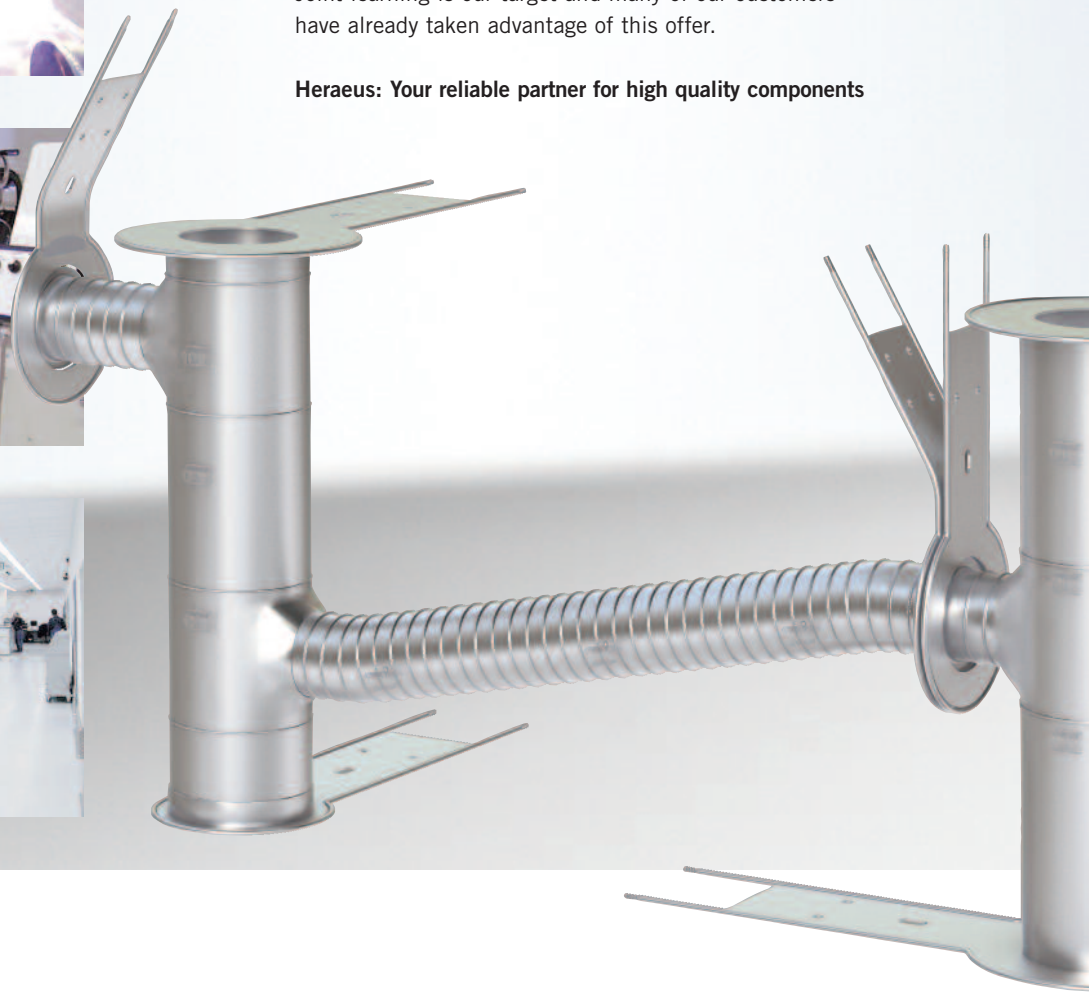


Broadly based experience in joining techniques – ranging from micro-systems technology to the construction of large vessels – guarantees the selection and application of the most suitable method. Tungsten inert gas (TIG) welding in particular has successfully established itself for precious metal equipment and components in the glass industry.

We use state-of-the-art automated welding (longitudinal and circumferential) for a wide variety of engineered components and, due to the excellent weldability of our DPH materials and the high strength of the weld seams, we are top of the class. We can confidently assure you that our products are the best on the market. Our aim is to enable you to operate a zero defect production. Thanks to modern inspection and analysis methods we maintain uniform material quality at the highest level.

We always ensure close cooperation before, during and after the use of our products, and it is our goal to work with our customers to achieve improvements of all kinds. Joint learning is our target and many of our customers have already taken advantage of this offer.

Heraeus: Your reliable partner for high quality components



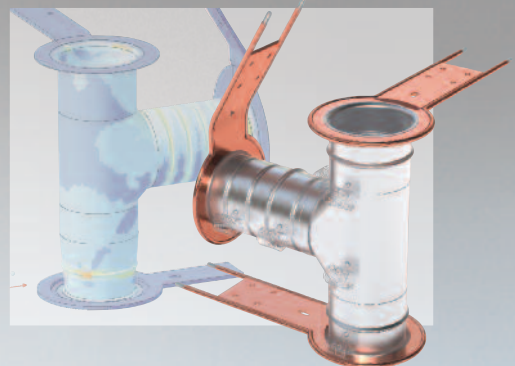
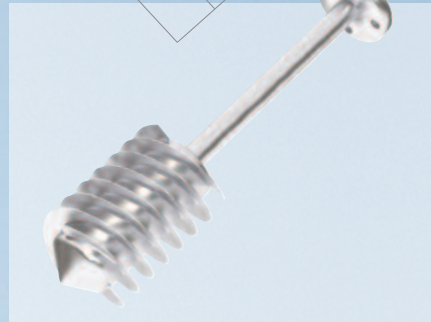
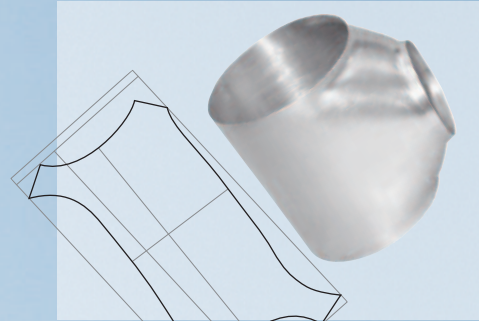
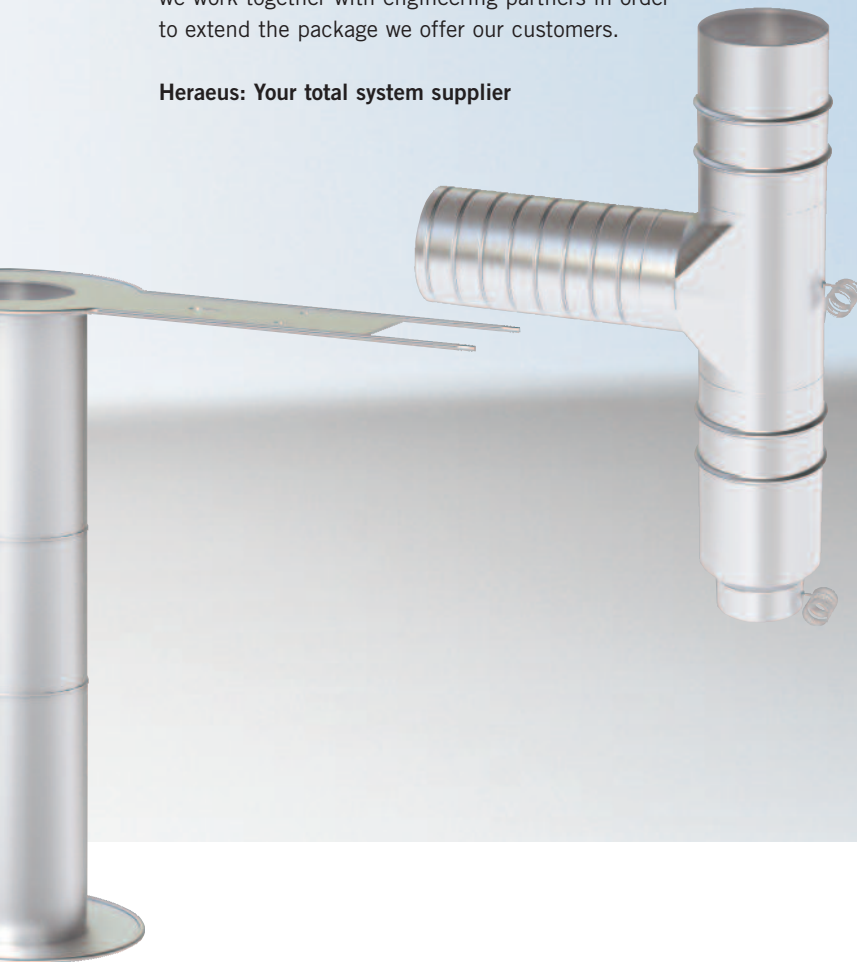
Engineered Solutions in Glass Manufacturing

For hundreds of years glass has been a challenging product, and future applications will be even more challenging. Heraeus has always been in the forefront of development, using their capability to support their customers' needs. We supply equipment for all types of glass – the right material selection is the key to our customers' requirements. In-house mathematical tools such as Finite Element Modeling (FEM) and other advanced methods are used by our skilled design experts to achieve customized engineered components. As an integral part of life cycle management, we aim to provide our customers with

- Uninterrupted component functionality
- Increased component lifetime and
- Optimized component weight.

We offer a considerable portfolio which is based on the unique properties of our DPH materials and supported by the experience of our engineers in design and special applications. Highly trained and qualified production specialists are responsible for the implementation of the product. In addition to the excellent performance of our materials and the consistent high quality of our products we greatly value the long-term relationship with our customers. In special cases we work together with engineering partners in order to extend the package we offer our customers.

Heraeus: Your total system supplier



Glass Fiber Bushings

Effectively all glass fibers (e. g. C-glass and E-glass fibers and related types) are manufactured using glass fiber bushings of PtRh alloys. Increasingly, the dispersion hardened (DPH) variants of these alloys are being used.

The development of Pt-5%Rh DPH as a full-value substitute for conventional alloys with 10% and 20% Rh enables glass fiber manufacturers to reduce rhodium inventories without sacrificing technical performance.

Heraeus produces glass fibre bushings to customer specifications with base-plates manufactured using either pressed or welded tips.

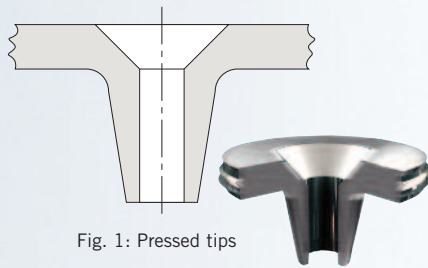


Fig. 1: Pressed tips

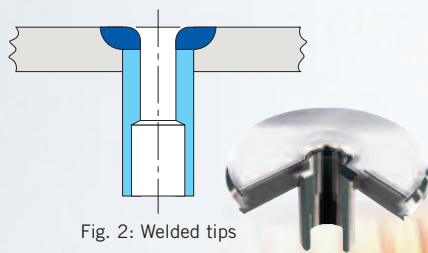


Fig. 2: Welded tips

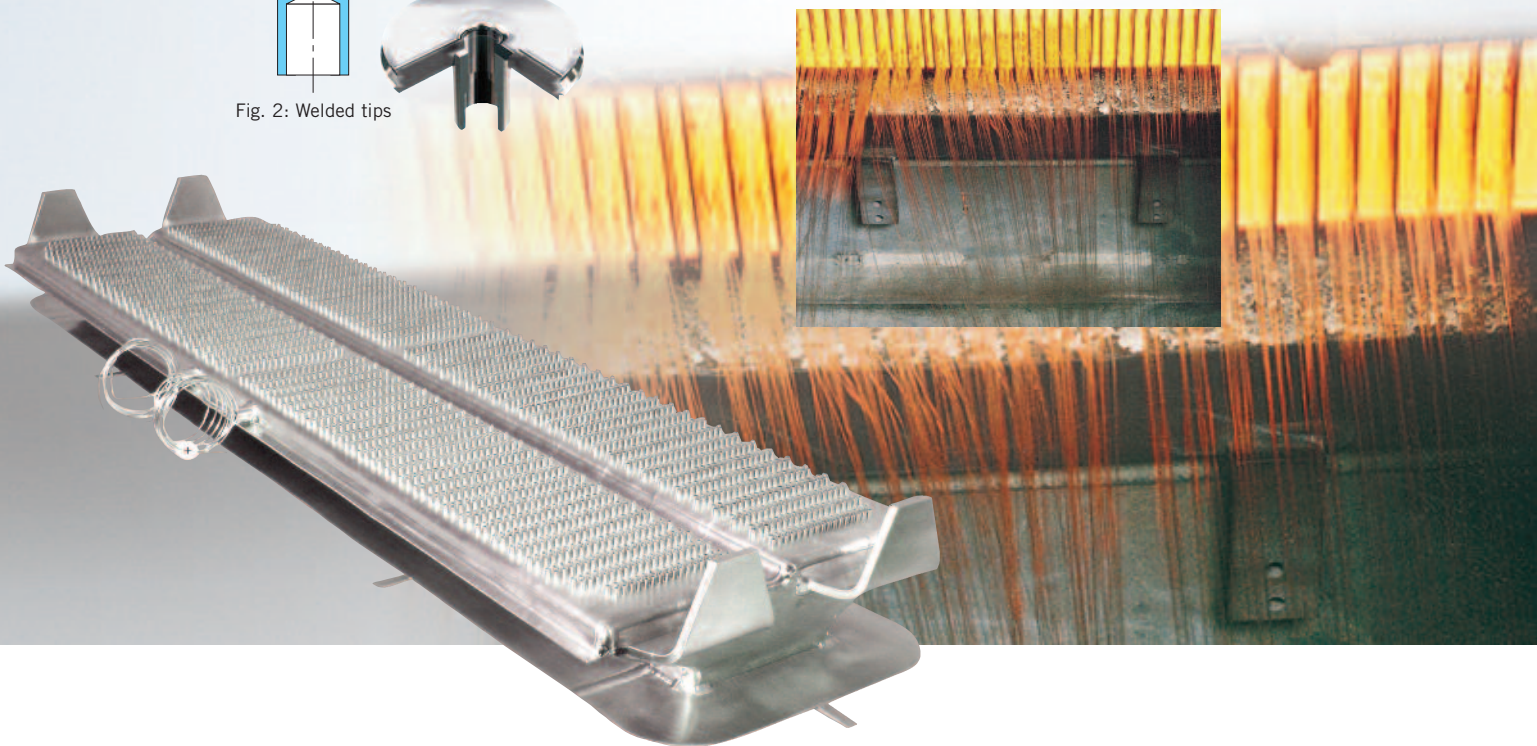
Bushing base-plates with pressed tips (Fig. 1) are free from welds which could become a weak point if operating procedures are not carried out correctly.

The advantages of welded bushing base-plates (Fig. 2) are that the tip geometry can be designed more freely (for example, variable diameters or differential internal diameters) and that the tips and the remainder of the bushing do not have to be made from identical materials. In this way load-bearing parts of the bushing can be produced from materials with maximum strength and service life whereas parts which are important for the fiberizing process can be selected from materials with optimum glass wetting behavior.

Heraeus also manufactures glass fiber bushings for extreme thermal and corrosive conditions such as occur in the processing of molten basalt, S-glass or mineral (insulation) glass.

We are pleased to cooperate with partners in optimizing the design of bushings with regard to strength and reduced precious metal costs.

Heraeus: Your partner for the glass industry



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