I’m feeling good again!
Palacos® Bone Cement from Heraeus sets standards in hip prosthesis

“The joke is over!”
Climate protection, “made by Heraeus”: innovative catalyst technology cuts harmful nitrous oxide emissions

Strong as steel
Even 1,750°C is no burning problem for immersion sensors from Heraeus
Dear Reader,

Welcome to the world of the precious metals and technology group Heraeus. We are delighted that you are taking the time to read the first edition of our technology magazine. With this publication, we aim to bring you a little closer to Heraeus, and take you on a journey through the innovative world of our products.

Whether in the field of chemistry, steel, medicine, automobiles, semiconductors, electronics, telecommunications or aerospace, Heraeus products can be found in virtually every branch of industry. With quartz glass prisms for a laser reflector, we have even made it to the moon!

Most of our products do their work out of sight, so you may be surprised to learn that you interact with Heraeus technology on a daily basis. It is found in many mobile phones, in most cars, in computers, and even inside the human body. Our products contribute to environmental protection, provide clean water and make hearts beat with the right rhythm.

We use our extensive expertise in handling modern materials to develop tailor-made and economically successful products, processes and technology. We put our specialist materials technology and technical innovations to work to yield decisive advantages for our customers and contribute to technological development. This philosophy inspired the founder of our company, Wilhelm Carl Heraeus, back in 1851, and has driven us to become a market and technological leader in the fields of precious metals, sensors, dental and medical products, quartz glass and specialty lighting sources.

For these achievements we rely on the creative ideas of our employees, the persistence and curiosity of our developers, and a feeling for and knowledge of what product solutions will really benefit our customers. The examples in the technology report 2008 are intended to illustrate this for you.

We welcome you to the innovative world of Heraeus!

Best regards,

H. Eschwey
Dr. Frank Heinricht
Jan Rimert
Contaminated water polluted with pathogens is increasingly becoming a health risk. According to a study by the World Health Organization (WHO), more than two million people – many of them children – die each year as a result of drinking contaminated water, e.g. from infections or diarrhea. Since 1900, the worldwide consumption of drinking water has increased six-fold, while the world population has only tripled.

The decontamination of drinking water is still often achieved with the help of chemicals such as chlorine or ozone – an effective but environmentally contentious method. It is possible to treat the water in a much more environmentally friendly manner, as no chemicals are used, by means of high-energy ultraviolet radiation. During this process, special UV lamps from Heraeus not only destroy micro-organisms such as bacteria, viruses, parasites, and fungi, but they also break down harmful chemicals.

UV lamps: ever more efficient and longer-lasting
The treatment of drinking water with UV radiation is a very effective physical process for reliably disinfecting water and breaking down harmful substances. The high-energy rays in the wavelength range of 254 nanometers (UV-C radiation) destroy genetic material and inactivate the cells of the micro-organisms contained in the water within a few seconds. Ultraviolet light even works on parasites that are resistant to chlorine. As the decontamination does not use chemicals and no chemical residues are left, the quality of the drinking water is affected in neither its taste nor its smell.

The first patented UV decontamination took place as early as 1910 in France with the aid of quartz glass lamps – a development that goes back to the chief developer at Heraeus, Richard Küch (1860 – 1915). There are worlds between these beginnings and modern high-tech UV lamps. “The challenges for the UV lamps today consist in significantly increasing the efficiency and service life of the lamps,” explains Dr. Sven Schalk, Head of the Environmental Technology Division of Heraeus Noblelight. The specialty lighting source manufacturer has developed innovative high-powered amalgam lamps for drinking water decontamination, which allow up to 16,000 operating hours with almost constant UV power output, and which thus last twice as long as standard low-pressure lamps.
Effective spectrum of a UV low-pressure lamp.

New high-performance amalgam lamps have long service lives (16,000 operating hours) and destroy germs in drinking water without using chemicals.

The right lamp for every purpose

For drinking water sterilization in waterworks, compact medium-pressure UV lamps and low-pressure UV lamps, (including high-powered amalgam lamps) are used. Low-pressure lamps emit radiation in the wavelength 254 nanometers and offer an exceptional degree of efficiency: up to 40 percent of the electrical power can be used for disinfection in the form of UV-C radiation. Where synthetic quartz glass is used as the lamp material, UV radiation of wavelengths below 200 nanometers is also emitted for oxidation processes.

Medium-pressure lamps emit a broad-band spectrum. For disinfection a wavelength range between 240 and 280 nanometers is emitted for oxidation processes. Where synthetic quartz glass is used as the lamp material, UV radiation of wavelengths below 200 nanometers is also emitted for oxidation processes.

This can be attributed to an innovative long-life coating. A superfine, closed protective layer is applied to the inside of the quartz glass encasing the lamp, which significantly slows the ageing process of the lamp. In conventional UV lamps, mercury diffuses into the quartz, and after 8,000 operating hours these typically only produce 50 percent of the original UV power. “With the new coating we have succeeded in preventing the detrimental transmission loss of the quartz glass seen in conventional UV lamps, and in achieving a virtually uniform sterilization effect over the entire service life,” Schalk describes the new development.

The new UV lamps also offer a further economic and environmentally friendly advantage. Thanks to the high UV power and the long service life, equipment manufacturer now require fewer lamps when designing sterilization facilities. This means a significant savings potential in the number of lamps, plant components, energy requirements, and service costs.

Disinfection with UV for large and small

The disinfection of drinking water with ultraviolet light is becoming ever more widespread. At a new waterworks in New York City, probably the world’s largest drinking water reservoir, the “stowaways” on ships can now be carefully eliminated.

One of the two reactors for UV disinfection at the Petersau/Mainz waterworks.

A ray of hope for drinking water quality

Substances and no chemical residues,” says Michael Henkel, Operational Manager for water mains and preparation at the Mainz municipal facilities, showing his satisfaction with the purification method.

Outlook: UV oxidation of harmful chemicals

Increasing environmental pollution from drugs in the ground water presents new problems for drinking water treatment. In order to destroy pharmaceuticals with very complex structures such as steroids or antibiotics, a combination of UV radiation and powerful oxidants such as hydrogen peroxide is needed. Pollution with fertilizers and pesticides from agriculture also represents a hazard for drinking water quality. UV oxidation is already being successfully used at Holland’s largest drinking water reservoir, IJsselmeer. There are particularly high concentrations of fertilizers and pesticides in the IJsselmeer.

In Germany, this process is currently only permitted for cleaning sewage. And in general throughout Europe there is a lack of uniform regulations regarding UV radiation. “In Germany and its neighbors, Austria and Switzerland, the use of UV lamps also ensures the high drinking water quality to which we are accustomed. For the increasing demand in Europe, a uniform European standard of use would be desirable,” emphasizes Sven Schalk.

Irrespective of the statutory regulations, it has been firmly established that UV light is one of the most environmentally friendly approaches to covering the increasing demand for clean drinking water. In the truest sense of the word, it is indeed a ray of hope for our future. "W
At the IAA 2007 International Automobile Exhibition in Frankfurt, a single vehicle drive system took center stage. The hybrid propulsion, a combination of an electric motor and a petrol engine. Thus far, this futuristic drive system was the domain of Japanese automotive manufacturers, but now the Europeans are catching up. Heraeus is also prepared for the new vehicle drive technology, and is already producing important materials for the power electronics in hybrid systems.

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Hybrid technology makes high demands. The integration of electronic systems in cars will continue to increase in future, especially with the environmentally friendly hybrid system. The combination of internal combustion engine and electric motor is technologically very complex, and apart from the electric motors, generators and a special gear concept, it also requires intricate power electronics. As an alternative drive system to the combustion engine, the electric motors have a much higher power level (up to 100 kW) than other electrically driven motors, e.g. for opening windows. In hybrid vehicles, it all depends on the perfect symbiosis of electric motor and generator. There is a constant transfer of energy between these two units. For example, the power electronics help by transforming the electrical energy to the right voltage and frequency for the electric motor.

“Heraeus is already producing important materials and components for the power electronics in hybrid drive systems,” explains graduate engineer Anton Miric, Head of the Automotive Team at W. C. Heraeus. “This includes joining elements such as bonding wires made from aluminum, coated stamped parts and solder pastes containing metal powders. These are required for mounting semiconductor chips on circuit supports.” Joining elements of this kind are used by various automobile suppliers in power modules for hybrid systems. Semiconductors chips in these modules are connected to the outside world by a solder paste or with bonding wire. But today’s joining technology is increasingly coming up against physical power limits with hybrid systems.

The fine aluminum bonding wires can only transmit limited amounts of power. In future, therefore, broader bonding ribbons made from aluminum will be used alongside wires. In developing these innovative metal ribbons, Heraeus profited from their experience in another field. “We had already been through the development of thin wires into ribbons that can transmit more power years ago, for the power electronics in electric motors for electric locomotives and industrial motors. This know-how is helping us now with the modern hybrid systems,” explains Anton Miric. The metal ribbons were developed in close cooperation with automobile suppliers and bonding device manufacturers.

In specially equipped laboratories for quality control and materials testing, the strength and stability behavior of the ribbons is tested on various substrates. This was also done with DCB substrates, the direct copper bonded substrates (an Al2O3 ceramic), which are amongst the most frequently used substrate materials in power electronics. In contrast to chips in PC’s, the silicon chips here are not enclosed and mounted on the substrate. The substrates, under high voltage and currents, are exposed to loads such as high ambient temperatures and vibrations.

In addition to this evolutionary step, Heraeus has also developed new solder pastes for power electronics, with which the unpackaged chips can be assembled without the previously problematic resin and flux residues. Conventionally, a solder powder (e.g. containing tin) is mixed with a flux (carrier material containing resin) to form a solder paste. After the assembly process is completed, a resinous residue typically remains. With a new resin-free solder paste, Heraeus has succeeded in reducing the flux residue from 3% to two percent by volume. Contamination of the chips with flux residues has thus been significantly reduced. These residues lead to faults on the surface of the chip. Furthermore, the contamination of the soldering furnaces with past components is minimized.

In any case, one thing is certain: however the hybrid vehicle market develops in the future, Heraeus and their innovative products will be in the starting pits. JW
Laughing gas is more than just a former fun-fair curiosity or an anesthetic, it is also a “climate killer” that must be taken seriously. In the atmosphere it contributes to global warming over 300 times as badly as carbon dioxide. Heraeus employees, however, have developed a technique with which the biggest producers can drastically reduce their emissions of this greenhouse gas – at low costs.
The artistic platinum gauze is a high-tech catalyst. Not the only thing produced. Some nitrous oxide is always produced, too. Not much, but that little adds up. This cloud has a silver lining. However, the majority of these platinum gauzes, which ultimately ensure worldwide that even barren land can produce enough food for everyone, come from Heraeus. And have done for decades. And this is why the knowledge of how we can close the tap on nitrous oxide has practically developed simultaneously.

The precious metal kitchen
The process of manufacturing the platinum gauze is a science all of its own. Where to get the “yarn” from, for example? There is no material in the world strong enough to spin liquid platinum into threads like artificial silk. Therefore the fine wires have to be produced by multiple mechanical deformation. The conditions for this are created by Heraeus in the precious metals foundry. At first glance, this looks like a combination of a large kitchen, a laundry and a garage. A worker with dark protective goggles brings a block of platinum – weighed with milligram-precision using special scales – and places it carefully into a crucible about the size of a coffee tin. Sometimes a few crumbs or small cubes of other elements such as rhodium are added. Then a button is pressed and the block gradually turns red, orange, yellow, then incandescent yellow. At the melting temperature of 1,900°C, the inside of the furnace is so bright that it is no longer possible to look in with the naked eye.

Angels’ hair for the heat of hell
After the catalyst has been freshly mixed together at almost 2,000°C and the workers have cast it into handy cubes of around 12 kilograms each, it passes through a number of manually controlled rolling mills, which press and draw out the material over numerous workstations until it is finally coiled up on spools in the form of a millimeter-fine wire many thousands of meters long. And even then it progresses further. In the end, the wire is cut to practical lengths, and at a few hundreds of a millimeter it is even finer than a human hair. But it breaks much more easily, which makes the next stage difficult. In the process a particularly tricky business, arranging several thousand of these threads together to form a diaphanous fabric that would do well as any bridal veil, were it not made from one of the most expensive metals in the world. The threads, almost as fine as gossamer, are placed in the machine that will then produce the valuable gauze.

Installation of a multiphase catalyst.
And on the subject of veils, the gauze really was woven until not very long ago. Until it was discovered that it performs its job as a catalyst with a higher degree of efficiency if it is knitted in a certain cunning way, “crocheted” to a certain extent. “The difference is small but significant,” says production manager Günter Glaab. Because ammonia is expensive, a catalyst that performs just half a percent better than its predecessor leaves the fertilizer manufacturers hundreds of thousands of euros better off each year. A rewarding business!

What the optimal fabric looks like and what designs were discarded during the development process are secrets, however. The development was surely helped, though, by the fact that the father of one of the developers worked in the textile industry. And, of course, Heraeus know-how. Because here, too, the purer the wire, the more stable and effective it is.

Fine fabric for the reactor
Once the fresh gauze has been gathered up on rolls, where it looks like lengths of cloth in a curtain shop (one square meter of this fine mesh weighs just 600 grams, and many cloths are heavier) it is cut to size by hand and welded in many layers where necessary to form circular mats up to six meters in diameter, which are then installed in reactors all over the world. At relatively low cost, incidentally. Relative to the material value inherent in a primary catalyst, the processing costs for which Heraeus invoice their customers are low. Depending on the size of the plant, which can contain between two and 40 of these gauzes, it can quickly add up to millions of euros at the current precious metal prices. Which is why everything must run quickly to make a profit. Which is why everything must run quickly in Hanau (while taking great care, of course). Platinum lying around gains about as much in value as a suitcase of money under the bed.

But what about the laughing gas? This is another area where the curiosity of Heraeus’ people paid off. Because, when they were attempting to improve their gauzes, they did not rely solely on more effective knitting. They naturally also looked at the chemistry. And that is how they happened at some stage upon catalyst mixtures...
“The joke is over!”

for an N₂O catalyst, the chemists led by Dr. Rainer Kiemel that cause all the problems. To find the optimum recipe Sounds simple, but naturally it is always the little things Long search for the perfect catalyst

that ultimately produced less nitrous oxide. These were investigated further, and after some searching a number of precious metal combinations were found that were just dying to break this gas down into harmless constituents. Conveniently, these can also be less expensively produced. Instead of knitting these to form artistic gauges, it is sufficient to dissolve the necessary metals in the proper proportions, dip small alumina spheres into the solution and then dry them. The anti-nitrous oxide granules thus produced then merely have to be placed into flat, gas-permeable cassettes made of stainless steel wire and installed in the nitrous oxide reactors.

Long search for the perfect catalyst

Sounds simple, but naturally it is always the little things that cause all the problems. To find the optimum recipe for an N₂O catalyst, the chemists led by Dr. Rainer Kiemel (catalyst production) had to investigate around 50 different catalyst mixtures in detail, and examine countless supporting media carefully. Do they only break down nitrous oxide, or perhaps also the valuable raw material for fertilizer? Do they break down all of the N₂O or do they allow some molecules to escape because the oxide spheres cannot take up enough gas? And if the catalysts get good results, do they behave in the reactor the same way as in the test tube? And if so, how long do they keep working? After all, they have to withstand 900°C over a period of months. In order to test this, test reactors are needed, which most companies do not have in the cabinets of their laboratories.

And then the installation. Even if the idea of a nitrous oxide filter attachment seems fairly simple, there is not nearly enough space in every reactor, and indeed there are barely two alike. 160 or 1,600 tons of ammonia per day? Either is possible, both are common. Is the air hot enough so that no more nitrous oxide than necessary is produced in the first place? And how clean are the raw materials, anyway? After all, even tiny traces of oil introduced by an old pump system could bring the finest catalyst to its knees in no time via the circuitous channels of precious metal chemistry. “In every individual case, the expertise is called for that really only exists at Heraeus,” says Jantsch. “A large proportion of our time goes into the detailed adaptation of catalysts.”

Achieving much at little expense

Nevertheless, the secondary catalysts from Hanau have got what it takes. They consist of the same metals that are used in the reactors anyway, which solves the problems of contamination. And in the end up to 90 percent less nitrous oxide comes out than previously, while the yield of usable product remains as it was.

So the hard work paid off? “Absolutely. The subsequent nitrous oxide eliminators do not cost much, but stop a lot of N₂O. However, it will only be possible to earn money with this when the production of nitrous oxide generates costs due to legislation. Or when not entirely clean manufacturers have to buy their N₂O pollution rights, converted into CO₂ certificates, from more advanced ones.”

Or when an entire company resolves to do something for the environment and for their own good name. Some have already taken this step — for example the nitric acid manufacturer Sasol in South Africa. And things are already happening in the countries neighboring Germany. But regardless of how long it takes before all 600 join in, “The important thing is that someone is doing something. And because nitrous oxide is so much more harmful than carbon dioxide, and because the fertilizer market is so transparent, it is possible to achieve a great deal with little effort,” says Jantsch. Good cause, therefore, to stay optimistic. One thing is certain, the sun shines brighter without laughing gas. Stefan Albus
Zirconium oxide basic structures are milled from “whites”.

Many dental laboratories can conduct the entire process themselves, but the high investment costs for the complex milling machines represent a barrier. Providing the service centrally can save resources and time. Centralized industrial manufacturing is the most economical option, and the newest equipment and software updates are always available in the milling machine plant.

The process is simple: a patient requires a dental prosthesis, the dentist takes an impression, a dental laboratory produces a plaster prototype, uses a software program to create a virtual 3D design for the new tooth, and sends the data over the internet to a CAM milling center, where a basic tooth structure made of zirconium oxide is produced and sent back to the laboratory by mail, which then completes the dental prosthesis for the patient by applying a full ceramic coating. The advantages: individualized products can be manufactured at a consistent quality, and the tooth is produced on short notice, generally within 48 hours.

For this reason, the dental and medical product manufacturer Heraeus Kulzer decided to build a milling center with CAD/CAM technology and an integrated dental laboratory. The company’s traditional business with alloys of precious metals has meanwhile been supplemented by ceramics, such as zirconium dioxide, which has appropriate material properties such as hardness, tensile strength and toughness.

Complete service package for dental laboratories

CAD/CAM technology started making headway into the production of dental prostheses around five years ago. The innovation introduced by Heraeus Kulzer is the complete service package, with which the long-established dental specialist can strike a new, customer-oriented path as regards operating processes. “We have observed the market for a long time, and we know that this service really distinguishes us from the competition,” Dr. Achim Nikolaus, project manager for CAD/CAM at Heraeus Kulzer, describes the considerations that went into the launch of the new service. The company is relying on a very promising business model. “By means of a flexible partnership model, our customers can be included in the prospective success of the CAD/CAM system. We want to give dental laboratories the chance to get involved in this market.” The final preparations for the new CAD/CAM system for series production were undertaken by the dental manufacturer together with 120 dental laboratories. As part of a test, the partner laboratories sent their plaster models to the newly designed milling center in Hanau, where Heraeus scanned and modelled them. The dental specialist then created the basic structures out of zirconium dioxide. In the process, the production quality of the milled structures was additionally tested for fit, edging, and outer and inner surface quality. The system is to be extended even further.

“The already working on rapid prototyping processes in the CAD/CAM technology and testing the use of new materials,” says Nikolaus.

The milling of the zirconium oxide blank disks, referred to in the technical jargon as “whites”, is performed with state-of-the-art five-axis high speed milling machines. The starting material consists of “soft” ZrO2 blanks, from which the highly complex basic structure is milled. These temporary forms are then sintered and hardened in special furnaces at over 1,600°C, during which they lose around 20 percent of their volume. This shrinking process must be taken into account in the manufacturing of the tooth, which will later fit perfectly. “By means of a special manufacturing process, we create an excellent surface quality and are also able to produce very complex geometries,” explains Achim Nikolaus. The zirconium oxide structures, which are composed of up to seven parts, are then sent back to the laboratory for veneering.

The CAD/CAM department at Heraeus Kulzer can be compared to a small start-up company: “On the one hand, as an independent company within the company we are able to react with agility and flexibility, while on the other hand we profit from the vast technical resources of Heraeus,” Nikolaus describes the advantages. The CAD/CAM expert and his team are just beginning to exploit the potential of this exciting technology. “Our goal is to produce over 50,000 zirconium oxide structures annually.” Measured against the potential market of 14 million tooth units in Germany alone, this figure at first sounds vanishingly small. But the market is growing disproportionately. And with the latest technology and a complete process that has been well thought-out, Heraeus is leading the way into the future. JW

Want to know more?
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Heraeus
Dental laboratory
A life-saving anchor in the heart

Tailor-made electrodes make cardiac pacemakers multi-functional

Modern cardiac pacemakers are true technological wonders. Miniscule and covered with special coatings only a few microns thick, they are held firmly in the muscle of the heart like anchors. They not only give life-saving impulses if the heart goes out of rhythm, but also measure the reactions of the heart and optimize the stimulation automatically. This technology – built on components and expertise from Heraeus – can even help Parkinson’s patients.

The expertise at Heraeus for such pacemaker applications resides with the Medical Components Division. This is where the necessary sub-components such as stimulation electrodes and many other metallic components are developed and produced. Platinum, platinum alloys, titanium and tantalum are the materials that are indispensable for the stimulation electrode. This specific component transfers the impulses from the pacemaker to the heart muscle and is critical to a pacemaker’s performance. A modern pacemaker system will do more than deliver the necessary impulses as it will monitor the reactions of the heart to the delivered stimulation, and adapt its therapy to the individual physical stress situation of the patient.

Modern electrodes are multi-functional

The electrodes, just millimeters in size, are designed to fulfill multiple functions. They can stimulate, but also sense, feel and detect. For this purpose, the electrodes are coated with special materials. The coating process used by Heraeus is the PVD process (physical vapor deposition). Various thin coatings made from metals, metal alloys and ceramics can be produced with the help of this special technique. The precious metals platinum and indium, and titanium nitride, are particularly suitable for use as biocompatible coating materials. Due to their demanding, delicate and complex structures, all micro-precision parts set high requirements for the production process. These components are manufactured on computer-controlled lathes equipped with specially designed tooling, and further worked with the application of EDM machines and laser technology.

The coating fulfills an important function. Relative to an uncoated electrode, it considerably reduces the impedance at the interface between the electrode and the heart muscle. The specific properties of the coatings can be adjusted to the various customer requirements by means of the material used, by the form of the coating, and by the thickness of the layers,” explains Heiko Specht, Head of Research and Development at Medical Components. “In the development of new surface coatings, we are constantly investigating the effects of material, surface structure and layer thickness using special testing methods such as electrochemical impedance spectroscopy.” These investigations are important because understanding the kinetics of the interactions at the electrode-tissue interface, and the physical and chemical properties of the coatings, yields decisive advantages in the production of suitable tailor-made coatings.

From the heart to the brain

The development in this field is still ongoing. For example, stimulation in the brain and nervous system requires even smaller electrodes than heart stimulation. The aim is to use selective neurological stimulation for the improved treatment of neurological diseases such as Parkinson’s, and to prevent epileptic seizures. Deep brain stimulation is a successful method in the treatment of Parkinson’s patients. A brain pacemaker is implanted in the patient, which sends electrical impulses through fine wires to the affected region of the brain in order to suppress hyperactive misfiring impulses. In epilepsy, stimulation of the vagus nerve is a suitable therapy. The vagus nerve controls the activity of many internal organs and is one of the largest brain nerves. Depending on its settings, the electrical stimulator stimulates this nerve with electrical currents, at fixed intervals or, if an attack occurs, when activated by remote control.

Unlike in modern cardiac pacemakers, where the stimulation electrodes can also monitor and determine appropriate therapy to be delivered when a malfunction has occurred, neurostimulator systems are still in the initial stages of development. These neurological applications and their developments underway leave the developers at Heraeus with great opportunities for innovative product development and optimization.

Want to know more?

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period, and that nevertheless hardened quickly. In ad-
ddition, unlike dental materials, bone cement had to be
sterilized and impregnated with an X-ray contrast agent.
Heraeus Kulzer’s* expertise in manufacturing dental
materials and understanding of polymer methacrylates
led to a second, relatively fast-expanding copolymer that
achieved the viscosity required. In 1943, Kulzer® patented
the first cold-hardening bone cement. As with plexiglass,
poly(methyl methacrylate) (PMMA) is a major component
of the bone cement. In contrast to plexiglass production,
however, the PMMA polymerizes of its own accord and
hardens automatically during surgery.

In 1959, the highly viscous bone cement from Kulzer®
was finally introduced onto the market under the name
Palacos®. To this day it is successfully used in hip and
knee endoprosthetics. Numerous studies and indepen-
dent sources have confirmed its effectiveness. From long
term studies, for example, it can be demonstrated that
there is a comparatively low risk of revision for prosthetics
cemented with Palacos®. The risk of revision indicates the
probability that an endoprosthesis will have to be removed
or reset. Such long term studies are facilitated among
other things by the Swedish hip registry, a database in
which virtually all hip operations in Sweden and parts of
Scandinavia are documented.

Palacos® has been on the market for almost 50 years:
“This bone cement is distinguished by reliable, well docu-
dented mechanical properties,” says Dr. André Kobelt,
General Manager of Heraeus Kulzer and Director of the
Heraeus Medical division, founded in 2004. “There are
relatively few medical products and medicines which have
been observed and studied over such a long period of
time.” Thanks to this technique, it has also been pos-
sible – in situations where modern, optimized cementing
technology is used – to achieve long service lives of up to
25 years from the prostheses, according to the specialist.

Avoiding infections
Infection and the often associated prosthesis loosening can
necessitate the removal and replacement of prostheses.
In order to prevent such bacterial infections, antibacterial
agents have been added to bone cement since the end
of the 1960’s. As early as 1972, bone cement contain-
ing gentamicin was marketed under the name Refobacin®
Palacos®. The specialists reacted to the increasing variety
of bacteria and resistance to antibacterial agents with
additional products for infected revisions. Thus in addition
to Copal® (with the broadband antibiotics gentamicin and
clindamycin, which is effective against streptococcus),
The Palacos® family has continued to grow in recent years. In response to the demands of the medical profession, Heraeus now offers bone cements for various requirements. A cement for filling out and stabilizing vertebral bodies and marketed under the name Osteopal® is now available. Due to the addition of zirconium dioxide (ZrO₂), all of these bone cements display a good degree of impermeability to X-rays, and thus allow physicians to more easily perform postoperative follow-up and progress checks.

What is the significance of the characteristic green coloring of the Palacos® products? The coloring, produced by the addition of chlorophyll, is not merely a trademark. It is helpful for the surgeon, and also during processing, as it is immediately clear where the bone cement is. “Correct mixing and rapid processing at the right time require well-trained personnel,” emphasizes bone cement specialist Kobelt. The temperature of the prosthetic material and cement components, and the humidity level in the operating room, also play a role. The quality of the bone cement is therefore not the only factor in the durability of a cemented prosthesis: correct mixing of the components and modern cementing technology are also vital for lasting success.

A look to the future
Under the terms of the German Medicines Act of 1972, Heraeus was obliged to transfer the approval and marketing of Palacos® to other companies. The manufacturing rights to the product remained with Heraeus, however. Since 1998, bone cements have no longer been considered drugs under the Medicines Act. In 2004, the subsidiary Heraeus Medical was founded to facilitate direct marketing of the bone cements in Europe. Since then, the new company has built up its own direct sales in most EU countries. In the first quarter of 2007, Palacos® registered a market share of 50 percent in Europe, and about 20 percent in the USA. Heraeus Medical entered the Asian market in 2007. “We are working with distributors in Malaysia, Thailand, Indonesia, Singapore, the Philippines and New Zealand, and we initiated direct sales in Australia in July,” says Kobelt. “A whole series of product innovations are currently in the introductory phase.”

Heraeus is also planning innovative products for other branches of orthopedic surgery. Physicians frequently choose to perform endoprosthetics without cement, especially for younger patients, whose stable bone structure enables the prosthesis to grow in well. The titanium prostheses used in such cases have to be implanted without bone cement, as the cement would rub off the oxide layer of the titanium like sandpaper, which in turn would result in complications. The risk of infection can therefore not be reduced here by antibiotics contained in bone cements: “For titanium prosthetics, we have developed a special coating containing antibiotic agents: a gentamicin palmitate is used, which forms a waxy coating and releases the agent very well,” Kobelt describes the promising innovation. With this development, Heraeus is opening up new opportunities in the cement-free endoprosthesis market. Barbara Schick

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**Comparison of Endoprosthetics**

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<thead>
<tr>
<th>Cement free method</th>
<th>Cemented method</th>
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<tbody>
<tr>
<td>Requires stable bone material</td>
<td>Also suitable for porous bone material</td>
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<tr>
<td>Requires lengthy recuperation after the operation</td>
<td>Rapid mobility</td>
</tr>
<tr>
<td>Expensive titanium prosthetic shaft</td>
<td>Shaft made from cheap steel alloy</td>
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<tr>
<td>-</td>
<td>Bone cements containing antibiotics prevent infection</td>
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<tr>
<td>-</td>
<td>Bone cement stabilizes bone material close to the prosthesis</td>
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<tr>
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<td>Bone cement has elastic and cushioning effects</td>
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Want to know more?
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I’m feeling good again!
The development departments of this Heraeus business segment, with its headquarters in Houthalen, Belgium, design a wide range of custom sensors for use in direct contact with molten steel, combining them with traditional measuring methods. An on-site report.

At the entrance to Heraeus Electro-Nite’s Belgian site at Houthalen, visitors are welcomed by a knight in armor and carrying a lance – the symbol of the division’s main products: lances and immersion sensors for the steel industry. Heraeus Electro-Nite has been operating as a market leader for many years in the steel industry, as well as in the foundry and primary aluminum industries. The site’s rather discrete production facilities are the setting for the development of innovative sensors and measurement systems. Every aspect of the production process, some of which is fully automated, is carried out in one place: quality assurance, the ceramics laboratory, the oxygen center, and the most advanced facilities for testing sensor functions. There is ample space for engineers to develop new projects in an open-minded atmosphere.

Some of the workplaces are reminiscent of a Do-It-Yourself workshop, while others boast cutting-edge 3-D technology to fine-tune sensor design. As a rule, each developer works on a specific sensor project, but they all benefit from their colleagues’ expertise as well. Chemists, physicists and electrical engineers mingle with metallurgists and materials engineers. More than mere specialists, sensor developers must be capable of rolling up their sleeves and engaging in hands-on work, while also being familiar with electrochemical functions such as the Nernst equation. Above all, they need expert knowledge of the most important material used by their customers: steel.

Francis Dams, Head of R&D at Heraeus Electro-Nite, summarizes the division’s core competencies as follows: “As an international supplier and expert in the field, we have a good grasp of how best to measure and monitor the melting process to streamline steel production. Our customers benefit from our experience and knowledge.” Particularly advantageous are the modular design of Heraeus’s sensors and the use of standard modules that can be combined in a variety of ways. Traditional temperature sensors are made of quartz glass tubes and platinum wire. With the help of a rigid roll of cardboard, the complete sensor head – which often contains an electrochemical measuring cell – is lengthened to form a lance. This makes it easier to immerse the sensor in molten steel.

Heraeus has found it to be particularly advantageous to have their own small steel furnace on site to test the performance of their temperature sensors. “The integrated steel furnace offers us a market advantage, since we can test our sensors under actual conditions and with a variety of types of steel,” Dams points out. The only method that is more realistic is testing in an actual steel plant, and here, too, Heraeus makes good use of its excellent customer relationships. The steel company Corus, for example, located in IJmuiden near Amsterdam, allows Heraeus to test their newly developed sensors there during the production process.

Each year more than 30 million sensors leave Houthalen, most of them disposable. They only need to operate for a few seconds in order to serve their purpose. Among the classic examples are Positherm®, which measures molten metal temperatures of up to 1,750°C in a matter of seconds, and Celox®, which measures the smallest amounts...
Strong as steel

Innovation Award and eventually took three first prizes and mining the slag thickness on steel. All of these products invented the Celox® Hot Metal Probe, a sensor for measuring results,” Francis Dams is happy to note. They have our developers take in creating something new is showing products for use in molten metals. The obvious pleasure of oxygen in molten steel just as quickly. But in the past and a sensor for measuring temperatures throughout the continuous casting process (CasTemp®). Most recently they developed Delta-Dist®, a “smart” sensor for determining the aluminum content in galvanization lines, and a sensor for measuring temperatures throughout the division’s excellent cooperation with steel manufacturers. Determining the sulfur content of hot metal in seconds

As the blast furnace iron ore is refined, the molten mass first undergoes desulfurization. This is necessary because excessive concentrations of sulfur can cause steel to become brittle. The sulfur concentration must be measured both before and after desulfurization. The faster this measurement is carried out, the less delay and interference with subsequent processing and refinement during the production process. A sulfur sensor can determine the sulfur content within a few seconds on the spot, using an electrochemical measurement process, and eliminating the need for an off-site chemical analysis or for spectroscopic methods. This has several advantages for steel production. Instant measurement following desulfurization reveals immediately whether treatment of the molten mass has been successful and the desired sulfur concentration has been achieved. The Celox® Hot Metal Probe sensors are used at temperature levels of 1,250°C and 1,450°C. They are capable, when directly immersed in molten steel, of identifying sulfur concentrations of between 5 ppm and 1000 ppm within 20 seconds. “In developing the sulfur sensor, we were able to take advantage of our expertise and experience with the oxygen sensor Celox®,” observes Johan Knevels, whose company produces over seven million metric tons of steel each year. Corus is one of the largest steel manufacturers in the world, producing worldwide around 19 million tons and nearly 400 different types of steel. “For years we have been using various Heraeus lances and sensors for quality assurance and for measuring the temperature and oxygen content of molten steel,” notes Hans ter Voort, the company’s Converter Process Manager. Corus benefits from the time, cost and production advantages of measuring the temperature and oxygen content of molten steel directly, without first having to go through the time-consuming process of taking a sample and having it analyzed in an off-site laboratory.

Despite high-tech developments, steel remains the most important material of our age.
it measures a difference in potential between the molten mass and the measuring cell, depending on the respective sulfur content. Sulfur reacts with certain components of the supplementary electrode, which results in oxygen developing on the surface coating of the electrode; the electrochemical measuring cell that is integrated into the sensor head can then determine the oxygen’s electrochemical potential.

“Smart sensor” sets new standards for steel production

Following desulfurization, the hot metal is mixed with steel scrap and blasted with oxygen. Hot metal is converted to steel in enormous converters. Multifunctional Multi-Lance® Sublance sensors monitor temperature and measure oxygen content. The converter itself weighs 500 metric tons; it is then filled with over 300 tons of molten steel. The finished steel is poured into huge ladles by the converter, after which it is conveyed to the next purification process. This is where the smart sensor recently developed by Johan Knevels comes in. To optimize productivity in a safe way, it is important that the ladle is filled to the optimum level. A certain amount of space between the rim of the ladle and the surface of the steel must remain available for the next step. Complicating matters is that slag is carried along when the steel is cast, which makes a visual assessment of the filling level more difficult. The new sensor solves this problem.

“This disposable, lance-shaped sensor is mechanically inserted through the slag layer at high speed until it reaches the surface of the steel,” explains Johan Knevels. An electromagnetic measuring process allows the sensor to measure the distance to the slag surface. The measuring signal changes abruptly as soon as the sensor head comes in contact with the steel layer. Using these two signals, the distance between the steel surface and the rim of the ladle can be determined within two seconds. If the desired level has not been reached, more steel can be added automatically to the respective ladle during the next filling process. This increases productivity by up to an additional five metric tons of steel per tundish, saving time and expense. Following secondary refinement – during which the temperature is repeatedly monitored using Positherm® sensors – the steel is finally cast into meter-long slabs for further processing.

When the most advanced production method, continuous casting, is used, it is vital to maintain a precise temperature of about 1,550°C during the critical step of casting the molten steel. Shortly before that step, the CasTemp® sensor comes into play. This is a new market segment for Heraeus, as this sensor measures temperature over a longer period of time – several hours rather than a few seconds. With the sensor measurement system, the temperature of the molten steel can be determined directly and continuously at the spot where it really matters. “This makes it possible for us to respond immediately if the temperature drops below a critical level,” says Hans ter Voert. For the steel industry, the advantages of continuous methods include greater process assurance, improved steel quality, energy cost savings and less waste resulting from steel that has cooled prematurely.

This product has also been developed in close cooperation with the customer and represents an important trend in sensor production. These days, customers demand instant measurements, yet also require sensors that can provide continuous, long-term measurement. Equally sought-after are more sophisticated multifunctional sensors that can measure several steel parameters, such as temperature and chemical composition, in one step, while simultaneously taking a sample of the steel for quality control purposes. Given the Belgian developer’s zest for innovation, these products will surely be made available to the steel industry soon.

Want to know more?

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Sputtered, not stirred

A new process increases ten-fold the capacity of magnetic data storage media

Today, computer hard drives and magnetic data storage media need to be able to store unbelievable quantities of data. A 3½” hard drive can now accommodate up to 500 GB, but before long it will be possible to achieve storage capacities in the terabyte range. Specialized metal alloys, applied in very thin layers to the data storage medium using sputtering targets, are the key to this technology. The composition and structure of the coating materials, which are made up of a variety of metals, determine storage capacity.

Heraeus is the world’s leading manufacturer of these specialized disk-shaped targets, offering more than 1,600 different alloys. The company produces these essential materials for the electronics industry at its modern production facilities in Chandler, Arizona, USA. It is widely recognized that most storage disks in fixed disk drives are now coated with thin film materials manufactured by Heraeus. Over 400 employees and numerous developers are constantly creating new target alloys at the Chandler site. There is substantial growth in this sector, not only because of computer hard drives, but in particular owing to micro hard drives, which are being used more and more frequently in game consoles, DVD players and digital cameras.

But what are sputtering targets? Although few people are familiar with the term, we all benefit from the use of sputtering targets in the manufacture of countless modern products.

Targets are plates, disks or tubes made of metal, alloys or ceramics. With their help a thin coating, often measurable only in nanometers, is applied to a base material using a technologically sophisticated process. Depending on the composition of the targets, this coating can serve a wide variety of purposes, for example as a coating for magnetic data storage media or to coat large surfaces of architectural glass, for the metalization process in the field of microelectronics, to produce thin-film solar modules, or to coat flat screens.

Sputtering technology is a key technique for thin film production. During the sputtering process, the targets are sprayed with the inert gas argon in a vacuum chamber under electric current. The energy-rich gas particles displace individual metal atoms from the surface of the target, which are then deposited in a very thin metal layer on the material to be coated.

Shift from a longitudinal to a vertical storage process

For some 30 years, magnetic data storage media have been the most important mass storage devices in the computer industry. Until 1990, the data storage layers contained only a magnetic layer measuring about 20 nanometers and made up of cobalt, nickel and chromium. The precious metal platinum was subsequently added to that layer to provide for higher magnetic moments and make the magnetic storage layer more stable. In the case of the most modern generations of longitudinal storage - where the magnetic bits are arranged horizontally to the media surface – there are up to eight different layers, one on top of the other. These now include a nanometer-thin separating layer consisting of the very rare precious metal ruthenium. However, longitudinal storage is subject to physical limitations; this process allows for no more than 500 GB to be stored on a 3½” hard drive. With this method, the storage elements cannot be packed more densely without risking a loss of data as a result of magnetic instability. However, an innovative recording process will make a substantial increase in capacity possible in the future.

“Intensive development work continues to be essential, since in the area of magnetic data storage the shift from a longitudinal to a vertical process represents a major technological challenge,” observes Michael Racine, Applications Group Manager of the Thin Film Materials Division in Chandler. With this recording technique, known as perpendicular recording, the storage capacity can be increased by a factor of ten by means of a vertical arrangement of storage units (in other words, with the magnetic alignment perpendicular to the media surface). We can expect 3½” hard drives to have a storage capacity of more than 2,200 GB or 2 terabytes as early as 2010. Moreover, the much greater data density will also mean increased reading and writing speed, since the reading head will process more data during each rotation. The new hard drives contain up to 16 layers, one on top of the other, which are arranged in a highly complex fashion. The new process requires new alloy combinations and much more complex target materials.

The developers at the Chandler site have responded to this challenge: “We have developed a new manufacturing process for alloys made of cobalt, platinum, chromium and ceramic components with a special microcrystalline structure and a specific magnetic orientation. These new sputtering targets are the first to make it possible for the hard drive industry to reliably manufacture a new generation of storage media with five to ten times the existing storage density,” explains Michael Racine. It is also thanks to this innovation that magnetic data storage media will continue to be one of the media of choice for storing large quantities of data.

Maximum storage capacity of a 3½” hard disk (in gigabytes).
The invention of the light bulb is attributed to Thomas Alva Edison. He succeeded in developing the incandescent lamp 130 years ago. “How can we ensure that every emitter has the same power? Edison had this problem, too. That’s what makes it so exciting! We can still learn a lot from his experiences and the notes he made back then,” notes Dr. Sven Linow, lamp developer at Heraeus Noblelight. “How do I prevent the bulb from blackening? How do I increase the service life of the emitters? These are the questions that drive us forward.”

The challenges during the development of the new generation of CIR emitters are almost identical to those faced by the developer of the incandescent lamp 130 years ago. “How can we ensure that every emitter has the same power? Edison had this problem, too. That’s what makes it so exciting! We can still learn a lot from his experiences and the notes he made back then,” notes Dr. Sven Linow, lamp developer at Heraeus Noblelight. “How do I prevent the bulb from blackening? How do I increase the service life of the emitters? These are the questions that drive us forward.”

While the age of the carbon incandescent lamp ended some 100 years ago, the use of CIR technology in industry has been increasing since the middle of the 1990’s. In 1993, Heraeus developed a new form of the lamp. It no longer bears much resemblance to the original light bulb shape. Instead, the infrared emitters are now tailored to the individual requirements of the user. This innovation is the straight, slim shape, the CIR emitters are typically 60 to 150 centimeters long. For special applications, however, the CIR emitters can reach lengths of up to three meters.

In principle, the components of a CIR emitter are fairly basic: you take a carbon filament, encase it in a protective sleeve of temperature-resistant and infrared-transparent quartz glass, attach electrical contacts, and you have heat available at the temperature of over 1,300°C and its heat is available immediately and with pinpoint accuracy, at the push of a button and precisely where it is required. CIR emitters are extremely good for drying water, and users can save electricity relative to conventional drying processes that use heating furnaces, since furnaces always have to be preheated in order to maintain a certain temperature. Carbon has also proven to be the best material for heating glass. For this reason, CIR emitters are also used for the display sector and in the photovoltaic industry for the manufacture of solar cells.

The advantages of CIR emitters can be readily demonstrated in industrial manufacturing processes: the medium-wave emitters combine high capacity and speed. The filament reaches temperatures of over 1,300°C and the heat is available immediately and with pinpoint accuracy, at the push of a button and precisely where it is required. CIR emitters are extremely good for drying water, and users can save electricity relative to conventional drying processes that use heating furnaces, since furnaces always have to be preheated in order to maintain a certain temperature. Carbon has also proven to be the best material for heating glass. For this reason, CIR emitters are also used for the display sector and in the photovoltaic industry for the manufacture of solar cells.

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In principle, the components of a CIR emitter are fairly basic: you take a carbon filament, encase it in a protective sleeve of temperature-resistant and infrared-transparent quartz glass, attach electrical contacts, and you have heat available at the push of a button. It sounds simple, but it is not. The decisive factor is an understanding of the chemistry of the carbon filament, and hence light source, glows in the protection of a vacuum without burning through too quickly. However, the carbon filaments used by Edison, which were actually strips of carbonized bamboo, were not ideal in this role – they produced more heat than light. Modern carbon infrared emitters (CIR) from Heraeus take advantage of this effect by using Edison’s idea of the carbon filament lamp for its true purpose: as an ideal heat source for industrial processes.

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The chances of a renaissance for carbon emitters look pretty good. It is even possible to grill food with these specialty lighting sources. Not in the sense of a barbecue, however, but in the form of a true production line, for example for roasting and heating meat products on a conveyor belt. At 50%, the process efficiency with which the emitter transforms electrical power in the substrate or process into usable heat, is up to four times higher than that of a halogen lamp. Those are cheap mass-produced goods, but CIR emitters are not off-the-peg products – each is adapted very specifically to the customer’s requirements. In any case, you certainly will not find them at your local hardware store. JW

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Where bamboo strips once glimmered, today high-tech materials shine.

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Where bamboo strips once glimmered, today high-tech materials shine.
Pure quartz glass (or better synthetic fused silica) consists exclusively of silicon and oxygen (SiO₂). Superficially, it can barely be distinguished from ordinary glass; however it has significantly different characteristics, such as resistance to chemicals, temperature and radiation, and optical transmission.

“Quartz glass is one of the purest technical materials used in industry today. Even the slightest contamination can lead to major process faults in the applications or even cause total failure,” says Dr. Ralf Takke, Vice President of the Optics Division at Heraeus Quarzglas. This business segment is one of the few specialists to master all aspects of this extraordinary material and produce it using all common processes in quality grades that are globally unique. With over 5,000 standard products for the semiconductor sector, the quartz glass specialist is amongst the leading technology companies in the application, product engineering, repair, measurement, cleaning and recycling of quartz glass.

This expertise is also required in semiconductor manufacturing, especially in the field of microlithography. In microlithography various photomasks are used to project the structures of highly-complex integrated circuits, as small as 45 nanometers (a nanometer is one millionth of a millimeter) onto silicon wafers. Lens systems made from bubble-free, optically homogeneous quartz glass reproduce the tiny chip structures. “But to a certain extent that is already standard. Quartz glass will also play a fundamental role in the next evolutionary stage of microlithography, immersion lithography,” quartz glass expert Takke is confident.

Long term partnership promotes and demands an innovative approach
Since 1989, Heraeus Quarzglas has been supplying the optics company Carl Zeiss SMT with high quality blanks of quartz glass, which are used for microlithography in the optics for excimer laser steppers used in industrial chip manufacturing. Carl Zeiss SMT manufactures state-of-the-art optical systems for the lithography industry. The complex lens systems up to a meter tall are the core component of wafer scanners, special production systems that are essential for manufacturing the microchips in electronic devices such as laptops, mobile phones and game consoles. The object lenses contain up to 100 kilograms of highest purity quartz glass with impurities in the sub-ppb range. Carl Zeiss SMT was even awarded the German economy’s “Innovation Prize” in 2006 for the

Quartz glass is one of the most remarkable materials in industry and research. Many high-tech applications owe their breakthrough to quartz glass, e.g. microchip manufacturing, data transfer using fiber optics, or state-of-the-art precision optics and laser technology. Strong partnerships help to make the high-tech product even more perfect.
Quartz Glass in Microlithography

In microlithography, various photomasks are used to project the small, highly-convoluted circuits only nanometers in size onto silicon wafers. Lens systems made of bubble-free, optically highly homogeneous quartz glass reproduce the tiny chip structures, and further reduce them by up to 4 times with sharp definition. Quartz glass also plays a fundamental role in the current evolutionary stage of microlithography, immersion lithography. Immersion lithography is a special process in microlithography. Heraeus has developed new types of synthetic quartz glass for this technology that are characterized by improved laser resistance, higher homogeneity and optimized stress induced birefringence, and are particularly suited for lithography applications in the range of 193 nanometers. The special feature of immersion technology is that a film of high-purity water is introduced between the optics and the wafer. This facilitates a higher optical resolution. As a consequence, even smaller structural widths (smaller than 45 nanome-
ters) can be produced than previously. It is therefore not without reason that the specialists are now talking about nanolithography.

Dr. Bruno Uebbing, Business Unit Manager of Microlithography at Heraeus Quarzglas for Carl Zeiss SMT, is certain that development and cooperation in the field of micro- lithography will continue to be significantly influenced in their success by new materials. The capacity of the optical materials to withstand the laser radiation used in the lithography process is an especially important factor. With increasingly homogeneous varieties of quartz glass, even finer structures can be produced on the microchips in the coming years, probably even below 30 nanome-
ters.**

**Withstand 200 billion laser pulses unharmed**

Heraeus responded to this challenge! “The exceptional optical character-
istics of our lens material, such as radiation resistance, have to remain practically unchanged for the entire service life required of a lens object-
er, generally more than 10 years,” says physicist Ralf Takke.

Another reason for the innovative developments in the field of micro lithography is the effective customer-supplier relationship, which has built up to a high level of trust between Heraeus Quarzglas and Carl Zeiss SMT AG. Amongst other aspects, the close cooperation was reinforced yet further in 2007. Heraeus is now an “Official Carl Zeiss SMT Supply Chain Partner”. The partnership agreement represents an impor-
tant milestone in the longstanding relationship between these two technology companies. The best of conditions under which to spend the coming years continuing to prove Moore’s Law together with Carl Zeiss. JJ

Dr. Bruno Uebbing, Business Unit Manager of Microlitho-
graphy at Heraeus Quarzglas for Carl Zeiss SMT, specifies a decisive requirement for the high-tech material. In its lifetime as lens material in stepper optics, for example, quartz glass has to withstand bombardment with over 200 billion laser pulses undamaged, and must display no more than the tiniest refractive index deviations or transmission losses.

**Quartz glass qualities, we therefore also develop chemical and physical methods for qualifying the characteristics, for example for measuring the stress induced birefringence,** says physicist Ralf Takke.

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Gold and aluminum finally united

In the development of new bonding wire, Heraeus relies on research cooperation

They are so fine as to be virtually invisible to the naked eye. Gold wires are the ideal connection (bond) between substrate and microchips, but they can only be processed at high temperatures. Industry requires, however, that these wires can be bonded at room temperature. So what is to be done? Heraeus has a solution ready.

Microchips would not function without product know-how and the bonding technology of Heraeus. Substrates with super-fine layers of precious metal contact alloys carry the microchips. Bonding wires mere microns in diameter and made of gold, aluminium or copper conductively connect semiconductor and substrate, and have become indispensable in the electronics industry. Electronic components are also mounted on printed circuit boards with solder paste, and with both conductive and non-conductive adhesives. As early as 1957, the first bonding wires made of gold were used for electrical connections to substrates. Back then only a few meters were used in the laboratory, but now the annual global production comes to around 140 tons of gold, or about 14.7 billion meters. Gold wire is thermally stable, homogenous, corrosion-resistant, has high tensile strength, and transports energy nearly without loss. The wire bonding to the semiconductor chip works like a sewing machine. At extremely high speed, up to 20 times per second, the fine wires are placed on the chip and immediately bonded. The number of wire bonds on a chip is determined by the function it is to serve. On a “smartcard”, six wires are enough, but for complex components such as DDR-RAM’s for a PC, up to a hundred wires have to be processed on an area of 112 mm².

Gold wires are getting thinner all the time

Heraeus is one of the global market leaders in the production and development of bonding wires, and with five manufacturing sites they are a supplier in the local vicinity of the customers worldwide. Heraeus has been present at the Incheon site in Korea since 1984. “Korea is now the third largest market in the world for the production of microchips. In some sectors, Korean companies are the leading developers of microelectronic components,” Dr. Nordholm Behrens, Director of the Contact Materials Division at W. C. Heraeus, describes the situation. Behrens himself spends a clear 30 percent of his working time in Asia, in order to hold top-level discussions with the customers, and to determine what requirements will be placed on the next generation of bonding materials.

One requirement is the constant miniaturization of the highly-integrated circuits in the microchip industry, which require ever thinner bonding wires with diameters smaller than 25 micrometres. The wires cannot afford to sacrifice any of their strength or conductivity, however. “In terms of physics, we are working pretty close to the technical limits with the bonding wire diameters. We can produce gold wires with diameters of 15 micrometres, with the appropriate tensile and tear strengths,” explains Dr. Tobias Müller, Head of the R&D department of the Bonding Wires business unit at W. C. Heraeus. By way of comparison, a fine hair from a human head has a diameter of 60 to 100 micrometres. Cooperation with local research partners therefore plays an increasingly important role. “In Korea we are working together with two local universities and two research institutes on the development of gold bonding wires. The coordination is conducted in close cooperation with the German R&D department,” says Müller.

Ultrasound bonding – a real challenge for gold wires

The semiconductor industry is also making high demands with regard to the development of new production techniques such as ultrasonic bonding. In this cold pressure welding process, pressure and ultrasonic vibrations are used to join materials together without the creation of a liquid phase. Aluminum wire especially can easily be processed in this way at room temperature, such that even temperature-sensitive components can be contacted. However, aluminum wire often cannot be used in highly-integrated systems with high reliability requirements, e.g. due to fatigue failure. Gold, in turn, is distinguished by these very characteristics, but it can only be bonded at temperatures between 150 and 200°C. Yet the demand of laboratory has been able to develop an aluminium-coated gold wire that unites these precise properties. “The gold wire is covered with a thin layer of aluminium, and this coating – though just nanometers thick – now allows the gold wire to be processed at room temperature for the first time,” explains Tobias Müller.

The new wire for optimized bonding processes is currently being used for special applications such as pressure sensors for controlling braking forces in automobiles. Applications in medical technology and in optical electronics are currently being investigated.

After almost 50 years of use in industry, even a classic like gold wire can still be reinvented as a reliable and stable connector for temperature-sensitive microelectronic components.

Want to know more?
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Compared to a human hair, a bonding wire is considerably thinner and yet has enormous tensile and tear strength.
Broadband — thin as a hair

Glass fibers open up new dimensions in information and communication

Although thin as a hair and fairly unimpressive, glass fibers, also known as fiber optics, have enormous capacities. They can transmit data at speeds of over a terabit per second. Downloading an entire movie in HD quality (HD = high definition) takes only 100 milliseconds – rather less time than it takes to blink.

Fiber optics thus ensure the rapid and secure transfer of vast quantities of data across continents and oceans. This capacity is in fact absolutely necessary, as the demand for broadband capacity via the internet is increasing constantly. Around 800 million kilometers of glass fiber had been laid worldwide by 2006. Conservatively, the estimated deployment rate is expected to exceed 130 million kilometers per year by 2010. Heraeus is amongst the global market leaders in the production of quartz glass for fiber optic data transmission. As early as 1975, their quartz glass specialists developed a technique for doping synthetic quartz glass with fluorine (Flussi®), which was used for manufacturing preforms for fiber optics. As an important partner of the telecommunications industry, the company develops and produces high-purity synthetic quartz glass tubes and hollow cylinders which are then used for the manufacture of high-performance glass fibers. With production sites in Bitterfeld, Germany, and Buford, USA, Heraeus supplies around a fifth of the global demand for high-purity quartz glass.

Glass made from gas

Synthetic quartz glass is created by the oxidation of silicon tetrachloride gas in a high-temperature oxyhydrogen flame. In this process, nanoparticles of quartz glass are created and deposited on a ceramic support tube. Over the course of many hours, this process creates a nanoporous high-purity body of quartz glass that is over three meters long and weighs a quarter of a ton. The body is then dried, vitrified to a transparent mass at 1,700°C, and machined into a geometrically precise cylinder with a drilled interior and an exactly ground exterior diameter. In order to meet these high purity requirements, the majority of the glass cylinder production process takes place under cleanroom conditions.

“Two major leitmotifs determine our practice here: the ‘evolution of purity’ and the ‘evolution of size,’” explains Jan Vydra, Director of the Division Fiber at Heraeus Quarzglas. “With synthetic quartz glass, we can reduce metallic impurities and trace moisture by many orders of magnitude compared to natural quartz glass.” The material has impurity levels in the sub-ppb range (parts per billion – i.e., one gram in 1,000 tons) and is one of the purest materials there is. Both the fiber strength and the distance that light can travel through the glass without signal regeneration are dependent on the purity of the glass.

Innovations ensure technological advancement

In addition to their purity, the quartz glass tubes or cylinders from which the glass fibers are drawn have continuously grown in dimensions (the “evolution of size”). An innovative manufacturing process for glass fibers thus allows considerably lower production costs for glass fiber manufacturers. Using the “online RIC” process (RIC stands for “rod-in-cylinder”), fiber optics can be manufactured from large quartz glass cylinders in a single step. The term “online” denotes that the core rods of the glass fiber manufacturers are placed directly into a precision-finished cylinder and then drawn into fibers in a single step. The new high-purity RIC quartz glass cylinders tailored to this new process are significantly larger than the tubes used previously. While the standard process allowed around 400 kilometers of fiber to be drawn from a single tube, the new process can produce over 6,000 kilometers of glass fiber at a time. Seven online RIC cylinders would be enough to draw a glass fiber that could stretch once around the Earth.

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“ OPC presents an immediately identifiable advantage over the competition,” explains Jan Vydra. “They can now produce glass fibers faster and cheaper, and reduce their production costs by up to 30 percent — and the internet user gets his information on screen even faster.”

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High-purity RIC quartz glass cylinder.

Quality characteristics: size and purity

A glass fiber for transmitting light consists of a core with a high refractive index that guides light and a cladding with a low refractive index. The light is reflected at the core to cladding interface, even if the fiber is bent, due to the process of total internal reflection. The core, just nine microns across and thinner than a hair, allows only one propagation speed and thus makes possible the uninterrupted and rapid transmission over long distances of information coded in densely packed light pulses. Size, precision processing, the highest purity, transparency, and homogeneity are quality characteristics for the performance of glass fibers.

Separation process – glass is made from gas.
Online RIC process.
XFEL and the Large Hadron Collider (LHC) are two projects that make the eyes of many top European researchers light up — and where materials competence from Heraeus is used. In June 2007, at the German Electron Synchrotron in Hamburg (Deutsches Elektronen-Synchrotron – DESY), the starting signal was given for the construction of the largest X-ray laser in Europe. The XFEL project – X-ray free-electron laser – should provide European researchers with previously unknown insights into the world of molecules and tiny structures. For the first time, it will be possible to observe chemical reactions in real time and understand them better. For the X-ray laser, high-tech material from Heraeus could also be used — high-purity niobium for producing the cavity resonators, the heart of the accelerator.

Cutting edge research I – Niobium and DESY

In the XFEL, electrons are accelerated to almost the speed of light, and then stimulated to emit high-intensity, extremely short flashes of X-ray laser radiation. The wavelength of this X-ray light is so short that even atomic details become discernible. Extremely high energy is needed to get the electrons moving in particle accelerators. In order to keep the energy requirement low, superconducting cavity resonators made from the special metal niobium are used, and operated at a fraction above absolute zero (minus 273°C). At this temperature, current flows through the components loss-free, without electrical resistance. In preparation for this cutting edge international research project, Heraeus is contributing its many years of experience in electron beam melting and processing of high-purity niobium. The technology group was already supplying CERN and DESY with semi-finished niobium products for cavity resonators in the 1980’s. The many years of cooperation and the technological competence of the business segment W. C. Heraeus, together with the researchers at DESY, have made it possible in recent years to consistently improve the quality and handling properties of the niobium for this type of application.

Professor Albrecht Wagner, Chairman of the Board of Directors at the DESY research institute, became convinced of the quality of the niobium production process for the elementary cavity resonators when he visited the electron beam melting facility in Hanau. While there, he considered the interaction of research institutes and industry.

"Cooperation between the fundamental research and partners in industry such as Heraeus is vital in projects of this magnitude, so that technological limits can be pushed back and insight into new worlds can be gained."

Researchers are exceptionally precise people. They want to penetrate to the tiniest detail, to unravel the last secrets of science. Their tools are becoming ever more gigantic and efficient. There was a time when a magnifying glass sufficed. Today, particle accelerators kilometers long are required to take a look back in time or to understand chemical reactions.

In electron beam melting, niobium is purified in a vacuum above 2,300°C.
Completely new insights with high-purity niobium

Niobium analysis: a case for experts
In electron beam melting, niobium is purified in a vacuum at over 2,500°C, and initially solidifies in the form of a cylinder with a diameter of around 300 millimeters. Plates are then produced from this in a multi-stage conversion process. Niobium expert Friedhold Schölz, Research & Development at W. C. Heraeus, sums up the challenge of working with the exceptional metal as follows, “Working with this metal requires a high level of expertise and manufacturing sophistication. One of the disturbing properties of niobium is its tendency to cold-weld itself to other metals during processing. Niobium reacts readily with atmospheric gases. Even reactions with the smallest quantities cause extremely negative effects.”

In particular, niobium reacts readily with oxygen wherever it gets the chance. Oxygen, in turn, has a harmful effect on the performance of the accelerator. Now, it is practically impossible to produce oxygen-free niobium. But with one of the largest and most modern melting plants and a special conditioning technique, it is possible to keep the oxygen content below 1 ppm (part per million). They are thus able to produce the purest niobium in the world on an industrial scale.

The constant quality and purity control have an important role in the manufacture of the cavity resonators. The smallest defect in the metal microstructure – if for example tiny scratches occur on the surface of the niobium plates, or if foreign material is included – could later lead to problems in generating X-ray light in the cavity resonators.

Even pure niobium is always also contaminated with the related metal tantalum – a further disruptive element, although it has also been possible here to reduce the degree of contamination to around 100 ppm.

Cavity resonators
High-tech in “caterpillar look”:
modern cavity resonators.

Parallel to the development of ever purer niobium, the analysis of the material has also been improved. “The analytical processes have to keep up with the development stages of niobium, and must generally be better in terms of the limits that can be demonstrated. International cooperation with other institutes and universities is a valuable aid here, especially as there are no niobium analysis devices available off-the-peg,” explains Friedhold Schölz. Together with the University of Gießen and DESY, Heraeus has developed a new measuring method (“Squid” technology: SQUID = Superconducting Quantum Interference Device), by means of which even the tiniest contamination or flaw in the metal lattice of niobium components can be quickly, reliably and non-destructively identified. The niobium component to be tested is moved back and forth under a tiny superconducting niobium ring, which acts as a sensor and is cooled to minus 270°C with liquid helium. Every minute flaw, every cluster of tantalum or oxygen deposit would later disrupt the superconductivity. These deviations can be measured and precisely localized on the component. Depending on the position and extent of the contamination, it is then decided on an individual basis whether the component can be used or will have to be reworked. Depending on the degree of resolution of the measurement, a niobium component a meter square can be completely scanned using Squid technology within 20 to at most 90 minutes.

Heraeus uses high energy physics research projects to continuously enhance products such as niobium, and to push on into new dimensions of quality and purity. The next objective after the polycrystalline niobium of the highest purity is thus to produce metal from the melt with a large central grain, and if possible even totally monocrystalline. That would certainly be the perfect material for cavity resonators. JW
Platinum goes multi-talented

Lupton became the head of a new department whose task was to breathe more life into new products with precious metals. First of all, that meant struggling to get to grips with the new ball game, iodium, for example: “A difficult metal with a life of its own. Very, very difficult to produce.” In a strange way, the elements to which Lupton, in his quieter minutes, assigns such personality seem to have been grateful for the constant attention. Bit by bit, they have given up their secrets. For instance, platinum and rhodium – the precious metal workhorses of one of the biggest global “consumers” of platinum – the glass industry. The reason is, “Above 1,100°C there are hardly any metal-mic materials that are resistant to both glass and air.” Non-metallic alternatives do not exist. Even hard ceramics would be leached out eventually by the glass, which shows similar chemical behavior. That not only means bidding farewell to original dimensions – flat-screen monitors, for example, can only be made by the use of platinum in the plants, otherwise they risk developing unsightly streaks. But can platinum be improved? Definitely, with what are known as “dispersion-hardened materials”. The glass industry has to rely not only on platinum, but also on highly resistant, long-lived materials. “It has long been known that the strength of metals such as nickel and platinum increases if finely distributed metal oxides are added to them,” says Lupton. This is no easy task, however. Metals and oxides often do not want to mix properly, and so they usually have to be compressed and sintered. Lupton was one of the first to try doing this a smarter way. The trick is to add metals such as zirconium, scandium, yttrium or cerium to the molten platinum, metals that dissolve well but are known to form oxides easily – and then simply to wait. “Oxygen gradually migrates into the metal. And the desired oxides practically form themselves. The resulting platinum materials resist application temperatures of up to 1,700°C,” emphasizes the metals connoisseur. The result is that the service life of glass industry tools made from platinum can be doubled at a stroke.

Teamwork is needed!

Lupton does not tire of emphasizing that he did not achieve these successes on his own. In his work he not only had a gifted team at his side – within the company the technology center of the Engineered Materials Division is in fact considered something of a “fast breeder reactor” for exceptional talents, who soon carry their knowledge on to other divisions – but also an address book that includes, amongst other contacts, the Jena University of Applied Sciences: Palpable glass expertise on the old site of the Zeiss corporation – “A great facility!”

What is important here for Heraeus is much more than just the measuring facilities: it is the mutual inspiration during the joint work. The dispersion-hardened materials without Jena these would not have been possible. Ultra-temperature-resistant iodium materials for growing laser crystals – researchers from the Jena University of Applied Sciences were involved here, too. “Academics simply have a different perspective,” says Lupton. “It is becoming increasingly important for us. As is the good connection to the students there, of course. The universities we work with are an important source of personnel for us.”

Practically oriented researches, research positions paid for by industry, precious metals from Hanau – cooperation with the University is always a liaison from which both sides profit. And not least of all, David Lupton himself contributes to the exchange of knowledge at the Jena University of Applied Sciences in his capacity as a visiting professor, by lecturing in metallurgy and high-temperature materials.

And what dreams are left for this man’s curiosity? Are there any metals that he still wants to get to know? “Oh, I’ve actually had pretty much all of them in my hands already at some stage,” says Lupton. “And platinum has still stayed my favorite.” We can look forward to seeing what comes out of Lupton’s forge next. Stefan Albus
Not many companies have as much experience and expertise in dealing with high temperatures and challenging materials as Heraeus. Two pioneering achievements symbolize the company’s success: the founder of the company, Wilhelm Carl Heraeus, first melted platinum in kilogram quantities using a ground-breaking procedure (oxyhydrogen burners) in 1856. It has since been possible to use the precious metal industrially. And in 1899, chief developer Richard Küch created a material of the highest purity by melting rock crystal – quartz glass.

Leap into the modern age: today Heraeus holds more than 4,300 patents, spends more than 60 million euros a year on research and development, and over 350 R&D employees at 25 development centers ensure fresh innovations. The importance of innovations for the company can be seen from the key figure termed the “innovation rate”, which is around 22 percent. The innovation rate is the proportion of product turnover achieved with products that are less than three years old.

Where do all the innovations come from?

“Innovations are a vital pillar of our growth strategy. They are less than three years old.

The cooperation agreement with the top Chinese university represents an important milestone in establishing long-term contacts between Asian universities and research institutes and Heraeus development departments in Asia, the USA and Europe.

“Our aim is to make even better use of the global innovation potential. Local innovation centers and research cooperation will help us to develop new ideas and enable us to better fulfill the country-specific requirements of our customers,” explains Dr. Frank Heinrich, Vice Chairman of the Board of Management at Heraeus Holding GmbH. In order to encourage innovation potential in the widely diverse research sector, “Innovations are a vital pillar of our growth strategy. They are less than three years old.

The transition from college to the development department was a seamless process, as I already knew Heraeus well from numerous visits. The working climate is stimulating and one is given a lot of latitude to implement new ideas,” enthuses Vorberg. “Of course, there ultimately has to be an economic advantage in it for the company, which is perhaps the biggest difference compared to fundamental research at university.”

The early contact during his student years benefited both sides. Stefan Vorberg works for a technology company that gives him the freedom he needs for research; and Heraeus has gained a young employee who demonstrably possesses a high degree of scientific and technical potential, which with the current shortage of qualified engineers is not always simple these days.

At 28 years old, Stefan Vorberg has already had his doctorate for two years and is now scientifically involved with the element that has fascinated him for years: platinum.

In 2008, Stefan Vorberg started working at the University of Jena as a research assistant and at the University of Bayreuth as a student assistant. The cooperation agreement with the top Chinese university represents an important milestone in establishing long-term contacts between Asian universities and research institutes and Heraeus development departments in Asia, the USA and Europe.

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Microstructure of platinum catalyst gauzes (scanning electron microscope photograph).

Want to know more?

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Young careers at Heraeus:

In the Technology Center of the Engineered Materials Division of W. C. Heraeus in Hanau, in his capacity as development project manager, Dr. Vorberg is investigating catalyzed gauzes made from platinum–molybdenum alloys, working on new compositions and designs for even more efficient gauzes, and investigating the mechanical properties of dispersion-hardened platinum for the glass industry.

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Curiosity as a driving force

An investigative spirit and interdisciplinary thinking produce innovations

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Young careers at Heraeus:
Heraeus Innovation Award celebrates fifth birthday

Prize-winning products open up new markets and generate new technologies

When Heraeus first awarded the Innovation Award to innovative developers in 2003, the festivities took place on a very small scale. For the awards ceremony in 2007 – the fifth time the Innovation Award has been awarded – over 120 guests were invited and the winners were announced in a ceremony worthy of the Oscars.
Heraeus Innovation Award celebrates fifth birthday

A quartz glass microphotoreactor for economically manufacturing high yields of the active ingredients used in chemotherapy drugs (such as irinotecan) through a photolytic reaction; a new generation of durable synthetic quartz glass for micro lithography lens systems used in manufacturing microchips; and an amazing combination of flux and ultra-fine-pitch solder powders for precision soldering of state-of-the-art electronic components – these are the prize-winning developments that were considered worthy of recognition in 2007. The first award, including a prize of 2,500 euros, went to Silvia Werner from the business segment W. C. Heraeus. The second prize was won by Dr. Stephan Thomas, Heraeus Quarzglas, for the development of Suprasil® 501. And Paul Niemczura, likewise from W. C. Heraeus, took third place with the special flux. With 37 submissions, the internal competition reached a new record for the number of participants. “With this award, we want to make the often hidden innovations in the company visible, and simultaneously recognize and honor the achievements and talents of the researchers and developers,” says Dr. Frank Heinricht, Vice Chairman of the Board of Management at Heraeus Holding GmbH. All Heraeus researchers and developers around the world may participate. “The jury selects winners based on four clearly defined criteria,” explains Dr. Wulf Brämer, Head of Innovation Management at Heraeus. “The degree of innovation the development represents, the advantages for the customer and for Heraeus, and the presentation of the innovation are all analyzed equally critically.” In this fifth year of the award, the members of the external jury included Professor Detlef Lühe (University of Karlsruhe, Institute for Materials Sciences), Professor Erd Möller (Fraunhofer Institute for Silicon Research, Würzburg) and Professor Arndt Simon (Max Planck Institute for Solid State Research, Stuttgart).

Innovation Award writes success stories

In addition to the introduction of “Technology Days” where the Heraeus developers can exchange ideas, and the construction of external and internal knowledge networks, the Innovation Award is an important tile in the mosaic of a culture of innovation. This culture further encourages the (already very high) innovation and development potential within the company yet more intensively, and generates platforms for exceptional performance. “Innovations are a vital pillar of our growth strategy. They open up new market segments and generate new technologies for our company. These are precisely the aims that the current and previous Innovation Award winners have achieved,” emphasizes Frank Heinricht.

New quartz glass microphotoreactor manufactures high yields of active ingredients for chemotherapy drugs

Heraeus ranks as a global leader in the manufacture of platinum-based agents for cancer treatment. In recent years, the company has also expanded its portfolio to include purely organic agents, because the expiration of patents for many of these compounds opens a promising market for generics. Among these agents is irinotecan, manufactured from a plant constituent. In 2005, Silvia Werner, a researcher for W. C. Heraeus GmbH (Pharma business unit), developed a new production method for this valuable substance. Using a coated quartz glass microphotoreactor and ultraviolet lamps, her team obtained high yields of irinotecan from a reaction solution through photolysis. Unlike existing photolytic reactors, the system developed by Heraeus permits continuous synthesis; it also conserves space and reduces costs, because it uses concentrated reaction solutions and therefore requires less solvent.

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Dr. Stephan Thomas, Heraeus Quarzglas, for the development of Suprasil® 501 (2nd place)

Suprasil® 501 – Durable quartz glass for micro lithography

In micro lithography, where various photo masks are used to project highly complex integrated circuits onto silicon wafers, lens systems made of bubble-free optically highly homogeneous quartz glass reproduce chip structures with structural widths smaller than 45 nanometers (a nanometer equals one-millionth of a millimeter). The storage density and performance of microchips doubles every two to three years. New generations of lenses that can project finer and finer structures are required all the time. Fused silica must keep up with this development. With Suprasil 501, Dr. Stephan Thomas and his Heraeus Quarzglas GmbH team have developed an especially durable generation of quartz glass. In its lifetime as a wafer in stepper optics, for example, fused silica must withstand more than 200 billion laser pulses while exhibiting almost no deviations in the refraction index or transmission losses. Suprasil 501 meets these specifications. The reason is that hydrogen molecules present in the glass can repair laser-induced defect centers that would otherwise degrade its outstanding optical properties.

Paul Niemczura, likewise from W. C. Heraeus, took third place with the special flux.

Flux eliminates rolling away of solder spheres on printed circuit boards

An innovative flux developed by Paul Niemczura and the W. C. Heraeus research team has resolved a vexing problem related to the assembly of state-of-the-art electronic components and the semiconductor industry. The complex circuit boards used in automotive electronics or high-definition television (HDTV), for example, contain of many tiny components that are soldered to the appropriate tracks with spheres of tin to form an electrical connection. During the soldering process, a certain number of the spheres ordinarily roll off the substrate, creating defects that can later cause the component to malfunction. In the Heraeus innovation, a specific quantity of ultra-fine-pitch solder powder is added to a specially developed flux. This innovative mixture holds the solder paste spheres securely in place during the soldering process.
Highlights from 5 years of the Innovation Award

Innovative sensors for the steel industry

The developments of Heraeus Electro-Nite have already won first place three times and second place once (picture above, from left): Martin Heinricht (2003, continuously monitoring CooHeX® Sensor), Victor Kassulis (2004, Smart Sensor for determination of filling level in steel converters), Danny Habets (2005, sulfur sensor for determining the level of sulfur in molten steel) and Paul Heinricht (2006, AER sensor for determining the aluminum content in steel). (More details can be found on page 24)

2005

1st place: Multi-phase catalyst for selective elimination of nitrous oxide

(Christina Modes and Ioan, W. C. Heraeus)

The project has led Dr. Uwe Jantsch developed a multi-phase catalyst with which nitrous oxide released during the production of fertilizer is selectively destroyed, thus protecting the environment. (More details can be found on page 18)

2004

3rd place: Laser excitation lamp

(Christopher Woffendin, Heraeus Noblelight)

When a laser excitation lamp for industrial lasers lasts six times longer than conventional models, this means a significant financial advantage for operators, e.g. in the automotive industry. In cooperation with a university, Jeremy Woffendin developed a pulsed laser lamp that lasts almost 1,500 hours instead of just 250 hours.

2003

2nd place: HeraLock (Christina Modes and Ioan, W. C. Heraeus)

In the development of complex, microstructured circuits, flexible glass ceramic foils (“LTCC foils” = “low temperature cofired ceramics”) play a decisive role as a base material. With the patented LTCC material system HeraLock, W. C. Heraeus developed a glass ceramic foil that allows almost total utilization of the available size of the processed substrates. The reason is that the foil hardly shrinks at all during processing.

3rd place: Online RIC technology

(Prof. Ralph Sattmann, Heraeus Quarzglas)

As preforms, high quality fused silica glass tubes are the basis for the production of powerful optical fibers used in optical data transmission. The “Online RIC” technology (RIC stands for “rod in cylinder”) from Heraeus Quarzglas is an ideal tool for Heraeus Network allows the production of extremely fine optical fibers from large quartz glass cylinders in a single process step. (More details can be found on page 44)

The precious metals and technology group Heraeus is a global, family-owned company active in the businesses of precious metals, sensors, dental and medical products, quartz glass, and specialty lighting sources. With revenues exceeding EUR 10 billion and more than 11,000 employees in more than 100 companies worldwide, Heraeus has been a globally recognized precious metals and materials specialist for more than 155 years. The company unites five business segments:

W. C. Heraeus

A world leader in industrial precious metals and special metals. Our largest business segment processes the precious metals gold, silver, platinum, and other platinum group metals, primarily to produce industrial products for the automotive, semiconductor, electronics, and medical industries. A global network of more than 30 companies includes production facilities for all phases of precious metal production and refining. In addition, W. C. Heraeus holds a leading international position in industrial precious metal trading.

Heraeus Electro-Nite

The world market leader in sensors for the steel industry. The expert for measurements in molten iron, steel, and aluminum operates 24 market-oriented companies on all continents for the production and distribution of high-quality sensors. Heraeus Sensor Technology rounds out the product program with platinum thin film elements for temperature sensors in household appliances and for the semiconductor, electronics, and automotive industries.

Heraeus Kuiper

A globally positioned company in the fields of dentistry and dental technology products. The specialist for dental alloys and single-source provider of systems for the conservation and restoration of natural teeth has an extensive product program for dental laboratories and dentists, and also produces bone cements and biomaterials for orthopedics and surgery. Heraeus Kuiper maintains a total of 20 companies in Europe, Asia, the Americas, and Australia to supply its customers around the world with innovative branded products.

Heraeus Quarzglas

The technology leader in high-purity quartz glass. With comprehensive know-how and more than 13 production facilities in Europe, Asia, and North America, this business segment produces and processes high-purity fused silica for the optical, chemical, and semiconductor industries. The product portfolio also includes synthetic silica glass for the manufacture of microchips and for optical fibers for the telecommunications industry.

Heraeus Noblelight

The technology leader in specialty lighting sources. The company develops, manufactures, and markets infrared heaters and ultraviolet lamps for applications in manufacturing, industrial process technology, environmental protection, medicine and cosmetics, research, development, and analytics.
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