



German ceramics market

By Alex Talavera and Randy B. Hecht

Like its counterparts in many other countries, the German ceramic industry has had to weather a variety of storms in recent years. It has seen much of its share of traditional ceramic manufacturing move to China, India, Indonesia and Vietnam, a revenue shift made more acute by the contraction of the global economy. As the new year begins, the world's finances are not yet in order, and jobs in lower-budget segments of the industry continue to migrate to countries like China, where a worker earns 5 to 10 percent of typical German professionals' salaries and none of their benefits.

Yet Rainer Telle, who for the past four years has served as president of Deutsche Keramische Gesellschaft, Germany's ceramics society, is bullish on his industry's and his country's economic prospects for 2011.

"First of all, certainly we will have a recovery of economics. This is quite clear," he says. The country's economy rebounded significantly from 2009 to 2010 (see *The German Market*), and, although its performance did not match that of 2008, Telle predicts that in 2011, "we will probably return to business as usual."

For the ceramic industry, "business as usual" means product launches that rely on the unusual and inventive. "Almost all companies have used this time to develop ... novel processes and novel products," Telle says. "Therefore, we have some interesting progress in almost all fields of materials and technologies, and this will be available [during 2011]. So I really expect a pushup in our technology."

Lars Schnetter, a development engineer at CeramTec-ETEC GmbH and a member of The American Ceramic Society, echoes Telle's comments. "We already started our development of new production technology to set our future focus in the improvement of our existing products and in the developing of new innovative products," he says. The company's focus is on "processing and production of submicron and nano materials based on nanosized raw materials."

Not surprisingly, the research conglomerate Fraunhofer-Gesellschaft adds its voice to the chorus of R&D gains achieved during the downturn. Andreas Kailer of Fraunhofer IWM cites progress made in such areas as

- Development and qualification of ceramic forming tools for metalforming;
- Diamond coatings on silicon carbide and other ceramics for seal and sliding bearing applications;
- New technologies in the production of solid oxide fuel cells; and
- Simulation tools for processing and sintering of ceramic components.

Looking ahead, Kailer believes the biggest challenges the industry will face in the coming years will be in the fields of energy and mobility – "this means regenerative energies and mobility-based electric drives (actuators)."

How did the country's ceramic industry manage to score such gains even as it was bleeding jobs in its low-profit segments? Part of the answer lies in a delib-

erate decision to focus on the higher-revenue-generating areas of the industry in which Germany maintains a strong competitive edge.

Telle foresees, for example, that, in the short term, large investment will flow to ultra high temperature ceramics. "Within higher-revenue-generating areas of industry, over next 5 to 10 years, thinks highest levels of investment will go to UHTCs with an application temperature far above 1300°C. That's really a big deal, because they are very delicate to handle and need continuous research in materials, research in production science," he says.

Areas in which he sees opportunities for Germany to lead the industry include ion conductors, batteries, fuel cells, membranes, biomaterials (such as implants), composites, and glass ceramics for dental implants, hip joints and knees.

Telle also notes that he expects that Germany will intensify research in refractory ceramics with an eye toward niche applications related to energy and waste disposal.

Energy-related products also are a particular focus of a 108-page report published in May 2010 by Germany Trade & Invest, the government's foreign trade agency. The report states, "From an economic viewpoint, the market for energy storage provides a technology-driven platform for building a sustainable, profitable business. ... The emerging markets for energy storage devices and fuels cells as well as efficient energy management systems (smart grids) are attractive new business opportunities for manufacturers and service providers. In Germany, these technologies represented 8 percent of gross domestic production in 2007 and are expected to amount to 20 percent of GDP in 2020."

Many companies and institutions engaged in ceramics research and development are anticipating that acceleration, and are already preparing to capitalize on it. (The report, *Germany: Lead Market for Energy Storage and Fuel Cell Systems – A Profile of Selected Market and Research Opportunities*, is available for download at [\[age/industries/energy-efficiency-sector/fuel-cellshydrogen-industry/new-publication.\]\(#\)\)](http://www.gtai.com/homep-</p></div><div data-bbox=)

But another factor has contributed to Germany's successful investment in R&D advances at a time when much of the global industry is concentrating on cost-cutting strategies: The nation's federal and state governments are providing an enormous amount of money to fund that research. These public-private partnerships are structured very differently from the way they are in the United States, where companies have fewer opportunities to seek government R&D funding that could lead to the introduction of a specific ceramic component that would go into a product. U.S. government funding instead is available to promote, for example, advances in satellite technology, and in that context,

The German market

Germany's economy is the largest in Europe and the fifth largest worldwide in terms of purchasing power parity. Although the economy contracted 5 percent during 2009, it rebounded quickly from the world economic crisis and is expected to have grown 3.5 percent during 2010 (an additional 2 percent growth is projected for 2011). The unemployment rate dropped to 7.5 percent as of October 2010, the lowest level in 17 years.

The country's 2009 GDP was \$3.339 trillion, which translates to \$44,525 per capita given the population of 82,329,758. Industry, which generates 26.8 percent of GDP, is dominated by automobile manufacturing; mechanical, electrical and precision engineering; chemicals; environmental technology; optics; medical technology; biotech and genetic engineering; nanotechnology; aerospace; and logistics. (Services account for 72.6 percent of GDP and agriculture is just 0.8 percent.)

Germany operates at a significant trade surplus, with \$1.124 trillion in exports and \$937 billion in imports during 2009. Leading export products include chemicals, motor vehicles, iron and steel products, manufactured goods and electrical products. The country's biggest export markets are the U.S., France and the Netherlands. Its major imports are food, petroleum products, manufactured goods, electrical products, motor vehicles and apparel. Its biggest import suppliers are the Netherlands, China and France.

Data sources: U.S. Department of State *Country Background Notes* and *CIA Factbook*.

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it funds the ceramics that go into that satellite technology.

Stephen Freiman, an ACerS Distinguished Life Member and former chief of the Ceramics Division at the NIST, offers the example of a Department of Energy program in high-temperature super connectivity that the government funds “because it holds the promise of lower-cost power delivery and voltage delivery, and [many] of those materials being developed under that program are ceramic.”

“But,” he says, “the U.S. government does not fund new products. It’s an agency-by-agency process, and they then only fund R&D development relevant to their own mission. The government is focused on the needs of the particular agency or subagency. It’s application driven and mission driven.”

Michael J. Hoffmann, who heads the Institute for Ceramics in Mechanical Engineering at Karlsruhe Institute of Technology and is a member of ACerS’s Board of Directors, explains how the system works in Germany, particularly with regard to three research conglomerates that serve as umbrella organizations over many smaller institutes.

The first is the Helmholtz Association of German Research

Centers (www.helmholtz.com), whose affiliates Hoffmann characterizes collectively as “maybe comparable to the national labs in the U.S.” He says funding for these national institutes, currently around €3 billion, is provided directly from Germany’s federal Ministry of Education and Research, which maintains a fixed annual budget for funding the Helmholtz Society. The organization’s affiliates can apply for long-term project funding, typically five years, from that budget.

“One research topic is on key technologies, which includes the program ‘NanoMicro:Science, Technology, System.’ Another program is on ‘Advanced Engineering Materials,’ Hoffman says. “This is a relatively large amount of money, and when they get it with this program, they have a certain kind of freedom with the basic funding.”

Another conglomerate, the Fraunhofer-Gesellschaft (www.fraunhofer.de), more commonly known as the Fraunhofer Institutes, also receives basic funding from the Ministry of Education and Research as well as from the state government. The organization says that it “undertakes applied research of direct utility to private and public enterprise and of wide benefit to society.”

“Fraunhofer Institutes are working on more specific problems. They don’t work on basic research. They get a problem from industry, and they try to solve it,” Hoffman says.

Conversely, the Max Planck Society (www.mpg.de) – which also receives a combination of federal and state government funding – concentrates on basic research, including interdisciplinary work. Even without a product-driven commercial focus, Hoffman says, “This society could have 100 percent financial support just from the government. There is no need to go outside, to write proposals. They do it, but they can survive [without external sources funding sources].”

Government euros also fund university research in Germany, which is financed predominantly by the Deutsche Forschungsgemeinschaft (German Research Foundation, www.dfg.de) with additional support from the Ministry of Education and Research.

After all that government underwriting, industry projects provide what Hoffmann calls a “second source” of funds. “The industry doesn’t pay you directly,” he explains. “It is still a publicly funded project on a certain topic. But, a proposal is mostly written by the

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The following information provides an overview of the scope and breadth of activities within the German ceramics industry. It includes profiles of prominent research and manufacturing organizations plus contacts to assist networking within the country.

Ammonit-Keramik Rolf Plümacher & Co. KG

Founded more than a century ago, the company produces a variety of ceramics for architectural applications. Since 1983, it has manufactured split tile in accordance with DIN 18 166 standards, and it produces all marketable sizes and trim pieces. Website content is published in English and Russian as well as German. Managing directors and owners: Vera Plümacher and Axel Plümacher

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www.ammonit-keramik.de
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Ceratec Technische Keramik GmbH

Founded in 1988, the company specializes in heavy-duty ceramic material components designed to optimize hardness, flexural resistance, impact resistance and process stability. Its products are manufactured for a variety of applications, including welding engineering, aerospace, lasers, semiconductors and engineering and jig-making. Its website content is published in English as well as German.

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57223 Kreuztal-Kredenbach
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Phone: +49 (0) 2732 - 59 16 90
www.ceratec.de
info@ceratec.de

CeramTec

The company’s website states, “CeramTec is one of the world’s leading manufacturers of technical ceramics and is specialized in the development, manufacturing and sales of innovative products made from ceramic materials. CeramTec has more than 100 years of experience in this field, and it plays a leading role in products, solutions and services related to advanced ceramics.” CeramTec’s website content is published in English as well as German and includes links to subsidiaries in Europe, Asia, Africa and North and South America. The company maintains seven facilities in Germany. See the website for contact information for each location.

www.ceramtec.com
info@ceramtec.de

Deutsche Keramische Gesellschaft

Germany’s counterpart to The American Ceramics Society. It was founded nearly three quarters of a century ago. The association’s website content is published only in German, but staff and members can communicate in English.

The organization’s membership represents two industry constituencies: Approximately 50 percent of its members work in technical ceramics and machinery supply, and the remaining work in the silicate industry. DKG conducts workshops and maintains working groups on raw materials, shaping and molding technologies, silicates, electronics, bioceramics and structural ceramics. The organization also encompasses what it refers to as research associations for which there is

industry partner, which is then submitted to the Minister of Education and Research.” He says that when a proposal is approved, government funding can reimburse up to 40 percent of industry investment and 100 percent of university expenditures.

Funding requests can follow either a top-down approach (responses to calls for proposals on a certain topic, like the recent example of energy-efficient production technologies) or a bottom-up approach (which allows fund seekers to request underwriting for a new product for which a market is clearly defined).

That research philosophy and structure are the foundations of upcoming developments in Germany’s ceramic industry. U.S. companies should bear in mind that they, too, can access that support if they engage in a joint venture with a German partner.

“The German Research Foundation has fostered collaboration with the United States,” Telle says. “We have programs open for German applicants, but if we have a partner in the United States, of course it’s open for these people, too.” And he is a strong advocate of increased collaboration across borders: “It’s very clear that there’s a lot of competition with the western

world, including France, Great Britain, the United States – there’s no question about that – and Japan. There are very strong industries which now should join together in a barrier against the lower-level processing countries.”

What should U.S. companies interested in joint ventures or international trade bear in mind about the German

ceramics industry?

“I think we are quite good in the transfer of material science to processing science. The communication between material scientists and processing application engineers is quite good,” Telle says. For example, in bioceramics, there is a lot of collaboration between hospitals and material developers, in

Foreign commerce resources

Extensive resources are available on both sides of the Atlantic to support U.S.–German international trade, commercial exchanges and joint ventures. If a company is interested in doing business in Germany or establishing a trade relationship with a German ceramics company, these materials can help create a business plan for this thriving market.

The U.S. Commercial Service, a division of the Department of Commerce, has published *Doing Business in Germany: 2010 Country Commercial Guide for U.S. Companies*. Available online in pdf format, the 89-page market guide covers the basics of doing business in Germany, an overview of the political and economic environment, trade regulations and standards, information about leading sectors for U.S. export and investment, and tips for selling U.S. products and services. The report can be downloaded at www.buyusa.gov/germany/en/doingbusinessgermany2010.pdf on the BuyUSA.gov website. The website also maintains a calendar of German trade fairs and events and provides an online form that can be

use to request industry-specific market research for Germany. The reports cover nearly four dozen topics, including the German dental and medical device markets, micro and nano manufacturing, various components of the automotive industry and the robotics and automation market.

Germany’s federal Ministry of Finance (www.zoll.de) offers several English-language business guides, such as a 36-page pdf booklet about the nation’s Customs Administration that covers such topics as excise duty collection and strategies for speeding the clearance of goods. The ministry also maintains an English-language online FAQ (www.zoll.de/english_version/faq/b0_customs_procedures/index.html) related to customs procedures and commercial goods traffic. Finally, the government’s Customs Information and Knowledge Management staff is available to respond to customs questions via telephone (011 49 351 44834-530), fax (011 49 351 44834-590) or email (enquiries.english@zoll.de). Information by phone is available Monday through Friday from 8.00 a.m. to 5.00 p.m. Central European Time, which runs six hours ahead of Eastern Standard Time.

an annual budget of more than €2 million in funding. President: Rainer Telle.

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DoCeram

The company produces advanced ceramic solutions for a variety of applications. The home page features an English language option, but the link is not live, and, as this article went to press, content was available only in German.

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www.doceram.com
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DoCeram Medical Ceramics

The company’s research and development of high-performance ceramic materials has been used in such diverse applications as mechanical and plant engineering, automotives and textiles. It manufactures ceramics used in precision-fit surgical and dental implants and components used in medical products and pharmacology. These products are known for their biocompatibility, high mechanical strength, wear resistance and corrosion resistance. Its website is published in English as well as German.

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44309 Dortmund
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Phone: + 49 (0) 231 / 92 56 68 - 17
www.doceram-medical.de
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Duravit AG

The company produces ceramics for the bathroom. Its website content is available only in German, but an

international directory provides contact information for inquiries in the U.S.

Werderstraße 36
D-78132 Hornberg
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info@duravit.de

Fraunhofer-Gesellschaft

Fraunhofer, Europe’s largest application-oriented research organization, focuses on such diverse needs as health, security, communication, energy and the environment. The organization’s annual research budget is €1.6 billion, of which two thirds is generated through a combination of industry contracts and publicly financed research projects. The remaining one-third is contributed by the German federal and Länder governments in the form of institutional funding. Fraunhofer also maintains research centers and representative offices at locations in Europe, the U.S., Asia and the Middle East. Content on

the website is published in English as well as German.

Fraunhofer employs a staff of 17,000, the majority scientists and engineers, in more than 80 research units located throughout Germany. Among these are 59 Fraunhofer Institutes, including the Fraunhofer-Institut für Keramische Technologien und Systeme IKTS (Fraunhofer Institute for Ceramic Technologies and Systems), located in Dresden. Its focus is the development of materials, technologies and components in the field of advanced ceramics as well as hard metals/cermets. According to its website, “Development work within the framework of R&D projects with our customers spans the entire value chain, extending to prototype production. Thus, the Fraunhofer IKTS is characterized by three core competencies: materials expertise, manufacturing technologies, and systems and product integration.”

Fraunhofer IKTS employs 400 people and collaborates with more than 250 national and international partners on

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research and industry. Telle believes this can aid U.S. researchers and manufacturers who are assessing the market for the products of prospective joint ventures. (To get started investigating options for collaboration with German ceramic partners, see *Foreign Commerce Resources*, page 33.)

Another area of opportunity is refractory producers. "We have some excellent progress here on corrosion and high-temperature properties," Telle says.

That's an area on which CeramTec-ETEC GmbH is placing increasing emphasis. "We're actually setting our focus in the development of submicron or nano crystalline materials with new improved material properties for the wear protection and armor protection industry. These materials provide higher strength, hardness and chemical resistance than conventional materi-

als," Schnetter says. "By improving the wear and corrosion resistance of our products, we help to lower wear in facilities like power plants, steel industry and mining industry. Several billion dollars euros are needed every year just in Germany to offset the consequences of wear. These new materials allow massive improved wear resistance and corrosion resistance."

Germany's approach to public-private partnership fosters another strength: knowledge sharing among universities, research institutes and industry often on an international scale. Fraunhofer's Kailer regards "transfer of knowledge from research institutes to German industries to realize new products or enhanced functionalities" and "close interaction of ceramic manufacturers and users all over Europe, and from this basis, global

commercialization of high-quality products" to be among the German ceramic industry's greatest competitive advantages in the global market.

As the new year begins, it will be interesting to see how that commitment to global interaction and collaboration helps to drive new ceramic industry trends within Germany and beyond. ■

Fast facts

"Italy is our most important raw material customer. Germany sells five million tons of clay minerals to Europe, and to Asia. We are one of the largest clay suppliers in the world after the United States. Italians buy these raw materials and sell back wall tiles." – Rainer Telle
The largest ceramic manufacturer in Germany is not a pure ceramic company. It's Bosch. "They produce, in house, more ceramics than any other company." – Michael Hoffmann

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its current projects. Institute director:
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Friedrich-Alexander-University Erlangen-Nürnberg

FAU, which receives €90 million in annual third-party funding in support of its research, is one of Germany's leading universities. Among its areas of research are new materials and processes, optics and optical technologies, health technology, electronics, information, communication, energy, environment and climate.

The university maintains close ties with 500 partner universities in 62 countries, and its faculty and research staff collaborate with leading universities throughout the world in more than 130 research cooperations. The website notes, "Every year more and more Humboldt scholars and prize-winning researchers choose this Northern Bavarian university as their research base." Its website content is published in English, Spanish and French as well as German.

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Helmholtz-Gemeinschaft Deutscher Forschungszentren

Germany's largest scientific organization, the Helmholtz Association, employs a staff of 30,000 at 16 research centers and operates with an annual budget of approximately €3 billion. Its six areas of research focus are energy; earth and environment; health; key technologies; structure of matter; and aeronautics, space and transport. In 2008, the association's scientific research work produced 12,104 scientific publications, 7,623 of those in ISI-cited journals. Its achievements also are measured by such benchmarks as 400 patents granted and 440 license agreements signed each year.

Within the realm of ceramics, scientists at the Helmholtz Association are working on new coatings for high-efficiency, low-emission power stations, in which the website explains, "combustion is carried out with pure oxygen, and the resulting [carbon dioxide] is filtered directly from the flue gas ... ceramic membranes are now being developed that rely on coatings like these as substrates." Another area of focus is developing new ceramic materials, such as oxides and chalcogenides with three-dimensional nanostructures, to substantially increase the energy density of Li-ion batteries.

The association places a strong emphasis on international collaboration. Its website states, "By establishing international strategic alliances, and by fostering and developing scientific cooperation and networking with national and international partners in universities and companies, the Helmholtz Association creates the necessary framework for producing outstanding research results more quickly and more efficiently." In keeping with this philosophy, the association publishes its website content in English, Russian and Chinese as well as German.

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www.helmholtz.de

Herbst Technische Keramik

Based in Dürrröhrsdorf (near Dresden), the company has been working in the ceramics industry for three generations. Its products and components include electrical heater components, foundry ceramics, welding aids and oxide ceramics. Its areas of focus include development and production of high-

precision ceramic components on the basis of oxide materials (aluminum oxide, partially stabilized Zirconia as well as Magnesium oxide) and development of nonstandardized products. The company's website is published in English as well as German. Managing director of sales, technology, research and development: Robin Herbst.

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Institut für Fertigungstechnologie keramischer Bauteile

In 1995, the University of Stuttgart established its Institute for Manufacturing Technologies of Ceramic Components and Composites, a division of the manufacturing engineering faculty. The institute's research focus is manufacturing techniques for ceramic components and composites as well as in material technology, with a particular emphasis on the interaction between modern material science, process engineering and manufacturing technologies.

The institute's four divisions are dedicated to structural ceramics and fiber-reinforced composites, functional ceramics and chemical technologies, surface technology and thermal spraying and material science and numerical analysis.

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Institut für Keramik im Maschinenbau

Mechanical engineering faculty members at the Institute of Ceramics in Mechanical Engineering develop engineering ceramics for various high-tech applications, including automotive, energy production and telecommunications. The website, which is published in English as well as German, notes, "Ceramics for piezoelectric injectors, porous and infiltrated structures, parts for high-pressure, tribological applications and for cutting tools mark actual research tasks of the institute. An outstanding feature at the Institute of Ceramics in Mechanical Engineering is that we are able to run through the complete process chain from powder preparation via fabrication to component testing."

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Max Planck Gesellschaft

The research institutes of the Max Planck Society are dedicated to work in the natural sciences, life sciences, social sciences and the humanities. The website states, "In particular, the Max Planck Society takes up new and innovative research areas that German universities are not in a position to accommodate or deal with adequately ... [or that] require more funds for personnel and equipment than those available at universities."

The organization includes 80 institutes and research facilities that employ a staff of approximately 14,300 – among them 5,150 scientists and 7,700 student assistants, fellows of the International Max Planck Research Schools, doctoral students, postdoctoral students, research fellows and visiting scientists. Since 1948, Max Planck scientists have been awarded 40 Leibniz Prizes, and they have been honored with 32 Nobel Prizes since 1911.

Within its chemistry, physics and technology section, areas of focus include astronomy/astrophysics, chemistry, solid-state research, material sciences, earth science, climate research, high-energy and plasma physics and

quantum optics. The website content is published in English as well as German.
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Carl Nolte Söhne GmbH/Morgan Molten Metal Systems

Manufacturer of more than 10 types of crucibles, Morgan MMS develops products that promote low melting loss, better metallurgical conditions, maximum flexibility, lower capital cost and economy of floor space and reduced cost of maintenance and downtime. Its products are used by companies in the automotive, aeronautics, mechanical engineering, electrical, construction and pharmaceutical industries as well as in precious metal refining and jewelry manufacturing. Carl Nolte Söhne GmbH is the German affiliate of this enterprise, which has additional locations in Europe, Asia, Africa and North and South America. The company's website, which is published in English as well as German, notes, "To complement these products we also offer a large range of foundry products, such as thermocouple sheaths, coatings, tubes ... foundry equipment for crucible lifting, ingot loading and temperature measurement."

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MTC Haldenwanger

Founded in 1865, W. Haldenwanger Technische Keramik GmbH Co. KG manufactures products made of oxide and non-oxide ceramic materials for the aerospace, medical, power generation and distribution, automotive, process control and monitoring, industrial equipment, household goods, electronics, and security and defense industries. The company, an affiliate of Morgan Technical Ceramics, publishes its website content in English as well as German and maintains sales offices and manufacturing facilities in England as well as Germany.

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www.haldenwanger.com

MTC Wesgo Ceramics GmbH

Morgan Technical Ceramics Wesgo supplies high-purity aluminum oxide ceramic components such as engineered and metalized products, ceramic-metal assemblies and active braze technology for applications used in the aerospace, medical, industrial equipment, thermal processing, and process control and monitoring industries. The company received DIN EN ISO 9001 certification in 1996 and established the Six Sigma quality concept two years later. Since 2004, its site has been DIN EN ISO 14001 approved. An affiliate of Morgan Technical Ceramics, the company publishes its website content in English as well as German.

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Sembach GmbH & Co. KG - Technische Keramik

Sembach Technical Ceramics manufactures high-performance ceramic products developed from a base of steatite, cordierite, alumina, zirconia and other high-performance materials. Its manufacturing technologies include dry pressing, extrusion and injection molding. The company works in cooperation with world leaders in the automotive, household appliances, mechanical engineering and medical instrument industries and has attained DIN EN ISO 9001/2000, DIN EN ISO 14001:2005; ISO TS 16949:2002 and OHSAS 18001 certification. Its website content is published in English and French as well as German and maintains a contact in the U.S.

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Technische Universität Darmstadt

Founded in 1877, the university has a long tradition of international collaboration in the natural and social sciences, technology, engineering and humanities. Its objective is to integrate research activities with active partnership with business, science, government and society. Departments and fields of study include civil engineering and geodesy, electrical engineering and information technology, mechanical engineering and materials, and earth sciences. The

university's website is published in English as well as German.

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Zell Quarzglas und Technische Keramik Technologie GmbH

Zell is an established European leader in the manufacture and procurement of structural parts made of quartz glass, glass and technical ceramics. Its expertise extends to meeting quality and precision standards in quartz glass material selection; managing development and design of complicated semi-finished components, material joins, or demanding cold or hot processing; and component purchasing.

The company developed and continues to refine technical ceramics that use high-purity aluminum oxide to meet the demands of such applications as chemical process technology; flue gas desulphurization technology; pump construction for chemical operations, steelworks and mines; wire, cable and paper manufacture; forming technology; size reduction technology; metallurgical property determinations; chemical laboratories; armor for security technology; semiconductors; and optoelectronics. Managing director: Eberhard Zell. Sales, marketing manager: Karen Wisanowsky.

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