

Germany

Systematic Growth

The FCT group of companies has had success with niche products that meet the highest technological standards.



Fig. 1 Spark Plasma plant

History

The **FCT group** of companies goes back to **KCE Sondermaschinen GmbH**, a company founded by *H. U. Kessel* in Rödental in 1982. This company was already developing processes and plants for the growing market segment of non-oxide high-performance ceramics. In this course of time, from this seed, the companies **FCT Fine Ceramics Technologies** (1985), **FCT Hartbearbeitungs GmbH** (1994), **FCT Ingenieurkeramik GmbH** and **FCT Systeme GmbH** (both 1996) grew up.

Activities initially focussed on the construction of efficient high-temperature plants for laboratories and production, this was followed by the introduction of the machining of ceramic components as a service, and finally the activities were successively expanded to cover the entire process chain from raw material to component. This was done primarily with regard to giving plant cus-

tomers the appropriate instruments for operation of a pilot production and for the efficient design of the production plants to meet the needs of the product range and the required capacity.

The availability of appropriate processing plants and their systematic expansion consequently led to the start of the production of ceramic components according to customer drawings, first in **FCT Hartbearbeitungs GmbH** and then in **FCT Ingenieurkeramik GmbH**. At **FCT Hartbearbeitung**, the initial focus was on **SSiC** components with high machining requirement. Then to meet the increasing demand for large and complex components made of **SSiC** and **Si₃N₄**, the two companies took up the challenge and invested in appropriate equipment. Today such large and complex components are supplied and sold worldwide either directly by the companies themselves or through partners.

The **FCT**-group of companies, **Rauenstein/Thüringen** (**FCT Fine Ceramics Technologies H.U. Kessel**), now consists of three independent companies: **FCT Hartbearbeitungs GmbH** (*MD W. Martin*), **FCT Ingenieurkeramik GmbH** (*MD K. Berroth*) and **FCT Systeme GmbH** (*MD H. U. Kessel*). The activities of **FCT Systeme GmbH** (hot pressing, **SPS** and gas pressure sintering as well as high-temperature sintering under inert gas) are strongly geared to the market, but are also closely associated with the component development of the affiliated companies. Not least

because of this have these then been able to make a name for themselves nationally and internationally as technology partners, producers of large and complex engineering ceramic components as well as service providers for hot pressing, contract sintering, cold isostatic pressing and precision hard machining of ceramic and other superhard materials.

R&D in the Pool of Companies

High-performance ceramics can be used to resolve materials-related problems and introduce new concepts and technologies in mechanical and chemical process engineering, electrical engineering and electronics, high-temperature and thermal systems, but also in optics and foundry systems. Outstanding properties such as temperature and corrosion resistance, high strength and stiffness, purity and biocompatibility qualify materials such as silicon carbide, silicon nitride, zirconium oxide and composites derived from these for extremely demanding applications.

An understanding of the materials combined with a knowledge of the requirements to be met by the raw materials, their processing and sintering are not enough to produce efficient and reliable components at acceptable cost. Rather, know-how had to be accumulated in respect of every single production step along the entire process chain, this accumulation being a continuous process

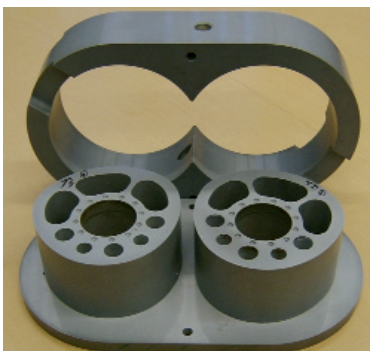


Fig. 2 Rotary piston engine

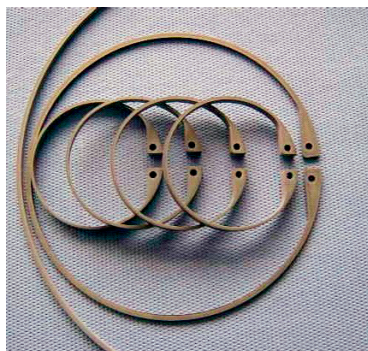


Fig. 3 Seeger circling rings



Fig. 4 Silicon nitride screw



Fig. 5
Strip mill rollers

leading to a steady optimization of process reliability. With the components produced by FCT, failure probabilities of 1: 1 000 000, as demanded in the automotive industries and electronics, do not play any significant role, as the lot sizes produced range from a few single parts and prototypes to piece numbers of around 500, although even with these numbers, no component should fail when in use. Particularly for large-size components with very complex geometry and the highest precision, an efficient function and extreme reliability is expected from every prototype as these are often integrated in very expensive equipment and must function under high loads.

With regard to shaping, FCT is intensively engaged in uniaxial and cold isostatic pressing, slip casting, uniaxial hot pressing in inert gas or vacuum, but also with different forms of injection moulding and extrusion. The new findings from development must be channelled already into slip and granulate preparation so as to guarantee the homogeneous microstructures indispensable for process and component reliability. As special components are generally produced in small series, a great deal of importance is attached to the green machining of isostatically or uniaxially pressed components, which are already produced with a largely adapted geometry. With regard to precision, here it is necessary to work with tolerances similar to those found in finish-turning and finish-cutting, to, for instance, to ensure an accuracy of 0,05...0,2 mm in boreholes, or to get a thread with a fit that does not require re-finishing after sintering. Threads from M3 to M40 with different thread types can be produced without the need for hard machining after the sintering process.

To make green machining economical, the recycling of "green" cuttings is an important topic especially when between 20 and 85 % of the volume of the green component is cut away. To re-use these "chippings", these must be first collected separately by type, without contam-

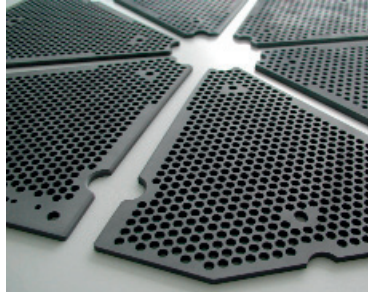


Fig. 6 Perforated setter plates

ination, and then prepared again appropriately. The temporary binder systems used must endow the mouldings with sufficient strength and at the same time good machinability to ensure low tool wear.

In the shaping of near-net compacts in combination with green machining, a near-net component design is the objective so that expensive hard machining is only necessary to obtain functional surfaces with very narrow tolerances or to meet high specifications for the quality of the surface finish. For the production of highly complex and high-precision parts, however, hard machining is in increasing demand and particularly indispensable for the realization of extremely narrow tolerances in the μm range. FCT is competent in all common hard machining processes such as cutting, surface grinding, cylindrical surface grinding and internal circular grinding, honing, lapping, polishing and profile grinding. An area of particular expertise is the machining of large-size components up to around 3000 mm in length and around 1000 mm diameter. New machining methods such as ultrasonic-assisted boring and grinding, twin-disk grinding and lapping, as well as laser and water jet cutting are currently being tested and are introduced where appropriate. Here FCT Hartbearbeitungs GmbH and FCT Ingenieurkeramik GmbH work technologically closely together by sharing and strategically expanding the range of specific machines installed.

Thermal processes play a particularly important part in the process chain, as specific temperature and atmosphere control can be used to "tune" the material properties of the components. Here the expertise of FCT Systeme GmbH really comes into play. As a specialist in the construction of high-temperature plants for vacuum and inert gas operation, gas pressure sintering plants and inert gas hot presses, the development of plants for innovative hot

pressing techniques (Spark Plasma Sintering/SPS – Field Assisted Sintering Technique/FAST) as well as melting and crystallization of solar silicon blocks with directional solidification, the company not only comes up with solutions to meet special sintering requirements, but, within the group of companies, can take new directions in the development of plants. In the development of prototypes, the company can realize a new furnace concept in-house and this can be tested, tried and optimized on pilot or production scale. With this internal network, a tool is available that can deliver practice-oriented results, both optimizing the production of the FCT ceramic producers and opening new marketing opportunities for the plant supplier.

Growth with Product and Process Innovations

Components made of high-performance ceramics often encounter high market barriers on account of their price. With the development of prototypes, the FCT group of companies aims to demonstrate how the substantial technical benefits of ceramic components justify their price. Nevertheless ongoing work is needed on the further development of the process engineering, not only with regard to the technological aspects, but also concerning economic aspects in order to make sure that the price does not become the sole decision criterion.

The group's growth proves that it has taken the right path. To enable further growth, FCT-Hartbearbeitungs GmbH moved into its own production facility in Sonneberg last year, which enabled an increase in the production area from around 1000 m² to 1700 m², but is already reaching the limits of its capacity. Even with the additional space of more than 1000 m² that became available when FCT Harbearbeitungs GmbH and a small mechanical engineering company moved out of the Rauenstein facilities, the premises have already become too cramped following the moving in of FCT Ingenieurkeramik.

FCT Systeme GmbH has moved into the new production facility built two years ago at the headquarters in Rauenstein. This has left further space for FCT Ingenieurkeramik in the old three-storey production building, in which the management

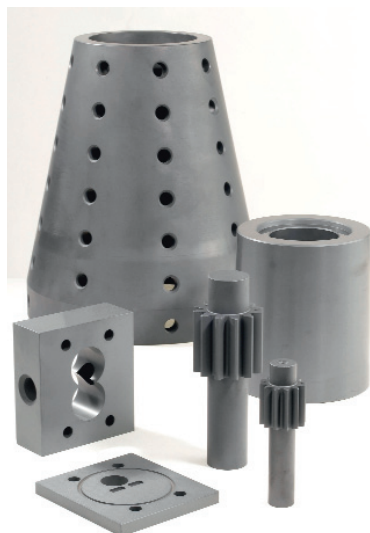


Fig. 7 Rotor for attritor mill and gears with housing for a gear pump

and administration are also based. Nevertheless there are already plans for building an extension.

The group's success is not only indicated by its expansion in terms of space, but by the increase in employees too. Last year 30 new jobs were created in the FCT group of companies, so the number of employees has been increased to 122 – and further new recruitment is planned. This was accompanied by sales growth reaching around 16 %. Product and process innovations can generally only be achieved with continuous investment in the company's own technological facilities. For many processes, to realize a unique selling point as a niche supplier in the market, a very high readiness to assume risk in investment decisions is essential. Often at this point in time only a utilization of 10...20 % can be realized. On advantage, however, is that the affiliated companies can increase the utilization rate based on their shared use. The business risk is, however, borne by the investing company.

With regard to cultivation of the market, development and technical marketing are closely intermeshed. Products that have become a permanent part of the range are not only sold directly but also through partners. This applies, for example, to aluminium foundry systems,

where the company *Drache* is active worldwide as a sales partner for FCT Ingenieurkeramik GmbH. Via direct and indirect sales, over 40 % of the components are sold to export markets. This is the mainstay for sintering systems. Here the export quota is 50...70 % and is subject to wide variation depending on the specific project.

Examples of Product Innovations

From planning to implementation, FCT Systeme GmbH supplies high-temperature plants and integrated production concepts with the corresponding know-how from raw material to usable component. On behalf of a foreign business partner, FCT Systeme GmbH undertook the technological development of the sintering process for diesel particulate filter elements, which led to an extensive order centring round the supply of a complete sintering line.

For the melting of Si blocks too, intensive technologically innovative developments have been made. These have led to the building and supply of several plants for the solar industry, with follow-on contracts having been signalled. As a further field of activity, FCT Systeme GmbH took up spark plasma sintering, working intensively over the last three years to secure a clear edge in this technology internationally and in the construction of plants fit for production. It now intends to systematically extend this lead.

This technology has met with great interest particularly in powder metallurgy, but is also to be tested for ceramic materials.

FCT Hartbearbeitungs GmbH has extensive expertise in wear protection, e.g. in grinding plants, and for this the company engineers components made of silicon carbide and zirconium oxide. Examples are stators and rotors for agitated ball mills or calender pipes up to 400 mm in diameter and around 1 m in length for processing paints and electronic printing pastes. Besides small, high-precision components, the focus is shifting more and more in the direc-

tion of large-volume complex components. The technological equipment for the production of these components has been installed over the last few years.

Particularly varied is the component range of FCT Ingenieurkeramik GmbH, which covers applications in optics, foundry systems, testing and metal forming, but also heat and electric engineering. For example, for a large-size, complex silicon nitride casing structure for an IR camera with around 20 % sintering shrinkage, a precision of + 0,2 % is achieved. This material impresses when used with properties such as high stiffness, fatigue strength, minimal thermal expansion, fatigue-resistance and good thermal conductivity combined with low weight. The aluminium industry has also recognized the benefits of this material for itself. Applications include thermowells, feed tubes, casting nozzles, etc.

For metal working systems, silicon nitride is interesting for new rolling tools. Besides metal working tools, various wear parts such as guide pulleys and idlers with different sizes and complexity are used in rolling mills.

Prospects

Our persistently pursued concept of developing and optimizing materials and production methods in cooperation with potential users seems to be working as their feedback from the different applications can be implemented directly. We shall therefore systematically continue with our development, geared to the different applications, and thus open up new markets.

With the combination of the individual expertise of the different companies affiliated in the FCT Group and the investment in human resources and modern facilities for the production of large-volume, highly complex and precise components, the FCT Group sees itself as well-equipped for further positive development in high-performance ceramics.

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