The Fraunhofer Institute for Silicate Research ISC in Würzburg does research in the field of glasses, ceramics and hybrid inorganic/organic polymers. In the field of ceramics the institute develops reinforcing and functional fibers as well as coatings and ceramic matrix composites (CMC). The optimization of heat-treatment processes in the ceramic manufacturing process is a further main focus. For this purpose in situ measurement methods are developed, providing a direct insight into the sintering furnace. By means of these thermo optical methods all important material properties can be measured during the heat-treatment process. Afterwards, optimal sintering cycles can be calculated on the basis of the in situ measurement data. Thus, heat-treatments of silicate ceramics (e.g. high voltage insulators) as well as electronic ceramics (e.g. zinc oxide varistors) or non-oxide ceramics (e.g. aluminum nitride substrates) can be optimized.

»TOMMI« is a spin-off of the development of thermo optical measurement methods. It is a high-temperature furnace with an optical dilatometer for dimension control in ceramic laboratories. »TOMMI« is produced by a certified method in the Bronnbach Branch Lab of the Fraunhofer ISC. In addition to sintering shrinkage it also measures warpage, changes of sample mass, melting and wetting phenomena during heat treatment. In comparison to conventional thermal analysis larger samples and a more flexible setup can be used. By »AdvAnCer« »TOMMI« is introduced to a wide circle of manufacturers and users of ceramics. The next fair presentation is at CERAMITEC in Munich from May 16 to 19, 2006 (see page 3).
Survey:

Ceramic Filters

Ceramic filters are used in many technical applications, primarily for the purification of liquids, molten metals and gases. The fields of application range from sterile and micro filters in pharmaceutical and food industry, via molten metal filters in foundry industry, to diesel particulate filters in automotive industry.

Operating Mode and Structure of Ceramic Filters

The operating mode of filters can be differentiated regarding separation mechanisms. In principle, filters can be differentiated in surface and depth filters – combinations of both effects can also occur. Design and shapes of ceramic filters are manifold, depending on the application and separation principle.

Filter materials differ in:
- Pore size (and pore size distribution, respectively)
- Number of pores (pore volume)
- Shape of pores/pore channels and shape of surrounding material, respectively
- Type and composition of ceramics (e.g. aluminum oxide, silicon carbide etc.)

The dimension of structures can be scaled in a wide range. Surface filters can be manufactured with pore sizes of approx. 2 nm to several 100 micrometers and pore volumes of 30-65 %. Depth filters made of ceramic fibers or open-cell ceramic foams can form pore sizes of approx. 50 µm to 5 mm and pore volumes of up to 97 %.

Applications

According to the state of the art, multi-channel elements are used for liquid filtration. These multi-channel elements have inside membrane layers cross-flowed by the liquid with a cut-off of several µm up to approx. 50 nm (for microfiltration or ultrafiltration). The latter consist of multi-layered membranes. Stacks of filter disc cartridges are used alternatively. Aluminum oxide is the material mainly used for substrate and membrane. In the development stage and first industrial applications, nanofiltration membranes with cut-offs below 50 nm (up to approx. 2 nm) are used.

For exhaust aftertreatment (diesel particulate filters), extruded honeycomb structures with 200-400 cpsi are used whose channels are closed alternately at the ends. The wall thickness of the ceramics ranges from 250 to 400 µm, so that high-filtration areas per filter volume with small filter-wall thicknesses can be achieved. At present, silicon carbide ceramics are predominantly used (pore width of approx. 10 µm) due to the high load of the filters during thermal regeneration.

Molten metal filtration is a typical application of ceramic depth filters. Coarse-cell ceramic foams (2-5 mm cell size) made of silicon carbide, alumina or zirconia are used for this kind of application. For casting cast iron and non-ferrous metals, approx. 150 million filters (50x50x22 mm^3) of silicon carbide ceramic foams are produced in Western Europe annually.

Current R&D aims in the field of ceramic filters are:
- Specific shape-forming technologies for filter substrates (extrusion, tape casting, sponge replication)
- Innovative solutions for the coating of defect-free and highly-permeable mesoporous corundum membranes
- New coating methods for concave components (especially LPS-SiC) for aerators and for levitation of molten metals
- Low-cost multi-channel elements for application in liquid and dust filtration by means of continuous series production and cofiring
- Specific filter ceramics and manufacturing technologies for diesel particulate filters (as wall-flow and as depth filter) as well as for wood fire places
- Improvement of composition and new applications for ceramic foam filters and metal foams
- Substrates for catalysts and adsorbent materials, e.g. for waste gas treatment
News

»AdvancCer« at the HANNOVER MESSE 2006

This year, the HANNOVER MESSE takes place from April 24 to 28. »AdvancCer« is presented at the joint stand of TASK GmbH in hall 5, stand F34. In addition to »CT-Mini«, ceramic forming dies and ceramic threads are highlights of the »AdvancCer« presentation. Amongst others, a forming die with inserts made of silicon nitride ceramics is shown by the Fraunhofer IPT. By using ceramics in highly stressed tools for forming CP and TRIP steels, the durability can be significantly increased (factor 5-10) in contrast to conventional tools. Furthermore, threads with shapes and manufacturing technology oriented to ceramic materials are presented.

The solution developed by IPK, IKTS and IWM includes positive and frictional connections without using auxiliary materials like adhesives or solder, in order to use the properties of ceramics in the complete system. In addition to these demonstrators, »AdvancCer« shows a rapid-prototyping process-chain considering medium pressure-injection molding technology as an example. The Fraunhofer Alliance Rapid Prototyping entered, processed and provided the 3D-data. Our visitors can look forward to a small present – a ceramic miniature bust of Joseph von Fraunhofer.

CERAMITEC 2006 in Munich

This year, CERAMITEC already takes place in spring, from May 16 to 19. For the first time there will be a Ceramics Meeting Point. »AdvancCer« is represented by the institutes IKTS Dresden, ISC Würzburg and IZFP Saarbrücken at the joint stand of TASK GmbH in hall B6, stand 132/236. The presentation focuses on »TOMMI«, »CT-Mini« as well as ceramic injection molding technologies. At our interactive information terminal we again will present the products and complete services of »AdvancCer«. We are looking forward to your visit as well as to interesting discussions with our friends, partners, and customers!

Extraordinary Sharpener

The Department of Ceramic Materials and Components at Bremen University, the Bremen University of the Arts and Prof. Andreas Kramer won the if-material award in January 2006 with this extraordinary design of a sharpener. The award will be presented at the special fair »material trends 2006« at the HANNOVER MESSE in hall 5 on April 24.

(Further information: www.ceramics.uni-bremen.de)

Retrospection:
Ceramics Vision 2006* in Dresden

The Fraunhofer IKTS was the host of the colloquium Ceramics Vision 2006* on January 12. More than 100 conference participants, mainly from industry, were welcomed and offered an interesting program. The colloquium which is oriented towards future developments was already held for the fifth time. However, for the first time the visitors met for a »Get Together« already the evening before in a relaxed atmosphere in the technical laboratories of the IKTS, which also served as an attractive exhibition area. Besides numerous exhibitors, »AdvancCer« also presented its innovative products there.

Change of Institute Director at the Fraunhofer ISC

Since February 1, 2006, Prof. Dr. Gerhard Sextl heads the Fraunhofer ISC in Würzburg. His objective is to advance the development of innovative components for new energy concepts and silicate materials.

During his 18-year-long career in the chemical industry Gerhard Sextl worked for Zeocern AG and Degussa AG. Gerhard Sextl also holds the chair of Chemical Technology and Material Synthesis at Würzburg University. On April 26, 2006 the previous director of the Fraunhofer ISC and spokesman of the Fraunhofer Materials and Components Alliance, Prof. Gerhard Sextl, is seen off with a ceremonial act, and Prof. Gerhard Sextl is appointed officially to office.

»AdvancCer« wants to thank Prof. Müller for good and successful cooperation, and wishes him all the best for the future!

Fraunhofer IKTS: The Term »System« Appears in the Name Now

Now, the Fraunhofer IKTS shows its orientation towards application also in its name. Since January 1, 2006 the »S« does not stand for Sintered Materials anymore but for Systems. At the end of January, Dr. Udo Gerlach retired. He was deputy director, head of the administration as well as department head of »Process and material characterization« at the IKTS. His work and activities at the IKTS were appreciated with a ceremony. Since January 1, Dr. Michael Zins is deputy director and head of the administration.

Current Training Courses

After a successful repetition of part I (Manufacturing technologies, properties, applications) in Dresden on March 14 and 15, »AdvancCer« continues its training course »Advanced ceramic materials« for technicians and engineers in 2006: with part II (Machining of ceramics) in Berlin on May 10 and 11, and part III (System integration, quality assurance, materials testing) in Darmstadt on September 27 and 28. »AdvancCer« also holds a workshop regarding materials testing and calculation of durability at the IWM Freiburg on November 16 and 17. The German Ceramic Society (DKG) and the IKTS offer an advanced training course regarding thermoplastic shape forming of advanced ceramics (technology and training) in Dresden on October 4 and 5.

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Success Stories: Diesel Particulate Filter (DPF) for European Automotive Application

With the tightening of environmental regulations, the demand for exhaust-gas purifiers for diesel-powered automobiles manufactured by IBIDEN Co. Ltd. with the main office Gifu Prefecture has been increasing in Europe and other areas of the world. A Diesel Particulate Filter (DPF) purifies Particulate Matter (PM) emitted by diesel engines. The trump card for purifying exhaust-gases in combination with the new diesel combustion system called common rail system is DPF. IBIDEN'S DPF material is made up of silicon carbide (SiC). Silicon carbide has been appreciated as a high-temperature material, and through various ingenious ideas it can be formed into a porous solid. IBIDEN applies the method of re-crystallization. Accumulation of PM captured by filtration walls degrades engine operation, worseing the fuel efficiency. Therefore, a system is installed which provides a process called regeneration, in which exhaust-gas temperature is raised on the engine side to burn and remove PM. Further, IBIDEN'S DPF is also characterized by a small variation in filtration wall pores (about 10 microns) and high capture efficiency. It can remove 99 % or more of solid particles. Mr. Koji Shimato who is the president of the Hungarian factory says that »it is a responsibility of a parts manufacturer to provide industrial products at a location which is situated close to the customers«. In Europe, diesel-powered passenger cars with good fuel efficiency and small carbon-dioxide emissions are in widespread use. As concerns new cars, the rate of ownership of such diesel-powered passenger cars has reached a point where they exceed 50 % of the total passenger car sales. Under the present circumstance where car manufacturers are competing for better environmental protection, IBIDEN'S DPF, having been rated highly in its durability and stability, has seen expanding installation on vehicles mainly in Europe. In order to comply with the increasing demand, the company has established a new system enabling an annual supply of 3 million units by 2005. IBIDEN will continue to meet increasing demands with the French and the Hungarian factories.

Extrusion Technology for Advanced Ceramics

Considering the fast development of heavy truck traffic and the development in engine technology resulting in smaller and smaller particles, it becomes obvious why the European emission standard EURO 4 could not be considered as sufficient in the long term. The standard became binding from January 1, 2005 and determines a PM value of 0.025 g/km. However, the »weight-oriented« picture is misleading: A particle with a diameter of 8 µm weighs as much as 0.01 µm. It is the particulate matter that is considered to be most dangerous for humans. Whereas research engineers concentrated on criteria like capture efficiency, durability, drop of pressure etc. so far, now the reduction of NOx is being regarded as a decisive criterion for the next generation of filter systems, in addition to particle capture. This development is a great challenge for materials as well as manufacturing technologies of honeycomb filters. Frank Händle, managing director of ECT GmbH: »For years we have been involved intensely in developing a technology for extruding ceramic honeycombs for DPF, SCR and as catalyst carriers. At a time when the chairman of the board of a large German automotive manufacturer was still polemizing about the »tiny filter« – »Si tacuisses, philosophus mansisses« –, we were already producing the first aggregates and discussing the next DPF generation with our customers and colleagues«. Today, more than 50 % of all DPF which are produced in Europe are extruded on vacuum aggregates by ECT GmbH.

The manufacturers of vacuum aggregates for extruding ceramic honeycombs have to meet diverse, partly contrary requirements: high pressures, tribological optimization, zone tempering, improved sensor technology, prevention of agglomeration in the rod, and increased reliability etc. ECT defines its position: »This can only be accomplished if extrusion is understood as a subprocess within the whole manufacturing process, considering interdependencies between mass preparation, mass, extrusion as well as the ensuing subprocesses«.