ceramitec FORUM 2018: Technical Ceramics Day

The conference program at the ceramitec FORUM will focus on a number of future-related topics. In 2018, it will be located in hall A5. Besides the top-class conference program, special shows, theme days and discussion panels are planned as a professional supplement to the key trade show. The overarching aim is primarily to give even greater visibility to the different fields of application of ceramics for the visitors' benefit. Attendance of the specialist lectures and discussions is free-of-charge. All lectures will be available with simultaneous translation in both German and English.

Thursday, 12.04.2018; 10:30 a.m. – 6:00 p.m.; Technical Ceramics Day

New powder qualities, enhanced technologies and demanding needs of users of Technical Ceramic components are the main drivers of progress in Technical Ceramics. Experts of applied science, suppliers and manufactures of Technical Ceramics will present new developments. Before closing the sessions, for the first time, the „Best Component Award Technical Ceramics" will be presented.

- **Organization:** Göller Verlag GmbH – CERAMIC APPLICATIONS, Baden-Baden/DE
- **Moderation:** Karin Scharrer, Editor-in-Chief cfi, CERAMIC APPLICATIONS, Göller Verlag/DE
- **Keynote:** Dr Michael Zins, Fraunhofer IKTS/DE

10:30 a.m. – 11:00 a.m. Keynote

- Technical Ceramics – to Fullfil Extreme Challenges from Deap-sea to ISS (Dr Michael Zins, Fraunhofer IKTS/DE)

11:00 a.m. – 12:30 p.m. New Materials for Ceramic Components with Enhanced Performance

- Specialty Aluminas for Technical Ceramic Applications (Dr Charles Compson, Almatis/US)
- Developments for Zirconia Powder as the Preferred Material in Established Industries (Adrian R. Toader, Tosoh/NL+JP)
- Focused on Boron Nitride (Andreas Rettinger, Henze Boron Nitride Products/DE)
- New Materials for Ceramic Components with Enhanced Performance: New Demands – New Feedstock Systems (Dr Karin Hajek, INMATEC Technologies/DE)
- New Range of Controlled Morphology Aluminas for Advanced Ceramics (Lionel Bonneau, Baikowski/FR)

12:45 p.m. – 2:30 p.m. Design of Ceramic Components for New Applications

- With Material and Technology Know-How to New Markets (Dr Karl Berroth, FCT Ingenieurkeramik/DE)
- Innovations with Applied Ceramics (Dr Reinhard Lenk, CeramTec/DE)
- New Diamonds/SiC-Composite Materials as Survivalists (Dr Mathias Herrmann, Fraunhofer IKTS/DE)
- Advances in Materials for AM of High-Performance Ceramics (Dr Johannes Homa, LITHOZ/AT)
- CMC – a New Class of Materials for Thermoprocess Technology (Dr Friedrich Raether, Fraunhofer HTL/DE)

3.00 p.m. – 4:30 p.m. Ceramic Components for Harsh Working Environment

- Power Distribution – Extreme (Dr Holger Wampers, ALUMINA SYSTEMS, formerly LAPP Insulators Alumina/DE)
- New High-Temperature Kiln Furniture (Alex Hilgenberg, Rauschert/DE)
- YSZ Materials for Harsh Working Environment Obtained by Emulsion Detonation Synthesis (Javier Montiel and Nuno Vitorino, Innovnano/PT)
- Ceramic Injection Molding: Technical and Commercial Innovtion Potential by Enhanced Development of Materials, Processes and Tools (Jens Graf, Kläger/DE)
- Requirements Engineered into Practise: Ceramic Fibre Composites for High-Temperature Fixtures (Dr Rolf Terjung, Graphite Materials/DE)

4:30 p.m. – 5:40 p.m. Technology Enhancement for New Applications

- Automatic Line for AM Manufacturing (Richard Gaignon, 3DCeram/FR)
- Fast-Tracking CIM Products (Senad Hasanovic, Ceramaret/CH)
- Numerical Simulation of the Sintering Process (Dr Anke Kaletsch, IAPK/DE)
- HIP Equipment for Densification of Ceramic and Metallic Powder Components (Marc Knauff, CREMER Thermoprozessanlagen/DE)

5:40 p.m. – 6:00 p.m. Best Component Award Technical Ceramics

From 6:00 p.m. „Get-Together at CERAMIC APPLICATIONS/Göller Verlag GmbH", Hall B6.321/420

Technical Ceramics Day – Abstracts

Keynote

Fraunhofer IKTS: Technical Ceramics – to Fullfil Extreme Challenges from Deap-sea to ISS
High-performance ceramics can demonstrate their strengths especially in the case of extreme requirements from deep sea to space. Referring to examples from waste-water treatment and water treatment, where ceramic filter systems are key components that achieve very long service lifetimes and optimum results in these extreme conditions the potential of ceramic membrane technology can be explained. In the production of biogas, the topics range IAPK from ceramic sensors through fuel cell systems for conversion into electricity or methane concentration based on ultrasonic activation of the biomass with piezoceramics. Ceramic components as an innovation for subsea systems are also challenging projects.

New Materials for Ceramic Components with Enhanced Performance

Almatis: Specialty Aluminas for Technical Ceramic Applications
Alumina is the most widely used material in technical ceramic applications, due to its physical, thermal and electrical properties. Some of the typical applications include catalytic substrates, electronic substrates, mechanical wear parts, spark plugs and thermal interface management. Each application and process has specialized requirements for their alumina powder, which greatly differentiate them within the field of Technical ceramics. Understanding the effects of raw materials physical and chemical characteristics on product performance is critical to every application. For example, some applications are very sensitive to particle size distribution or surface area, while others are most sensitive to chemical impurity content. In this talk, will be discussed the importance and effects of specific chemical impurities (Na_2O, SiO_2, CaO, MgO, etc.), and impurity levels, within various specialty aluminas, on the sintering profile, mechanical and dielectric properties of alumina-based technical ceramic parts.

Tosoh: Developments for Zirconia Powder as the Preferred Material in Established Industries
From the starting point of employing zirconia as structural ceramics, the use of this material in the industry has been widely expanded. With the expansion of the usage, also the demand for better and more diverse products has been demanded by the industry. Besides Technical ceramics, industries like SOFC, biomedical, dental industry even fashion are already established industries for Zirconia. Tosoh is employing its own proprietary technology. Using the latest hydrolysis processes and nano-technologies, Tosoh produces the TZ-Series of zirconia powders. E.g. Tosoh has developed a series of shades for the dental industry to supplement existing Tosoh materials for dental industry and will continue to optimize powders according to the needs of targeted industries

Henze: Focused on Boron Nitride
Boron Nitride is recognised as a technical ceramic material, which as a result of its versatile material properties and high temperature resistance is used in a broad spectrum of applications. Boron Nitride is used in powder form, forms a base constituent in suspensions and is available in the form of sintered components - depending on the application and demands that need to be placed on the material. The combination of its high thermal conductivity whilst simultaneously maintaining its electrical insulating properties make Boron Nitride an innovative filler in plastics such as cast resins and polymers. It represents a breakthrough in respect of the rising demands arising from the miniaturisation of electrical and electronic equipment. The high release and lubricating properties make this white ceramic material a first class dry lubricant.

Inmatec: New demands – New Feedstock Systems
The market also is asking for the possibility to produce high quality ceramic parts based on the new powders by means of Ceramic Injection Moulding (CIM). Ceramic feedstocks have to fulfill these increasing requirements. This challenge has been accepted, new binder-systems for ceramic feedstocks have been developed successfully. Now it is possible to choose the ceramic powder as well as the suitable binder system and have both compounded to a ceramic feedstock. Injection moulding properties as well as post processes (i.e. behavior during green machining or the de-binding mode) are mostly defined by the binder-system and can be driven by the respective formulation.

Baikowski: New Range of Controlled Morphology Aluminas for Advanced Ceramics
Baikowski® has recently developed a new range of high purity products with controlled morphology (CMA®).Such products make it possible to envisage the synthesis of ceramics with controlled porosity.The solid formulation via size and shape control allows to optimize the packing density for improved ceramic process and final ceramic properties. The control of porosity in high purity alumina parts can be considered to modify certain properties towards electromagnetic radiation (reflection / absorption / transmission) and heat transfer as well as to manufacture ceramic membranes for filtration.

Design of Ceramic Components for New Applications

FCT Ingenieurkeramik: With Material and Technology Know-How to New Markets
For many new applications, ceramic materials offer a good option to get improved product properties, higher service time for equipment and less contamination to the processed product. In order to reach this, material properties sometimes have to be adopted by optimized recipes and effective production technologies must be developed, to find a good compromise between technical, environmental and economic requirements, given by the intended application. This can be temperature, atmosphere and mechanical load as well as physical properties like density, stiffness, thermal expansion, thermal conductivity, electrical insolation or conductivity, corrosion resistivity and others. With this approach, new applications and markets can be served and niches can be broadened.

CeramTec: Innovations with Applied Ceramics
Advanced ceramic materials make applications possible today that were virtually inconceivable just yesterday. This material group covers many different and in part highly-specialized ceramic compositions with unique mechanical, electrical, thermal and biochemical properties and property combinations. Advantages and limitations of different manufacturing concepts are discussed. Both material properties and process capability are in focus of innovation. Deep material know how, technological reliability and an effective process control will be the guarantee for the long-term success of new ceramic solutions

Fraunhofer IKTS: New Diamonds/SiC-Composite Materials as Survivalists
In many cases, advanced ceramics show high wear resistance at room and high temperatures. Nevertheless, there is a demand of a further improvement of the wear and tribological behaviour of these materials. A promising and cost effective way for the production of diamond/SiC components was found to be the reaction bonding of diamond by silicon infiltration. This is a conventional ceramic technology analogous to those used to manufacture SiSiC allowing to produce large and complex shaped parts. It is possible to generate components having the SiC-bonded diamond surface layer only in areas, where wear resistance is required. During the infiltration process a three dimensional skeleton of SiC is formed. Due to the epitaxial growth of the SiC on diamond, a strong interface between diamond and SiC is formed resulting in the superior wear properties of the materials. An overview of the mechanical, wear and thermal properties and possible applications will be given.

LITHOZ: Advances in Materials for AM of High-Performance Ceramics
While lithographic techniques, in general, have taken a leading position in additive manufacturing (AM) of highly precise and strong ceramic parts, the available material portfolio is significantly smaller than for powder bed processes or extrusion-based techniques. This is mainly due to the difficult processing of darker powders because of light absorption and scattering phenomena.
By optimizing the photocurable suspensions towards very high reactivity the printing of materials such silicon nitride or cermets could already be realized. Especially in the case of silicon nitride-based ceramics, it was already possible to produce 3D printed parts with mechanical properties which are equal to conventionally formed components. Very recently it could also be demonstrated that lithographic AM can also be used to fabricate translucent alumina parts with a grain size below 1 µm, underlining the extremely high quality of printed parts that can be obtained by using lithographic techniques.

Fraunhofer HTL: CMC – a New Material Class for Thermoprocess Technology
CMCs consist of a ceramic matrix in which reinforcing fibres are embedded. Fibres and matrix can consist of oxide or non-oxide ceramics. Unlike conventional ceramics, CMCs exhibit very high damage tolerance. They can therefore substitute metallic materials that do not reach the required higher working temperatures. In comparison with metals, their high resistance to corrosion is an advantage; in comparison with monolithic ceramics, CMCs enable lightweight structures, reduce energy consumption and lengthen maintenance intervals. CMCs are a separate material class with great future potential. This applies particularly to thermal process engineering, in which new challenges are arising in response to the demand for increasingly efficient plants and equipment.

Ceramic Components for Harsh Working Environment

ALUMINA SYSTEMS: Power Distribution – Extreme
Thyristor housings can handle power till 12 GW and more. This immense power can be controlled by a small gate current of some volts. The housing protects the inside placed chip from corrosion and warrants a vacuum tight joint. All Thyrsitors are tested till a Helium-Leakage-Rate of 10^{-8} mbarL/s. They transform alternating current (AC) – produced f.e. from a 50 Hz – water turbine – in direct current (DC). By transporting the power over large distances the losses are lower compared to AC handling due to missing idle power. This technology is suitable to transport high power streams with minimum of losses over long distances. Countries with a centralized energy production (reservoir dams) are suitable for this technology (CN: IN; RU or US). China today is by far the biggest market for high end applications with >800 kV-lines with a market share bigger 50 %. Competing technologies like IGBT (Integrated Gate Bipolar Transistors) have even lower losses, but are not able to work in the power range higher 4 GW. They can be switched flexible (black start capable) and are used in deep sea cables, wind energy cables or other applications with power demand lower 4 GW.

Rauschert: New High-Temperature Kiln Furniture
Paul Rauschert Steinbach GmbH successfully developed new kiln furniture materials, branded as Rakor, Ramul and Ramul HT, which have superior thermo-mechanical properties than any other benchmarks available on the market. The major advantages are the creep resistance even up to 1700 °C, lower density having a porous structure and mechanical stability, which allows further mass reduction due to thin-walled geometry. Using those new materials can help ceramic industry to save energy and reduce costs, because of the longer life span. Furthermore, having a very high purity, Rakor can withstand harsh conditions like lead containing atmospheres for a very long time.

Innovnano: YSZ Materials for Harsh Working Environment Obtained by Emulsion Detonation Synthesis
Involving a cycle of high temperatures, pressures and rapid quenching, EDS produces nanostructured ceramic powder with extremely favorable properties compared to conventional micro-structured powders ensuring the control of powder chemistry, uniform grain sizes, low sintering temperatures and enhanced physical and chemical properties. 2 mol-% Y_2O_3-stabilized ZrO_2 was synthesized through this method, resulting in a product with outstanding mechanical properties without being significantly affected by the typical ageing process (thermal, hydrothermal and low temperature degradation ageing processes) of the YSZ ceramics materials. Cyclic stress-strain ageing tests in saline solution were additionally carried out successfully performed but using 1100 MPa as maximum pressure, highlighting the outstanding resistance of Innovnano 2YSZ powders to mechanical ageing.

Kläger: New Developments in Binder Systems for Ceramic Injection Moulding (CIM)
Advances in the material development of ceramic injection moulding feedstocks over around the last five years give users greater potential with regard to both technical and economic aspects. Technical limitations have been pushed further thanks to optimized workability. New geometries, whether with regard to their filigree structure, as well as in respect of their volume and component size are becoming possible, and consequently new applications can be developed. The development of the feedstocks on the basis of different thermoplastic carrier systems has been accompanied by new technical challenges for mould manufacturers and users. A really big step was the widening of binder systems from POM to include PP and PA. The concentration of know-how from material, tool, existing hardware and process is needed more urgently than ever.

Graphite Materials: Requirements Engineered into Practise – Ceramic Fibre Composites for High-Temperature Fixtures
The requirements on a component demand the combination of two materials in a new design by means of a high temperature joining process above 1200°C. The selected furnace concept ensures productivity and process reliability by means of workpiece carriers made of ceramic fibre composites. The example of composite carbon and aluminium oxide shows how, by their combination, defined material properties can be made use of for an industrially proven carrier system. High-tech niche materials become suitable for series production by means of engineering and are fundamental to the added value of a new component.

Technology Enhancement for New Applications

3DCeram: Automatic Line for AM Manufacturing
3DCeram developed a fully automated line for ceramic additive manufacturing. Marketed in 2014, the CERAMAKER 3D printer was developed to meet industrial specifications: the size of the tray and the constant printing quality (adapted to the series) have allowed to position the printer as a true production equipment. 3DCeram capitalizes on the CERAMAKER for the development of 3DCERAM 4.0, a fully automated line, from printing to sintering. The tray used as a print medium is automatically introduced into the printer. After 3D-printing of the ceramic part, it is transferred to a suction booth to remove the unpolymerized paste before entering the automated cleaning booth and the debinding and sintering kilns. This line maximizes printer uptime and minimizes waste while producing at high speed.

Ceramaret: Fast-Tracking CIM Products

The manufacturing of ceramic components using the injection molding process offers significant advantages in terms of costs and complexity of shape. The injection machines and feedstocks proposed on the marked as well as the experience acquired during the years of production allow the industry to produce today high quality components and in various ceramic materials at the most competitive costs. However, high costs and extended manufacturing time of the molds remain the major obstacles to an extensive use of injection molding in the production of ceramic components.

Ceramaret has developed an innovative molding solution, which reduces the tooling costs and shortens significantly the manufacturing time of injected ceramic components. The developed solution aims the achieve a production of initial series (up to 1000) of parts in less than 3 weeks and EUR 2000 tooling costs

IAPK: Numerical Simulation of the Sintering Process

For Ceramic Materials as well as for metals the process of sintering can be simulated with different sinter-models. In this regard, not only the densification and shape deformations during sintering can be predicted, but also residual stresses.

The presentation shows that different sintering processes can be considered in the simulation, like normal pressure less sintering, but also pressure assisted sintering within hot isostatic pressing (HIP) or field assisted sintering (FAST). In case of FAST, additionally the influence of electrical current can be integrated into the numerical model. There are different sintering models developed and presented in literature. This presentation shows a comparative study of three commonly applied models. The first model is based on a physical approach (Riedel) and the other two are phenomenological based models (the modified Skorohod–Olevsky Viscous Sintering (SOVS) model and a modified Abouaf model). The material models have been implemented through FORTRAN Subroutines used for the FE-Software ABAQUS. The simulation results demonstrate their advantages and disadvantages based on sintering simulations exemplarily for an alumina ceramic cylinder and a bilayer laminate.

CREMER Thermoprozessanlagen: HIP Equipment for the Densification of Ceramic and Metallic Powder Components

Regardless of the shaping method (uniaxial pressing, MIM/CIM, AM, etc.), due to the nature of the sintering process after shaping, such components contain a high percentage of pores. Depending on the application area of the components, these pores may be undesirable as they might be the source of defects and could impair mechanical material properties. For most medical or aerospace applications, pores are inadmissible. Now opportunities arise when combining powder-forming of components with the HIP process. E.g.: by means of MIM and CIM, pore-free high-strength and complex components can be manufactured in large quantities and at low costs. On the other hand, by means of AM + HIP, implants of highest strength can swiftly be customized for individual patients. High value small series or rapid prototypes follow that production line.