CZECH CERAMIC SOCIETY
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Book of abstracts

REFRA 2022

18th – 20th May 2022

Book of abstracts REFRA PRAGUE 2022
The Czech Ceramic Society
Authors: Ing. Anna-Marie Lauermannová, Ing. Jan Luxa, Ph.D.
Prague, May 2022

Conference program

18th May

12^{00} – 13^{00}	**Registration (Novotného Lávka 5, Prague)**
Section 1	**Chairman: Michal Příbyl**
13^{00} – 13^{30}	***M. Přibyl*** **(The Czech Ceramic Society)** Words of welcome
13^{30} – 14^{05}	***P. Šajgalík*****, Z. Lenčéš, C. Zhang, A. Mukasyan (ECerS, Slovak Academy of**
Keynote	**Sciences)** Rapid hot-pressed ultra-high creep resistant silicon carbide ceramics
14^{05} – 14^{40}	***H. Jansen*** **(Refratechnik Steel)** HYBRID – Innovative bonding technology for
Keynote	refractory concrete
14^{40} – 15^{00}	**Coffee break**
Section 2	**Chairman: Christoph Wöhrmeyer**
15^{00} – 15^{35}	***C. G. Aneziris*****, P. Gehre, B. Bock-Seefeld, T. Wetzig, P. Malczyk,**
Keynote	**S. Yaroshevskyi, C. Weigelt, J. Hubálková, E. Storti (TU Bergakademie Freiberg)** 3D-AM in Advanced Refractory Applications
15^{35} – 15^{55}	***E. Storti*****, M. Neumann, T. Zienert, J. Hubálková, C. G. Aneziris (TU Bergakademie Freiberg)** Metal-ceramic beads based on niobium and alumina produced by the alginate gelation
15^{55} – 16^{15}	**Coffee break**
Section 3	**Chairman: Christos G. Aneziris**
16^{15} – 16^{45}	***C. Heuer*****, C. G. Aneziris, R. Soth, A. Priese, C. Wöhrmeyer, C. Parr (TU Bergakademie Freiberg)** Impact of the stabilizer type and the phase composition on thermal shock performance of zirconia ceramics
16^{45} – 17^{05}	***B. Bock-Seefeld*****, T. Wetzig, J. Hubálková, G. Schmidt, M. Abendroth, C. G. Aneziris (TU Bergakademie Freiberg)** A novel approach for the production of carbon-bonded alumina filters by water-soluble filter templates
17^{05} – 17^{25}	***K. Moritz*****, S. Dudczig, H. G. Endres, D. Herzog, M. Schwarz, L. Schöttler, T. Schemmel, C. G. Aneziris (TU Bergakademie Freiberg, Refratechnik)** Use of recycled materials for producing magnesia-carbon refractories
18^{00} – 21^{00}	**Get together**

19th May

Section 4 **Chairman: David Salamon**

9^{30} – 10^{05} ***S. Dvořák*, K. Lang, L. Vašica (P-D Refractories CZ)** Hot blast stove and choice of refractories
Keynote

10^{05} – 10^{25} ***L. Keršnerová*, Š. Keršner, D. Zemánek, E. Bartoníčková, J. Švec, P. Hrubý, F. Šoukal (P-D Refractories CZ)** Lightweight insulating castables made by sol-gel technology

10^{25} – 10^{55} ***E. Bartoníčková*, J. Švec, L. Galvanková, P. Hrubý, J. Koplík, F. Šoukal, D. Zemánek, L. Keršnerová, Š. Keršner, K. Lang (BUT Brno)** Densification of porous mullite-based castables by sol-gel impregnation

10^{55} – 11^{15} **Coffee break**

11^{15} – 11^{35} ***P. Leto* (Průmyslová keramika)** A novel method for characterization of refractory plastic materials

11^{35} – 11^{55} ***H. Ovčačíková*, M. Velička, J. Vlček, V. Matějka, B. Kostura (VSB Technical University of Ostrava)** 3D Ceramic print

12^{00} – 14^{00} **Lunch**

Section 5 **Chairman: Hana Ovčačíková**

14^{00} – 14^{35} ***C. Wöhrmeyer*, F. Simonin, F. Ahouanto (Imerys)** A review of Al_2O_3-rich aluminosilicate aggregates and their impact on thermomechanical properties of refractories
Keynote

14^{35} – 14^{55} ***P. Vadász*, B. Plešingerová, D. Medveď, G. Sučik, R. Bakajsová (Technical University of Košice)** Corrosion of corundum refractory materials in intensive process of dendromass combustion

14^{55} – 15^{15} ***B. Lekkerkerk* (Vulcor Insulation)** Generation III spinning/Ultra low shot production of high temperature fiber products

16^{00} – 22^{00} **Cruise (boarding 16^{00} – 16^{45}) and Dinner**

20th May

Section 6 **Chairman: Pavol Vadász**

9^{30} – 10^{05} **R. Bakajsová, *G. Sučik*, B. Plešingerová, P. Vadász, D. Chudíková (Technical University of Košice)** Influence of SiC content on the resistance of low-cement and non-cement refractory materials against corrosion by oxide melts

Keynote

10^{05} – 10^{25} ***J. Fruhstorfer*, D. Gruber, H. Harmuth (Montanuniversität Leoben)** Analyzing crack deflection behavior of refractories by digital image correlation

10^{25} – 10^{45} **D. Salamon, J. Roleček, L. Pejchalová, J. Sedláček (BUT Brno)** Freeze-casting of highly porous ceramics

10^{45} – 11^{05} ***J. Kočí,* M. Havlík Míka, J. Hamáček (UCT Prague)** Synthesis of mullite fibers from boehmite nanoparticles

11^{05} – 11^{25} ***M. Havlík Míka* (UCT Prague)** Heat resistant nanofibers for batteries in electric vehicles

Rapid Hot-pressed ultra-high creep resistant silicon carbide ceramics

Pavol Šajgalík[1], Zoltan Lenčéš[1], Chengyu Zhang[2], Alexander Mukasyan[3]

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[2]North Western Polytechnic University, Xi´An, China

[3]University of Notre Dame, Notre Dame IN, USA

Freeze-granulated silicon carbide powder was densified to the full density without any sintering aids by rapid hot-pressing at 1850 °C. This densification temperature is at least 150–200 °C lower compared to the up to now known solid state sintered silicon carbide powders. Presented silicon carbide hot-pressed ceramics have excellent mechanical properties. Samples densified by ultra-rapid hot-pressing have also full density and hardness of 27.4 GPa. Partial phase transformation beta/alpha - SiC was observed in the granulated and rapid hot-pressed samples.

These additive-free silicon carbide ceramics was crept in vacuum at temperatures of 1500 °C to 1750 °C and compressive loads of 200 MPa to 400 MPa. The results showed that this way prepared ceramics had the lowest creep rate reported in the literature. The observed strain rates increased from 2.5×10^{-9} s^{-1} at 1500 °C and a load of 275 MPa to 1.05×10^{-7} s^{-1} at 1750 °C and a highest load of 400 MPa. The average creep activation energy taken from all creep tests was 315 ± 20 $kJ\cdot mol^{-1}$, and the stress exponent was 2.22 ± 0.17. The suggested creep mechanism is GB sliding accommodated by GB diffusion and $\beta-\alpha$ SiC phase transformation.

HYBRID – Innovative bonding technology for refractory concrete

H. Jansen[1]

[1]*Refratechnik Steel GmbH, Germany*

3D-AM in Advanced Refractory Applications

C. G. Aneziris[1], P. Gehre[1], B. Bock-Seefeld[1], T. Wetzig[1], P. Malczyk[1], S. Yaroshevskyi[1], C. Weigelt[1], J. Hubálková[1], E. Storti[1]

[1]*Institute of Ceramics, Refractories and Composite Materials, TU Bergakademie Freiberg, Germany*

Metal-ceramic beads based on niobium and alumina produced by alginate gelation

E. Storti[1], M. Neumann[1], T. Zienert[1], J. Hubálková[1], C. G. Aneziris[1]
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Full metal-ceramic composite beads containing different amounts of niobium and alumina, particularly 100 vol% alumina, 100 vol% niobium, and 95/5 vol% niobium/alumina, were produced by the alginate gelation process. The suspension for bead fabrication contained sodium alginate as gelling agent and was poured dropwise through nozzles with different diamters into a calcium chloride solution to trigger the consolidation process. After debinding in air, sintering of the composite beads was performed under inert atmosphere. Full beads with good spherical shape and average final diameters in the range 1.75-2.9 mm were obtained. Investigations by mercury intrusion porosimetry revealed that pure alumina beads featured smaller pores compared to composite beads, although the open porosities were comparable. The fracture strength was evaluated on single beads. Contrary to the pure alumina, the composite beads showed a clear plastic deformation. Pure niobium beads showed a ductile behavior with very large deformations. XRD analyses revealed the presence of calcium hexaluminate and beta-alumina as minor phases in the alumina beads, while the composite ones contained about 25 wt% of impurities. The impurities comprised NbO arising from the oxidation, and beta-Nb_2C, from the reaction with the residual sodium alginate. This study demonstrated that the gel casting process allows to reliably produce spherical grains with defined properties, which can be used as aggregate fraction in new coarse-grained refractory castables, among others.

Acknowledgement: This research was funded by the German Research Foundation (DFG) within the Research Unit FOR 3010 (Project number: 416817512). The X-ray diffractometer was acquired through the “Major Research Instrumentation” funding program of the German Research Foundation (DFG), reference number: INST 267/157-1 FUGG (Project number: 395259190).

Impact of the stabilizer type and the phase composition on the thermal shock performance of zirconia ceramics

C. Heuer[1], C. G. Aneziris[1], R. Soth[2], A. Priese[2], C. Wöhrmeyer[2], C. Parr[2]
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[2]*Imerys S. A., France*

Zirconia based ceramics are among the most promising engineering materials. They are widely used in continuous steel casting as tundish nozzles, slide plates or as wear parts in areas with high thermal and chemical stresses. Understanding the thermomechanical and thermochemical performance as a function of the stabilization, the grain size distribution, and the sintering accompanied by the real thermal conditions during operation are unlimited tools for material and component design and developments in the iron and steel industry as well as in the non-ferrous industry. Within the present contribution, four different zirconia materials are investigated. Aspects of the stabilizer type, phase compositions of the starting materials as well as of the sintered components are examined with the aid of electron backscatter diffraction and X-ray analysis. The influence of the sintering/annealing temperature on the phase formation is studied and related to the mechanical and thermo-mechanical properties. Moreover, the corrosion resistance of the zirconia ceramics against molten steel as well as the thermal shock performance under industry-related conditions have been evaluated in a steel casting simulator.

Acknowledgement: This is an industrial project funded by IMERYS S.A., France.

A novel approach for the production of carbon-bonded alumina filters by water-soluble filter templates

B. Bock-Seefeld[1], T. Wetzig[1], J. Hubálková[1], G. Schmidt[1], M. Abendroth[2], C. G. Aneziris[1]

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[2]*Institute of Mechanics and Fluid Dynamics, TU Bergakademie Freiberg, Germany*

Carbon-bonded alumina filters have been established in the steel industry to reduce the amount of non-metallic inclusions and hence to improve the quality of cast steel products. The filter structures are commonly manufactured by the multi-stage replica technique, whereby carbonaceous alumina slips are applied on polyurethane foams, exhibiting a random structure with triconcave, sharp-edged struts. During the pyrolysis of the filters, the foams decompose and cavities with the same shape emerge within the filter struts, which could encourage the growth of critical cracks under mechanical load. In order to manufacture defined filter geometries with a circular strut shape, a novel approach for the filter fabrication was investigated. For this purpose, water-soluble polyvinyl alcohol filter templates were fabricated by means of additive manufacturing. The filter templates were coated with alginate-containing slips and placed in an aqueous solution enriched with Ba^{2+} ions to trigger the gelation of the slip. Simultaneously, the water-soluble filter templates are removed from the filter structures by the aqueous solution. After drying, the hollow filters were coated twice with alginate-free slips and pyrolized at 800 °C. To evaluate the process feasibility, the filters were analyzed after each coating step by SEM and CT. Additionally, the mechanical filter properties were examined by determining the cold crushing strength. The results revealed that the novel approach is suitable for the fabrication of carbon-bonded alumina filters without a thermal filter template removal. The filters exhibited a cold crushing strength of 0.13 MPa, which possesses a great potential for the steel melt filtration.

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Separation of iron oxides from fly ash by magnetic field

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Magnesia-carbon (MgO-C) refractories have been established in the steel industry for applications such as ladle and converter linings. Correspondingly large quantities of used MgO-C materials are generated. Recycling these materials and reusing the obtained recyclates as secondary raw materials for the production of refractories can make an important contribution to conserving natural resources, saving energy, reducing greenhouse gas emissions and reducing deposition in landfills.
In the research project presented here, the influence of a stepwise replacement of virgin materials by a MgO-C recyclate on the properties of the produced MgO-C refractories, whose carbon content was adjusted to about 10 wt%, was investigated. Recyclate contents of the mixture up to 82 wt% were used. The test specimens were prepared on a laboratory scale by uniaxial pressing and coked under reducing conditions at 1000 °C.
The open porosity of the specimens showed an increase with increasing recyclate content, which is typical for recyclate-based refractories and can be attributed mainly to the internal porosity of the recyclate aggregates. Supported by scanning electron microscopy studies, another influence is seen in the different size and orientation of the graphite in the recyclate aggregates compared to the flakes of the virgin graphite. The recyclate content in the MgO-C specimens led on the one hand to a decrease in the cold modulus of rupture and the dynamic Young's modulus, but on the other hand to an improved thermal shock resistance.

Acknowledgement: This project was funded by the German Research Foundation (Deutsche Forschungsgemeinschaft) under project number 437121912.

Hot Blast Stove and Choice of Refractories

S. Dvořák[1], K. Lang[1], L. Vašica[1]
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The requirements for quantity, temperature and pressure of the blown hot air have grown together with the dimensions of blast furnaces. At the same time, the requirements for the operation and reliability of hot blast stoves were increased as well. As the original stoves got up to their limits of the air temperature and pressure very soon, they have started to be replaced by so called high-temperature stoves of new designes.

The potential of the up-to-date hot blast stoves is above all determined by the quality of the used refractories and the way and accuracy of the checker-works assembly. That is why there have always been a maximal attention paid to the development of materials applied in the parts of stove lining which are permanently exposed to a huge mechanic tension and high temperatures. The choice of suitable refractories is focused on dimensional accuracy, high and stable quality parameters and reasonable price linked with a supplier's reliability.

Knowing the behavior of these materials in heat is a basic condition for the successful and effective use of refractories in the linings of hot blast stoves with a long-term impact of high temperatures and load. This article therefore also deals with the causes for plastic deformations of refractories in the area of high temperatures, dependency of refractories creep on temperature and pressure and shows methods of both, measurements and assessment.

Lightweight insulating castables made by sol-gel technology

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Insulating materials are an important part of refractory industry, especially these days when demand for energy savings increases. At the same time, cement free castables (both dense and insulating) are gaining more and more importance in applications which require fast heating-up procedure. Development of lightweight castable with colloidal binding system seems to be promising for both producer and customer.
The aim of this study is to evaluate production possibilities of insulating castables based on lightweight aggregate, high alumina matrix and silica sol bonding. For further lightening, the foaming agent was added. Although the previous experimental works in laboratory scale were successful, it was necessary to evaluate the influence of mixing process, stability of foam, setting time and demolding process during production trials. Significant difference between parameters obtained from laboratory trials and plant trials was observed.

Acknowledgement: This project was funded from *FW01010077: "Refractories manufactured by sol gel technology"* with financial support from the Czech Technology Agency

Densification of porous mullite-based castables by sol-gel impregnation

E. Bartoníčková[1], J. Švec, L. Galvánková[1], P. Hrubý[1], J. Koplík[1], F. Šoukal[1], D. Zemánek[2], L. Keršnerová[2], Š. Keršner[2], K. Lang[2]

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In recent years the nano-technological approach has entered the field of refractory industry with the promising strategy of mechanical and physical properties improvement. The application of colloidal suspensions as cement-free binders seems to be one of the possible routes to successfully improve the mechanical strength of lightweight castables. Here we present the fabrication method of mullite porous ceramics using a calcium-free colloidal binding system followed by sol-gel impregnation. The lightweight castables were prepared by direct foaming of slurry containing colloidal silica binder, gelling agents, surfactant, micro silica, and reactive aluminas. The foam mixture was cast, de-moulded and dried using a cascade drying procedure. Then the sintering curve consisting of various temperatures combined with relaxation dwells was applied to obtain the highest mechanical properties. The so-called precursor foam (with open porosity, volume density about 400 kg/m3 and mechanical strength about 7 MPa) was then impregnated in colloidal suspensions based on silica and alumina sols. The investigation of reaction kinetics and mechanism, especially mullitization process, that occurred during the high-temperature treatment was performed by HT-XRD, TG-DTA analysis and heating microscopy. Foam microstructure was observed by an electron scanning microscope. The porosity evolution was studied by mercury intrusion porosimeter and calculated from image analysis.

Acknowledgement: This project was funded from *FW01010077: "Refractories manufactured by sol-gel technology"* with financial support from the Technology Agency of the Czech Republic.

A novel method for characterisation of refractory plastic materials

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Plastic refractory materials are favourite choice for application, where a quick installation without using a form is needed. Therefore, they quickly gained popularity, which drives further research of these materials. A novel method of testing was employed to investigate plastic refractories and their behaviour from different perspectives. For this purpose, a universally applicable material testing machine was specially equipped to enable load-deformation tests at up to 300°C. Material characterization using this device involved adjustment of rheology, observation of hardening of chemically bonded plastic refractories, scrutinization of taphole clay “ripening” or its deformation at various temperatures.

3D Ceramic Print

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3D ceramic printing is not a common technology in the Czech Republic for production of ceramic materials. The current experience in 3D ceramic printing is based primarily on testing the technology in laboratory conditions. The potential of this method is great; it allows the printing of complex shapes using variable speed, without the need for human supervision. 3D printers can work on different principles depending on the printing material and the purpose of the product. At the workplace of the Department of Thermal Engineering, Faculty of Materials Science and Technology, VŠB-TU Ostrava, is a complete of 3D printers, which is supplemented by auxiliary equipment, such as a filling screw press, pressure vessel. Printer is designed on the principle of open-source RepRap architecture. Experience to date shows that for the needs of ceramic printing, it is necessary to focus on quality preparation of the material for printing (homogenization without air bubbles, convenient rheology) and the appropriate setting of the discharge pressure and the printing speed or width of the ceramic line. This study focuses on the evaluation of the system's parameters for 3D printing and compares the basic properties of samples prepared by 3D printing technology with samples from standard production.

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A review of Al_2O_3-rich aluminosilicate aggregates and their impact on thermomechanical properties of refractories

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Corrosion of Corundum Refractory Materials in Intensive Process of Dendromass Combustion

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The combustion of biomass, namely wood chips, is characterized by a relatively high content of incompletely combusted fraction. One way to prevent this is to improve the combustion, intensify the process. However, it changes the thermal and physico-chemical condition of the combustion. The temperature in the combustion chamber and flue system determines the corrosion degradation extent of refractory linings by molten slag. The fine sticky particles of ash are captured on the surface of the lining, the created melt and also the vapours attack and corrode the refractory material. The increased temperature accelerates all chemical interactions taking place on the surface of the refractory lining.
We have tried to increase the melting temperature of ash (ash fusibility index) by adding the dust $MgCO_3$ to dendromass ash. Dust magnesite sludge was used to modify the ash. The effect of MgO addition to ash on the melting was monitored in a high temperature microscope according to STN ISO 540. Then we verified by the static corrosion crucible tests an inhibit effect of the modified ash on the corrosion of corundum refractory materials.
Static corrosion tests were carried out with the dendromass ash without/with $MgCO_3$ (weight ratio 1 : 2) on the crucibles prepared from the corundum refractory material at 1450°C/ 7 hours at a max. temperature. The aggressiveness of the corrosive medium to the refractory material was evaluated from: the changes in the chemical and phase composition of the corrosive medium/ post mortem slag; the degree of degradation of the corroded crucible material (the corrosion profile, the depth of ash element penetration into corroded materials). EDS analysis was used to study of the macro- and microstructures of the corrosion interface l-s (melt – refractory material); the element maps and analyses from selected locations in the corrosion interface area have been studied.

Acknowledgements: This study was financially supported by the Slovak Grant Agencies through *VEGA – MŠVVaŠ SR a SAV project No.1/0060/22 and project APVV-17-0483.*

Generation III spinning/Ultra low shot production of high temperature fiber products

B. Lekkerkerk[1]
[1]*Vulcor Insulation, Netherlands*

The new Tempering Kiln at SLOVMAG a.s. in Lubenik, Slovakia

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[2]*RMS Košice, s. r. o., Slovak Republic*

If the alternative fuels (biomass combustion) are used, the working lining of high-temperature aggregates are exposed to more aggressive flue gas and alkaline ash melt. The work is aimed at the corrosion resistance evaluation of refractory castables with a different chemical and phase composition of binder phase. After the corrosion test, the degradation of low-cement castables (LCC) based on bauxite, andalusite, fireclay, bound by hydraulic bond and non-cement castables (NCC) with a coagulation bond were compared; all tested castables contained different content of SiC. The temperature and corrosion resistance of castables was considered in relation to the type of the used binder phase and the SiC amount.

After the primary firing of the casted samples (1450 °C/7 h), the new phases in varied proportions, mainly mullite and anorthite were detected by the X-ray diffraction analysis. Mullite and anorthite originated in situ reactions of the ultrafine matrix phase.

The corrosion resistance of fired crucible-shaped samples from mixtures of castables has been tested by a static corrosion crucible test with duration of 10 hours at a maximum temperature of 1450 °C. Dendromass ash from a power plant was used as a corrosion medium. The post-corrosion profile of the inner wall of the crucibles, the displacement of the interface and the concentration of the elements from refractory concrete in the solidified post-mortem melt indicated the level of resistance of the tested materials to the ash melt. The concentration of elements coming from the ash in the corrosion interface (l-s) and the intensity of penetration — the diffusion of the components (K, Na and Si) into the refractory concrete indicate the ability of the connective phase to prevent corrosion.

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Analyzing crack deflection behavior of refractories by digital image correlation

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[1] *Chair of Ceramics, Montanuniversität Leoben, Austria*

This study investigates the potential of digital image correlation (DIC) to analyse energy dissipation occurring during wedge splitting tests. Two alumina refractories showing different matrix density with a maximum grain size of 3mm were investigated. The denser matrix showed higher widths of delamination between aggregate grains and matrix. The DIC analyses were performed with two resolutions. One allowed to evaluate the fracture process zone (FPZ), the other visualized the macrocrack (MC) path (incl. branching) without the FPZ. In both samples, multiple strain concentration sites occurred, but more in the denser sample. In this sample, the following connection of these sites during propagation of the MC led to MC deflection, but only a small FPZ developed. For the less dense sample, the developing FPZ was larger. This indicates a higher contribution of events outside the crack tip to the fracture process. Consequently, it showed a higher fracture energy than the denser material.

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Freeze-casting of highly porous ceramics

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Ice templating, also known as freeze-casting, is a relatively simple, inexpensive, and versatile technique to fabricate bulk porous scaffolds. The basic idea of ice-templating is to obtain porosity, a replica of ice crystals, by freezing suspension and subsequently removing the ice crystals by sublimation of the solvent (most commonly, water is used as a solvent). The solid phase in the suspension can be of practically any nature, from ceramic to metal particles or polymer, but ceramic particles are the most used. Porous ceramic scaffolds can be obtained by controlled freezing of ceramic slurries, which is followed by sublimation of water and densification (sintering). In ice-templating, the particles in the ceramic slurry are ejected from the moving solidification front and pile up between growing ice crystals creating multilayer porous ceramic structures with well-defined architecture.

The main challenge linked with large porous ceramics prepared by the freeze-casting method is achieving controlled ice crystals throughout the sample volume. This phenomenon is caused by the loss of sufficient temperature gradient in the ceramic suspension as the solidification front moves away from the cooling plate. Thus it is necessary to control the freeze-casting process precisely. The ceramic suspension containing alumina (Al2O3) based materials in water and bioceramic materils was used in this work. An influence of suspension solid loading and additives on the formation of lamellar roughness and interlamellar bridges was investigated during freeze casting of large ceramics scaffolds. The suitability of freeze-casting technique for refractory materials is discussed.

Acknowledgement: This work was co-financed from the state budget by the Technology Agency of the Czech Republic within the TK – Program na podporu aplikovaného výzkumu, experimentálního vývoje a inovací THÉTA (TK03020005).

Synthesis of mullite fibers from boehmite nanoparticles

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Mullite ceramics is a type of commonly used high-temperature material, made from the most available ceramic raw materials (Al_2O_3 and SiO_2) in the right proportions. In the form of fibers, mullite is one of the best and cheapest thermal insulation materials, e.g. in industrial furnaces. Due to its refractory properties, high melting point (1840 °C) and economic availability, it appears to be one of the most effective ceramic materials. The use of electrospinning for the production of mullite nanofibers by the sol-gel technique is not new and fibers of this type have been produced for many years, but mostly by precipitation reactions which are not entirely economically advantageous. New possibilities of filling organic templates with inorganic nanoparticles and sintering into a fibrous structure are not yet as effective as older and more expensive methods, but they give the possibility to produce nanofibers from any material that can be grind to the required small fractions.
This work focuses on the preparation of mullite nanofibers from boehmite (AlOOH), obtained in the form of nanoparticles as a waste product, tetraethylorthosilicate (TEOS) with a silica component and PVP polymer, which together with colloidal TEOS form fibrous templates for nanoparticles. The purpose of using cheap and refractory fibers produced in this way is from hot filtration and insulation, through non-flammable textiles to safe solid electrolytes in batteries.

Heat resistant nanofibers for batteries in electric vehicles

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