SFB 920

Multifunktionale Filter für die Metallschmelzefiltration – ein Beitrag zu Zero Defect Materials

# NEWSLETTER 21 (2/2021)

DFG Deutsche Forschungsgemeinschaft

TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG
Die Ressourcenuniversität. Seit 1765.

## DEAR READERS,

research into functionalized filter materials and the design and construction of new types of filter systems for metal melt filtration requires focused collaboration between scientists from different scientific fields. In view of the rising complexity of the issues to be addressed, it is becoming increasingly important to promote the exchange of scientific knowledge and the transfer of research results, and to open up new areas of applications.

Against this background, the focused qualification and networking of young scientists in the Collaborative Research Center CRC 920 is of great importance. Through a variety of activities, they are to be enabled to conduct excellent research, develop new ideas and successfully transfer knowledge. Details on these and other activities are available in our latest issue of this newsletter. Further information is provided at https://tu-freiberg.de/forschung/sfb920.

We hope you will enjoy the newsletter!

Yours sincerely,

Prof. Dr.-Ing. habil. Christos G. Aneziris
CRC 920 Coordinator

Prof. Dr.-Ing. habil. Horst Biermann
CRC 920 Vice Coordinator

## CONTENT


CRC 920 News

*Networking and qualification to improve skills* 2

*More News* 3

*Working Group's Report* 4

Research Highlights

*Raman investigation on CarboresP, Lactose, and Tannin* 6

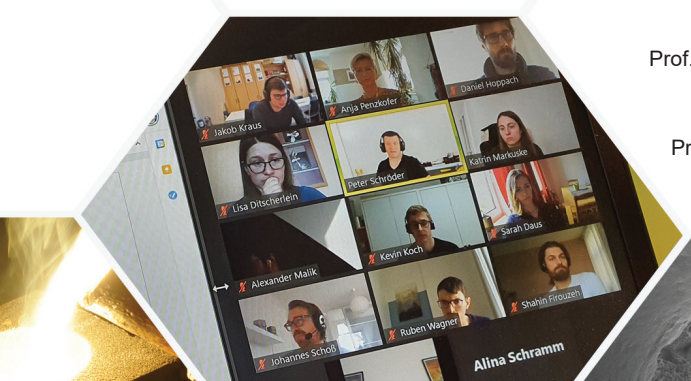
*Determination of extinction coefficients of ceramic filter structures* 7

Current Publications 8

Future Ceramics 9

Graduation in CRC 920 10

Dates and Imprint 10




# NETWORKING AND QUALIFICATION TO IMPROVE SKILLS

**Cross-project networking as well as the integration of doctoral students into networks with national and international scientists serves to broaden and deepen expertise on the way to the successful completion of the doctorate and to further qualification for the international scientific and the economic-industrial labor market. The Research Training Group of the CRC 920 offers a comprehensive qualification and organization concept for this purpose.**

In addition to the interdisciplinary as well as process- and problem-solving-oriented cooperation in the four working groups of the CRC 920 "Multi-Functional Filters for Metal Melt Filtration - A Contribution to Zero Defect Materials", the teaching of technical and methodological skills as well as relevant soft skills in workshops and training courses are important instruments to acquire competences for the presentation and publication of scientific results of the project work as well as social competences in the environment of cross-scientific research work.

One's own publication or doctorate is also a project. Under this slogan, the doctoral students were able to familiarize themselves with the rules for planning, implementing and successfully completing project work under the professional guidance of the trainer Dr. Peter Schröder from Golin Wissenschaftsmanagement Berlin in the workshop on **"Project Management in Science: Tools for Challenges"** within the framework of the Research Training Group of the CRC 920.

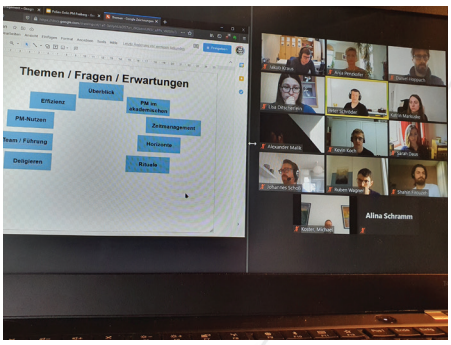



Photo: Participants in the digital workshop „Project Management in Science".

How do I make contact with scientists outside my research area, my research institution? How do I reach potential users of my research results in industry? These and other questions were addressed at the workshop on **"Networking in the academic context: Establishing and maintaining contacts using traditional and digital means"**, which was conducted by trainer Dr. Cornelia Altenburg from Golin Wissenschaftsmanagement Berlin. ■


From the very beginning, the doctoral students of the CRC 920 dedicated themselves with great enthusiasm to pupils of all ages in order to arouse their interest in engineering and scientific topics. In addition to joint workshops, training sessions and the supervision of groups of schoolchildren at the university or school institution, they were thus able to successfully develop their own skills in imparting knowledge and thus in attracting young scientists.

A special highlight was the joint **art project with the Geschwister-Scholl-Gymnasium in Freiberg**. Under the topic **"Future Ceramics"**, pupils were asked to artistically explore the possible applications of ceramic materials. After numerous online sessions on real and future application possibilities, the high school students from the advanced art course (12th grade) further developed the impulses from ceramics research, which ultimately found expression in works of art. From June to September 2021, the results of the visions for the "Future Ceramics" were made accessible to the public in an exhibition at the TU Bergakademie Freiberg. ■

A particularly efficient tool for the integration of young researchers into the scientific community is their accompaniment by national and international visiting scientists as well as longer stays in research institutions abroad.

Thus, from September to December 2021, members of the research group of **Ass. Prof. Ondřej Jankovský from the University of Chemistry and Technology in Prague (VŠCHT Praha), Czech Republic,** were invited by CRC 920 to work together with scientists in subproject A01 on the use of nanomaterials for the production of novel filter materials for metal melt filtration. Dr.-Ing. Claudia Voigt completed a research stay at the **Norwegian University of Science and Technology (NTNU)** and Dipl.-Ing. Ruben Wagner at the **European Synchrotron Radiation Facility in France (ESRF)**. Currently, Dr.-Ing. Hanka Becker is conducting research at the **Technical University Denmark (DTU)** on the kinetics of Fe-containing particles in aluminum melts. ■

# MORE NEWS

## AWARD

For his outstanding scientific and organizational achievements, **Prof. Dipl.-Ing. Björn Kiefer, Ph.D.** from the Institute of Mechanics and Fluid Dynamics (IMFD) was awarded the degree of **"Fellow" by the American Society of Mechanical Engineers (ASME)**.

The holder of the Freiberg Professorship of Engineering Mechanics - Solid Mechanics received the honor for his many years of diverse involvement with ASME, one of the world's largest professional associations for engineers. It also honored his work in scientific exchange and in promoting future specialists and managers.

"I am very honored to be named a Fellow, especially since this award is the highest level of membership and requires nomination by several Fellows who have already been appointed", explains Prof. Kiefer.

Since the founding of the American Society of Mechanical Engineers in 1880, fewer than 20 scientists and engineers from Germany have received this honor. To be nominated as a Fellow, a person must have been an active member of the Society for at least 10 years and have produced significant engineering achievements. ■

Photo: Prof. Björn Kiefer was appointed „Fellow" of the American Society of Mechanical Engineers (ASME).

## INTERNATIONAL EXCHANGE

From September to December 2021, at the invitation of the Collaborative Research Center CRC 920, **Dipl.-Ing. Anna-Marie Lauermannová and Dipl.-Ing. Michal Lojka from the University of Chemistry and Technology in Prague (VŠCHT Praha), Czech Republic,** will conduct research together with scientists from subproject A01 on new approaches to the manufacture of ceramic filter materials. This involves investigating the use of carbon-based and cement-based nanomaterials for the processes developed in CRC 920 for the production of composite materials for ceramic molten metal filters, for example by means of additive manufacturing (3D printing).

Both guest scientists are PhD students in the research group of **Ass. Prof. Ondřej Jankovský (VŠCHT Praha),** who is one of the leading international experts in the field of graphene and graphene oxide fabrication. Together with Prof. Christos G. Aneziris' research group in CRC 920, initial results on the use of graphene-containing materials in porous large-volume functional components for metallurgy have already been obtained and published in international papers. ■

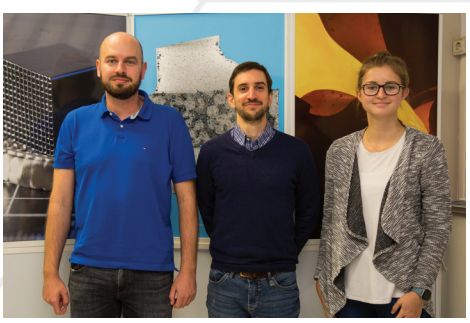


Photo (from left to right): Ass. Prof. O. Jankovský (VŠCHT Praha), Dr.-Ing. E. Storti (ICRCM), Dipl.-Ing. A.-M. Lauermannová (VŠCHT Praha).

## JUNIOR GROUP ON COPPER CASTING

**Dr.-Ing. Claudia Voigt**, postdoctoral researcher in subproject A02 of the CRC 920, will take over the leadership of the **junior group "PurCo - Purification of Cooper - Contributions to Copper Filtration and Recycling of Copper Scrap"** funded by the **German Federal Ministry of Education and Research (BMBF)** in January 2022. This pools the expertise of the Institute for Ceramics, Refractories and Composite Materials (ICRCM) and the Institute for Nonferrous Metallurgy and Pure Materials (INFMPM) at TU Bergakademie Freiberg for research into new filtration and recycling techniques for copper and copper alloys. Together with two industrial partners, new filtration techniques for copper casting are to be developed.

For the new challenge as head of the junior group, Dr. Voigt can draw on a wealth of experience from her research activities in CRC 920. Here, molten metal filters made of ceramic materials, e. g. ceramic foam filters, have already been successfully developed for the cleaning process in aluminum and steel casting. The research content of the junior research group "PurCo" on copper filtration and recycling of copper scrap has a fundamentally different scientific and technological object and thus differs from the research funding in the Collaborative Research Center CRC 920. ■

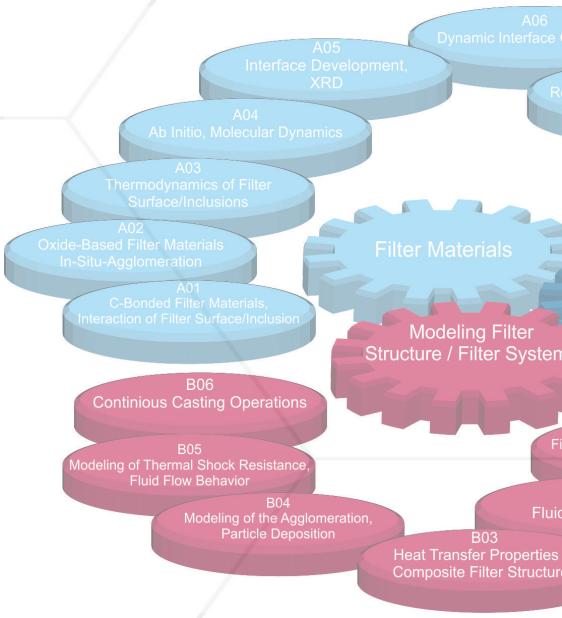
Photo: Casting of a copper alloy.

# WORKING GROUPS' REPORT

**Research teams in the CRC 920 are connected in four working groups, thus ensuring targeted activities, close collaborations between subprojects, and intensive exchanges between all researchers involved. Young scientists are taking responsibility for coordinating these working groups - a measure the CRC has taken to support young scientists already in early career stages to promote their capabilities to work independently as well as in teams and to strengthen their management skills.**

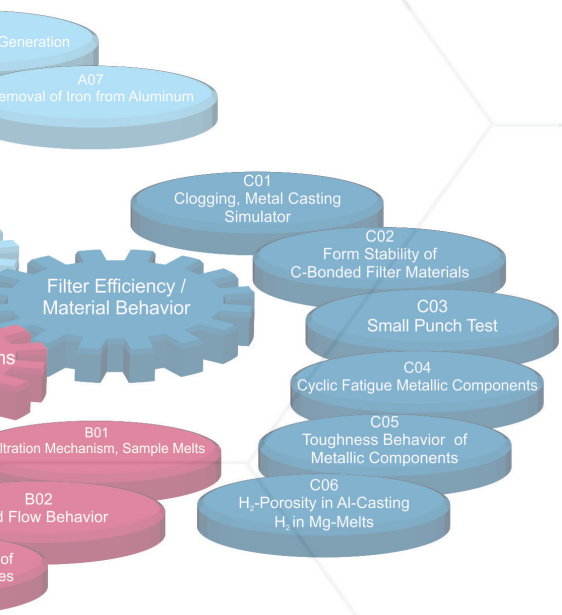
## Working Group 1: „Metal melt/inclusions, active/reactive filter material, boundary surface design" (Coordination: Dr.-Ing. Claudia Voigt)

- Investigation of the effect of nanofunctionalization on carbon-bonded $Al_2O_3$ filters with environment-friendly binder (A01),
- Flow-through experiments in a water-based model system for the evaluation of the influence of the surface roughness of ceramic foam filters (A02),
- Preparation of samples by the co-hydrolysis routine followed by the investigation of the ternary MgO-$TiO_2$-$SiO_2$ system at 1400 °C (A03),
- Determination of transition states in the decarboxylation reaction of gallic acid using the NEB method (A04),
- Temperature dependent *in situ* Raman measurements on ellagic acid using photobleaching to minimize photoluminescence effects (A04),
- Detailed investigation of the spinel-type MgAlON structure and the homogeneity range. The results cannot confirm the postulated formation of magnesium- and nitrogen-rich spinel-type structures with cation interstitials or anion vacancies (A05),
- Complementary experiments concerning the formation of whiskers in the system MgO-C/$Al_2O_3$-C/Fe for quantitative XRD phase analyses (A06),
- Investigation of the formation of Fe-containing intermetallic in the quaternary systems Al-Si-Fe-M with M = V, Cu (A07),
- Design and construction of an experiment for the filtration of magnesium melt with ceramic foam filters under protective Ar-SF6 cover gas mixture (C06),
- Performance of a new casting series with AlSi7Mg recycling material from ACTech GmbH, Freiberg. The aim is to investigate the effect of the reactive filter materials with regard to particle filtration and to determine the influence of the particles on the effectiveness of the spodumene containing filter materials regarding their ability to influence hydrogen porosity (C06),
- $Al_2O_3$-C foam filters with $Al_2O_3$ flamespray coating and tailored geometry (5 ppi PU foam templates by means of Selective Laser Sintering) were tested for the first time in a bottom-teeming ingot casting of steel melts at the company Deutsche Edelstahlwerke Specialty Steel (T04),
- Conduction of sand casting with AlSi10Mg-alloy for the investigation of the effect of ceramic fibers and ceramic foam cubes (T05).




## Working Group 3: „Thermomechanical properties of the filter material and structures" (Coordination: Dipl.-Ing. Alexander Malik)

- Studies on the physical (density, porosity, pore size distribution), mechanical (cold crushing strength, splitting tensile strength, elastic modulus) and thermomechanical (compression, bending, creep at 700 to 1500 °C) properties of $Al_2O_3$-C filter materials based on the lactose/tannin binder system (C02),
- Improvement of high-temperature Brazilian Disc test methods for determination of elastic material properties of the filter materials based on developed room-temperature test variations (C03),
- Development of a cohesive zone model for Brazilian Disc test to determine the high-temperature fracture toughness of filter materials (C03),
- Conducting Ball on Three Balls tests at high temperatures to investigate the temperature dependent shift in ductile properties of filter materials (C03),
- Simulative determination of the structural stiffness at application conditions with variied porosity, strut geometry, pore size and filter dimension (B05),
- Implementation of the developed effective material law for foam structures to design ceramic filters subject to small strains. Required data for the filter material are provided by the subprojects A01, A02 and C01 (B05),
- Strength evaluation of the immersed filter in comparison to the experimental data from subproject T04 (B05),
- Mechanical, numerical and physical characterization of $Al_2O_3$-C foam filters produced by distinct routes (A01, T01, B05, S01).




## **Working Group 2:** „Modelling and designing of the filter geometry“ (Coordination: Dipl.-Ing. Eric Werzner)

- Model calculations of the developed van der Waals layer model for the determination of the distribution functions of the vdW force including AFM topography scans between alumina particle and further filter materials (B01),
- Experiments at the semi-automated pilot plant to study the effect of flow rate on the integral and local separation efficiency of graded filters as well as development and validation of a Python-based 3-phase detection algorithm for the evaluation of the inline probe data in the water model (B01),
- Implementation of a Navier-slip boundary condition for the filter wall for effective modelling of the effects of nanobubbles and low wettability on the melt flow in the LBM simulation (B02),
- Evaluation of the aluminium filtration tests to determine the volumetric heat transfer coefficient between filter and melt as well as planning of further filtration tests with steel melt (B03, S03),
- Enhancement of the sample crucibles for determination of the temperature-dependent sorption characteristics of aluminium melt with respect to free surface and possible measurement temperatures (B03),
- Measurement of force-distance curves between poorly wetted particles and gas bubbles by AFM, using a long-range scan head, as well as batch agglomeration experiments with spherical alumina particles as preparation for continuous agglomeration experiments (B04),
- Molecular dynamics simulations of the solidification of sintered alumina nanoparticles (B04),
- FE-simulation of layer formation at a solid-liquid interface by chemical reactions (B05),
- Extension of the graphical user interface FoamGUI to generate foam structures with graded porosity as well as development of an Abaqus plugin for the simulation of foam structures using a FE² homogenization approach (B05),
- Commissioning of an experimental setup for 3D investigation of the inclusion-bubble attachment and start with the first measurements (B06),
- Completion of comprehensive simulations of the filtration process in periodic computer-generated filters (various strut shapes, finger-like struts, mono-/polydisperse cell structures) and comparison with a real filter structure (CT scan) using continuous casting of molten aluminum as example (S02, B02, B05).

## **Working Group 4:** „Mechanical properties, metallic materials, critical inclusions” (Coordination: Dr.-Ing. Sebastian Henschel)

- Investigation of interaction between liquid iron and carbon-bonded ceramic substrates C-CA6 and two types of C-MgO·$Al_2O_3$ substrates (MgO enriched substrate C-MR 66 and less MgO enriched substrate C-AR 78) at 1625 °C (C01),
- Simulation between iron and substrates was conducted by utilizing the previous published thermodynamic database from descriptions of ternary systems Al-Fe-O, Al-Mg-O and Fe-Mg-O, and the stability of the oxides were calculated FactSage software (C01),
- Mechanical Characterization of samples of filtration test utilizing a combination of immersion and casting filters at quasi-static loading rats and different temperatures and at fatigue loading conditions in the VHCF regime (C01, C04, C05),
- Characterization of multiphase particles from experiments with reactive and active metal melt filtration of 42CrMo4 in steel casting simulator using nanoindentation and atomic force microscopy (C01, B01, C04),
- Mechanical and microstructural characterization of AlSi10Mg specimens after filtration tests in subproject T05 to quantify the effect of filtration on material properties under tensile loading and fatigue (C04, T05),
- Mapping of 3D simulation results for the temperature field to cross sectional areas of the cylinder geometry used to represent a 1D temperature distribution along the gauge length based on averaged temperature values on the cross sections (C04),
- Determination of the model's heat source's geometry and intensity as the difference of experimental and computational 1D temperature distributions along the gauge length, taking into account superposition of boundary conditions and dissipative effects (C04),
- Approval of computing time at the Jülich Supercomputing Center (JSC) for one year, starting in November 2021, with an amount of 2.2 million core-h for HPC computations to mimic high numbers of cycles in ultrasonic fatigue experiments in a realistic way (C04),
- Investigation of the impact pulse and inertia effects during dynamic loading and their effect on characteristic values of the linear-elastic fracture mechanics and elastic-plastic fracture mechanics concepts (C05).

# RAMAN INVESTIGATION ON CARBORES P, LACTOSE, AND TANNIN

Authors: Simon Brehm,
Jakob Kraus
(Subproject A04)

**The subproject A04 investigates the binders CarboresP, lactose, and tannin, which are used for the production of more environmentally friendly carbon-bonded alumina filters in subproject A01, by means of Raman spectroscopy. For annealing temperatures of approx. 800 °C and above, the structural transformation of amorphous, hydrogen-rich carbon to nanocrystalline graphite was observed.**

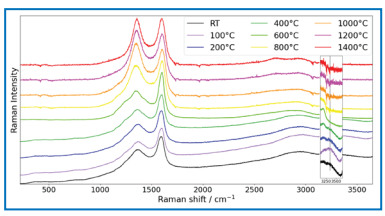



Fig. 1: Raman spectra of CarboresP. The CarboresP samples were heated up to 1400 °C under reducing atmosphere. The zoomed-in part of the figure shows the spectral region where OH vibrations occur.

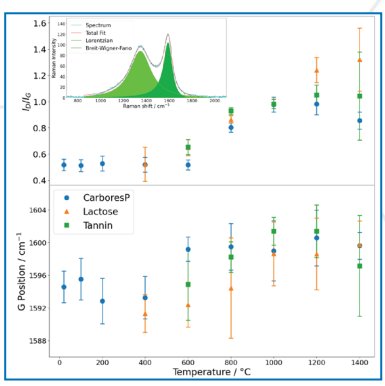



Fig. 2: The intensity ratios of the D and G peaks as well as the positions of the G peak as a function of temperature. The fit process of the D and G peaks is shown in the top left picture.

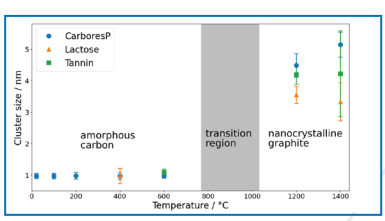



Fig. 3: The $sp^2$ carbon cluster sizes for CarboresP, tannin, and lactose as a function of temperature. Between 800 °C and 1000 °C, a conversion of amorphous, hydrogen-rich carbon to nanocrystalline graphite occurs.

The binders CarboresP, lactose, and tannin are used to produce environmentally friendly carbon-bonded alumina filters for the filtration of molten steel [1]. These binders and their firing products were studied using Raman spectroscopy. Raman spectroscopy provides information about molecular and solid-state vibrations and is therefore excellent for studying the chemical structure of organic and inorganic carbon compounds in a non-destructive manner.

The investigated CarboresP, lactose, and tannin samples were fired under reducing atmosphere generated by using a coke bed. The normalized Raman spectra of CarboresP for temperatures from room temperature (RT) to 1400 °C are shown in Fig. 1. The so-called D peaks at ca. 1350 $cm^{-1}$ and the G peaks at 1600 $cm^{-1}$ are clearly visible. The G peak originates from vibrations between $sp^2$-hybridized carbon atoms, as found in graphite, while the D peak is exclusively seen in disordered carbon systems. In the spectra from RT to 600 °C, the D peak exhibits shoulders originating from trans-polyacetylene, a chain-like hydrocarbon with alternating single and double bonds. The disappearance of the shoulders at higher temperatures indicates the pyrolysis of transpolyacetylene. Moreover, the spectra indicate that the OH groups split off at ca. 400 °C, since the associated band with a maximum at 3350 $cm^{-1}$ disappears above this temperature (see the zoomed-in part of the figure). From the background slope of the spectra, the hydrogen fraction of the system can be estimated, which decreases from more than 40 % at RT to less than 20 % at 800 °C.

Thus, the investigated CarboresP samples change chemically and structurally with increasing temperature. Further information about these changes is provided by the position of the G peak and the intensity ratio of the D and G peaks ID=IG (see Fig. 2). To determine these parameters, the D and G peaks were fitted with a Lorentz and a Breit-Wigner-Fano function, respectively (Fig. 2, top left). The spectra of lactose and tannin were treated in an identical manner.

At temperatures up to 600 °C, there is hardly any variation in the intensity ratios and peak positions, indicating that the system undergoes minimal chemical and structural changes. In the range of 600 °C to 1000 °C, the intensity ratio ID=IG increases and the position of the G peak shifts to higher wavenumbers, indicating a transformation from hydrogenrich amorphous carbon to nanocrystalline graphite [2]. This is associated with a decrease in the content of $sp^3$-hybridized carbon, hydrogen, and chain-like carbon compounds such as trans-polyacetylene. During this process, the size of graphitic $sp^2$-carbon ring clusters increases [3]. Fig. 3 shows the significant increase in cluster sizes determined from the ID=IG ratios. As a continuation to this work, the pyrolysis processes that occur during the heating of tannins will be studied in more detail using in-situ Raman measurements. ■

[1] C. Himcinschi, C. Biermann, E. Storti, B. Dietrich, G. Wolf, J. Kortus, C. G. Aneziris, Innovative carbon-bonded filters based on a new environmental-friendly binder system for steel melt filtration, J. Eur. Ceram. Soc. 2018, 38 [16], 5580-5589.
[2] S. Brehm, C. Himcinschi, J. Kraus, B. Bock-Seefeld, C. Aneziris, J. Kortus, Raman spectroscopic characterization of environmentally friendly binder systems for carbon-bonded filters, Adv. Eng. Mater. 2021, 2100544 (1-10).
[3] M. Dopita, M. Emmel, A. Salomon, M. Rudolph, Z. Matej, C. G. Aneziris, D. Rafaja, Temperature evolution of microstructure of turbostratic high melting coal-tar synthetic pitch studied using wide-angle X-ray scattering method, Carbon 2015, 81, 272-283.

# DETERMINATION OF EXTINCTION CEOFFICIENTS OF CERAMIC FILTER STRUCTURES

**The subproject B03 focuses on the characterization of the heat transport processes in the filter structures and the determination of thermophysical properties of filters and base materials. Due to the high process temperatures, knowledge of the radiation behavior and the radiative optical properties of the filters is of particular relevance.**

Authors: Lisa-Marie Heisig, Katrin Markuske (Subproject B03)

A special characteristic of oxide ceramic foams, compared to metal structures or carbon-containing foams with opaque strut material, is the wavelength-dependent transparency of the struts for infrared radiation, which takes effect especially in the high-temperature range and leads to a changed absorption, scattering, and thus extinction, behavior. [1]

Experimentally, the radiation behavior is analyzed by spectroscopic measurements with a Fourier-transform infrared spectrometer (FTIR). Because of the strong inhomogeneity of the samples, the FTIR is combined with an external, gold-coated integrating sphere. In the conducted investigations, the hemispherical transmission as well as reflection of industrial filters made of different materials ($Al_2O_3$, $ZrO_2$, SiC and $Al_2O_3$-C) with 10 ppi each, along with $Al_2O_3$ filters of different pore density were measured in the near- and mid-infrared range (NIR and MIR). Whereas a higher pore density generally leads to a lower transmittance, the results showed that the reflectance in the MIR (radiation at low to moderate temperatures) is independent of the pore size. The spectral transmittance as well as the reflectance of the 10 ppi filter made of the four basic filter materials are shown in Fig. 1. The $Al_2O_3$ and $ZrO_2$ filters are distinctive of a strong wavelength-dependent radiation behavior at wavelengths $\lambda < 5$ µm with high transmittance and reflectance in the NIR at $\lambda < 2.4$ µm, which leads to strongly reduced IR absorption in this wavelength range. In contrast, in the MIR all filters are characterized by weak wavelength-dependent, significantly lower transmittance and reflectance, and thus high absorbance. This necessitates consideration of the temperature dependence of the radiation-optical properties of oxide filter materials. [2]

In practice, simple empirical correlations are often used to predict radiative properties required for the calculation of the process design and optimization. Especially for the determination of the extinction coefficient, numerous correlation equations are presented in the literature. However, their universal applicability must be challenged due to high differences between the calculated results (> 100 $m^{-1}$), which could result from a limited database on which the correlations are based. By comparison with experimentally determined extinction coefficients, two correlations (out of a total of seven considered ones) could be identified that allow a prediction of the extinction coefficients [1, 3] with acceptable accuracy (mean deviation of 10 or 16 %), see Figure 2. [2] In the future, investigations (including numerical) on the effects of specific filter characteristics (e.g. structural specifics or radiative properties of the strut material) on the extinction coefficient should be used for further improvement of existing correlation equations. Furthermore, it could be confirmed that, in addition to the empirical correlations, the projection method of Loretz et al. 2008 [4], which is based on the evaluation of 3D CT scans of the filters, allows a fast and simple, predictive determination of the extinction coefficient with a mean deviation of 12 % (Fig. 2). Additionally, remaining deviations can be further reduced by correcting a systematic error. [2]

The heat transfer in the filter structures as well as the thermophysical properties of the filters can have an influence on the infiltration, and thus on the filtration efficiency, as well as on the thermal shock behavior. For a thermal optimization of the filters, further filter types and functional coatings will be investigated in the future. ■

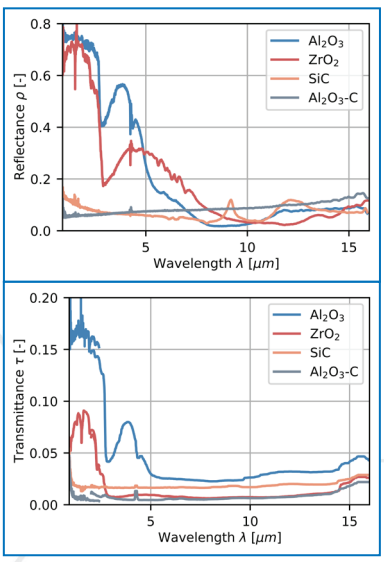



Fig. 1: Spectral transmittance and reflectance of 10 ppi filters made of $Al_2O_3$, $ZrO_2$, SiC and $Al_2O_3$-C in the NIR (0.9 - 2.4 µm) and MIR (2- 16 µm).

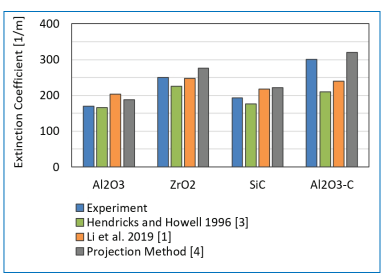



Fig. 2: Comparison of the experimentally determined extinction coefficients with results of selected empirical models [1, 3] and projection method [4] for different filter materials.

[1] Y. Li, X.-L. Xia, C. Sun, S.-D. Zhang, H.-P. Tan: Volumetric radiative properties of irregular open-cell foams made from semitransparent absorbing-scattering media, Journal of Quantitative Spectroscopy and Radiative Transfer 2019, 224, 325-342.
[2] L.-M. Heisig, K. Markuske, E. Werzner, R. Wulf, T. M. Fieback: Experimental and Simplified Predictive Determination of Extinction Coefficients of Ceramic Open-Cell Foams Used for Metal Melt Filtration, Advanced Engineering Materials 2021, 2100723 (1-13).
[3] T. J. Hendricks, J. R. Howell: Absorption/scattering coefficients and scattering phase functions in reticulated porous ceramics, Journal of Heat Transfer 1996, 118 [1], 79-87.
[4] M. Loretz, E. Maire, D. Baillis: Analytical modelling of the radiative properties of metallic foams: Contribution of X-ray tomography, Advanced Engineering Materials 2008, 10 [4], 352-360.

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# CURRENT PUBLICATIONS (JUNE - NOVEMBER 2021)

**Further information about the 120 publications that have been generated since the start of the third program period as well as about the currently 21 patents and patent applications are available at https://tu-freiberg.de/forschung/sfb920**

## Projectarea A - Filter materials

### Subproject A01

Neumann, M., Gehre, P., Hubálková, J., Zielke, H., Abendroth, M., Aneziris, C.G.: Statistical analysis of the flexural strength of free-standing flame-sprayed alumina coatings prior and after thermal shock, 4th International Postgraduates Seminar on Refractories, June 12-13, 2021, Wuhan, China, web conference, oral presentation.

Bock-Seefeld, B., Wetzig, T., Hubálková, J., Schmidt, G., Abendroth, M., Aneziris, C.G. (2021): Fabrication of carbon-bonded alumina filters by additive manufactured, water-soluble polyvinyl alcohol filter templates and alginate-based slips, Advanced Engineering Materials, 2021, 2100655, pp. 1-10, DOI 10.1002/adem.202100655.

### Subproject A02

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### Subproject B02

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## Projectarea C - Filter performance, materials properties

### Subproject C01

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Gehre, P., Preisker, T., Dudczig, S., Schmidt, G., Wöhrmeyer, C., Parr, C., Aneziris, C.G. (2021): Impact of MgO-C with CMA- and Nanaocarbon Addition on Steel Cleanliness, Interceram - Int. Ceram. Rev., 2021, Vol. 70, pp. 26-31, DOI 10.1007/s42411-021-0461-0.

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**Subproject C04**

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**Subproject C05**

Koch, K., Kietov, V., Henschel, S., Krüger, L.: Effect of ceramic particles on the dynamic strength, deformation and toughness behavior of 42CrMo4, DYMAT 2021, Madrid, Spain, September 20-24, 2021, poster.

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**Subproject C06**

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**Transfer projects**

**Transfer project T03**

Schoß, J.P., Becker, H., Keßler, A., Leineweber, A., Wolf, G. (2021): Removal of iron from a secondary Al-Si die-casting alloy by metal melt filtration in a laboratory filtration apparatus, Advanced Engineering Materials, 2021, 2100695, pp. 1-15, DOI 10.1002/adem.202100695.

**Transfer project T04**

Wetzig, T., Neumann, M., Schwarz, M., Schöttler, L., Abendroth, M., Aneziris C.G. (2021): Rapid prototyping of carbon-bonded alumina filters with flame-sprayed alumina coating for bottom-teeming steel ingot casting, Advanced Engineering Materials, 2021, 2100777, pp. 1-10, DOI 10.1002/adem.202100777.

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**Service projects**

**Service project S02**

Lehmann, H., Werzner, E., Malik, A., Abendroth, M., Ray, S., Jung, B. (2021): Computer-Aided Design of Metal Melt Filters: Geometric Modifications of Open-Cell Foams, Effective Hydraulic Properties and Filtration Performance, Advanced Engineering Materials, 2021, 2100878, pp. 1-11, DOI 10.1002/adem.202100878.

**Service project S03**

Baumann, B., Keßler, A., Hoppach, E., Wolf, G., Szucki, M., Hilger, O. (2021): Investigation of particle filtration in aluminum alloy, Archives of Foundry Engineering, Vol. 21, Iss. 3, 2021, pp. 70-80, DOI 10.24425/afe.2021.138668.

**Patents and patent applications**

**Transfer project T05**

Ceramic molten metal filter and method for the filtration of molten metal. Patent no.: DE 10 2018 126 326 B4, patent granted: 2021-09-09.

## FUTURE CERAMICS

Smart contact lenses that help with communication problems, oversized shells as water reservoirs in dry environments or space vegetables from the ceramic greenhouse? The pupils of the **Geschwister-Scholl-Gymnasium Freiberg** involved in the **art project "Future Ceramics"** came up with these and other ideas after they had informed themselves about and discussed real and possible future applications of the material ceramics in several online sessions at the Institute for Ceramics, Refractories and Composite Materials. Despite temporary alternating lessons and homeschooling, the participants in the advanced art course (12th grade) developed the impulses from the ceramics research further in such a way that they found expression in works of art at the end of the project.

Photo: Naike Richter explains the idea behind the artwork "The Smart Desert".

Under the leadership of Naike Richter, Max Porstmann and Malte Fischer, the high school students involved wrote in the foreword to the exhibition catalog: "When the project got underway in late summer 2020, the first question on our minds was what technical ceramics actually are. What is it used for? What makes them so special? ... Step by step, our visions took shape. May our ideas now inspire students and researchers to create unprecedented things with the special material of ceramics!"

"We were very impressed how intensively the students dealt with the material ceramics and its specific properties. The artistically implemented ideas show that modern technology would already be inconceivable today without the use of ceramics - and certainly not in a distant future!" explains Prof. Christos G. Aneziris.

Photo: Participants of the art project.

Until the end of September, the artworks were publicly exhibited at the TU Bergakademie Freiberg. The exhibition catalog is published on the homepage of the Institute of Ceramics, Refractories and Composite Materials under the following link: https://tu-freiberg.de/ikfvw/schuelerprojekt-zukunft-keramik. ■

## GRADUATION IN CRC 920

**Dr.-Ing. Lisa Ditscherlein**, a doctoral student in subproject B01 of CRC 920, successfully defended her dissertation entitled **"Contribution to the calculation of adhesive forces on rough surfaces using the example of ceramic filter systems in molten metal filtration"** in September.

The dissertation deals with the measurement and modeling of adhesive forces on rough surfaces. Filter materials from the Collaborative Research Center 920 were investigated using atomic force microscopy methods. A large number of adhesive force measurements showed that for poorly wetting surfaces, roughness leads to an increase in the attractive forces, since capillary interactions are to be expected to a greater extent. For this reason, a characterization of the surface morphologies of the filter material samples and a critical evaluation of models that determine the surface energies from contact angle data were carried out. ■

Photo (from left to right): Prof. U.A. Peuker, Dr.-Ing. L. Ditscherlein.

## CONFERENCES AND CALLS FOR PAPERS

**12th Freiberg Refractory Forum:** December 08, 2021, TU Bergakademie Freiberg.

**CERAMICS 2022:** 97th Annual Meeting of the German Ceramic Society (DKG), March 07-09, 2022, Karlsruhe Institute of Technology (KIT), virtual conference, http://www.2022.dkg.de/info/home/en.

**UNITECR 2022:** 17th Biennial Worldwide Congress on Refractories, March 15-18, 2022, Chicago, USA, https://ceramics.org/event/the-unified-international-technical-conference-on-refractories.

**REFRA PRAGUE 2022:** 21st Conference on modern refractory materials and key achievements in high temperature technologies, May 18-20, 2022, Prague, Czech Republic, http://www.silikaty.cz/www-30-refra-prague-2022.

**CIMTEC 2022:** 15th International Ceramics Congress, June 20-29, 2022, Montecatini Terme, Italy, http://2021.cimtec-congress.org/.

**CERAMITEC 2022:** Trade fair for the international ceramics industry, June 21-24, 2022, Munich, https://www.ceramitec.com/en/.

**ECerS 2022:** 17th Conference of the European Creamic Society, July 10-14, 2022, Krakow, Poland, https://icc2022.syskonf.pl/

## IMPRESSUM

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*PHOTOS*
TU Bergakademie Freiberg, CRC 920 "Multi-Funktional Filters for Metal Melt Filtration - A Contribution towards Zero Defect Materials", Detlev Müller.

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SFB 920
Multifunktionale Filter für die Metallschmelzefiltration – ein Beitrag zu Zero Defect Materials