SFB 920

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

NEWSLETTER 23 (2/2022)

DFG Deutsche Forschungsgemeinschaft

TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG
Die Ressourcenuniversität. Seit 1765.

DEAR READERS,

in the past months, scientists of the Collaborative Research Center 920 have been actively represented at conferences, workshops and trade fairs in order to present the results of their research work along the entire process chain of metal melt filtration and to have an exchange with an expert audience from science and industry. In particular, the focus was on application-relevant issues that support the transfer of research results on multifunctional filtration of metal melts into industrial applications.

Information on our international activities, the transfer of research results and other relevant events is made available in this issue of our newsletter. Details on these and other activities can be found on our homepage at http://tu-freiberg.de/forschung/sfb920.

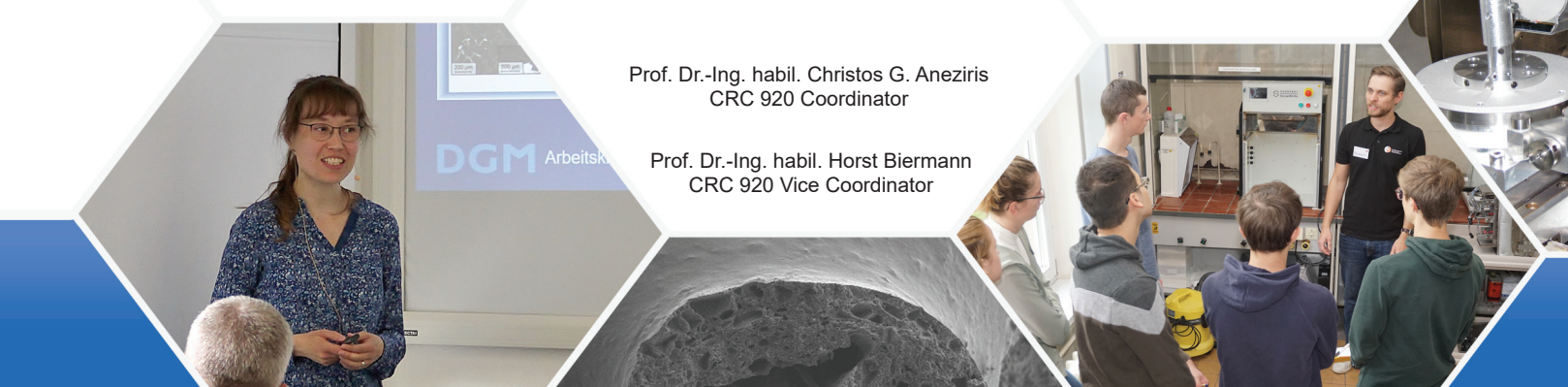
We hope you will enjoy the newsletter!

Yours sincerely,

CONTENT

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

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



SCIENTIFIC EXCHANGE AND KNOWLEDGE TRANSFER AT CONFERENCES, TRADE FAIRS AND WORKSHOPS

The transfer of scientific research results in the CRC 920 along the entire process chain of metal meltfiltration is promoted in particular through presentations, active exchange and implementation in industrial applications. The Collaborative Research Center "Multi-Functional Filters for Metal Melt Filtration - a Contribution towards Zero Defect Materials" presents current results of its fundamental and application-oriented research work at several national and international conferences, trade fairs and workshops.

An important platform for the visualization and exchange of research results, for scientific projects and for the recruitment of young scientists is the **leading international trade fair of the ceramics industry - ceramitec 2022 in Munich**. The Institute of Ceramics, Refractories and Composite Materials and the CRC 920 presented themselves on a joint exhibition stand in June 2022. The ceramitec is the leading trade fair of the international ceramics industry, which takes place every three years and at which the entire industry is represented in its value chain, including teaching and research institutions. During a common trip to Munich, PhD students of the CRC 920 had the chance to gain knowledge on the current state of the ceramics industry and research trends, as well as to establish their personal networks.

In addition, the CRC 920 was represented at numerous national and international conferences in September and October 2022. Current results of their research were presented by Dr.-Ing. Hanka Becker, Dipl.-Ing. Johannes Schoß, Dr.-Ing. Martin Abendroth and Dipl.-Ing. Ruben Wagner at the **Materials Science and Engineering Congress - MSE 2022 in Darmstadt**. The main focus was on the areas of formation of intermetallic phases in aluminum alloys and their removal by filtration on an industrial scale, the use of neural networks to describe the mechanical behavior of the microstructure of foams, and the application of the nanoindentation method to identify non-metallic inclusions in steel. The MSE is one of the world's largest international congresses in the field of materials science, engineering and materials technology and is held every two years under the patronage of the German Materials Society (DGM).

Photo: Participants at the Ceramitec 2022 exhibition stand.

Dr.-Ing. Tony Wetzig, Dipl.-Ing. Eric Werzner and Dipl.-Ing. Johannes Schoß presented their research results along the entire process chain of molten metal filtration in the CRC 920 in talks on additive manufacturing of carbon-bonded alumina filters, virtual prototyping of foam ceramic structures, and the influence of the filter material on filtration efficiency in molten metal filtration in October 2022 at the **7th CellMAT 2022 - International Conference on Cellular Materials in Dresden**. The CellMAT conference is an important forum of the German Materials Society (DGM) for industry and science in the fields of manufacturing, application as well as research and development of cellular materials of all material classes and takes place every two years. The focus of this years conference was in particular on application related issues. Hence, CellMAT is one of the major podiums for the CRC 920 to present and exchange its fundamental and application-oriented research work and findings on multifunctional filtration of metal melts.

Under the aspect of characterization of phase boundaries, this year's **meeting of the working group "Microstructure Characterization in the Scanning Electron Microscope (SEM)" of the German Materials Society (DGM)** took place as a hybrid event in Freiberg in September 2022 with the support of the CRC 920 and the Institute of Materials Science. In 14 contributions, different methodological and material-specific perspectives of electron backscatter diffraction in the SEM were presented and jointly discussed by the approximately 70 participants from all over Germany and neighboring countries.

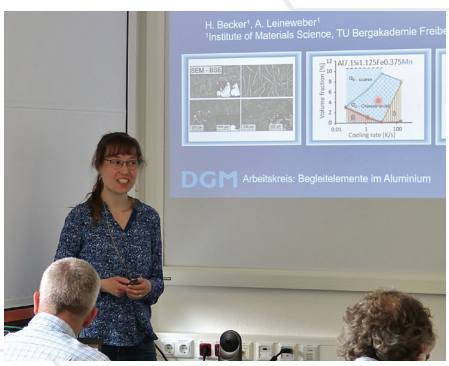


Photo: Dr.-Ing. Hanka Becker at the working group meeting of the DGM Technical Committee on Aluminum.

Futhermore, the **DGM Technical Committee on Aluminum** organized a working group meeting on the topic of **"Accompanying elements in aluminum"** in Freiberg in June 2022. In addition to invited guests, Dr.-Ing. Hanka Becker, Dipl.-Ing. Ruben Wagner and Dipl.-Ing. Johannes Schoß gave insights into their research work in CRC 920, focusing on the formation of ferrous intermetallic phases, the influence on fatigue behavior and deposition by metal melt filtration in aluminum alloys. ■

MORE NEWS

By invitation of the CRC 920, from October to December 2022 **ass. Prof. Ondřej Jankovský** and **Dipl.-Ing. Anna-Marie Lauermannová from the University of Chemistry and Technology in Prague (VŠCHT Praha)** will support the research work in CRC 920. Together with scientists from subproject A01, they are investigating the additive manufacturing of ceramic metal melt filters using electrospun fibers made of carbon-based nanomaterials. Novel manufacturing technologies such as electrospinning and powder bed water jet printing will be applied. ■

Furthermore, **Prof. Simon Reichstein from the Technische Hochschule Georg Simon Ohm in Nuremberg** was a guest at the Institute of Materials Engineering of the TU Bergakademie Freiberg in November 2022 for a joint exchange with the CRC 920 in the area of aluminum materials. In his lecture "Formation, detection and avoidance of defects in aluminum components" Prof. Reichstein presented the latest findings in the field of manufacturing and design of aluminum components as well as defect analysis and damage mechanisms on aluminum products. ■

GUEST RESEARCHERS

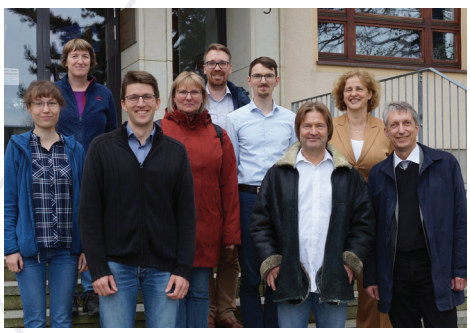


Photo: Prof. Simon Reichstein (3rd from right) from the Technische Hochschule Georg Simon Ohm in Nuremberg and scientists of the CRC 920.

The German Research Foundation (DFG) has approved two new transfer projects for the CRC 920. The focus of a **new transfer project** headed by **Prof. Christos G. Aneziris** (Institute of Ceramics, Refractories and Composite Materials) is on research into **novel filter systems in an ingot casting mold during the uphill-teeming ingot casting of electrodes made of high-alloy steels for the electroslag remelting process (ESR)** at an industrial partner in Saxony. In order to increase the initial degree of purity of ESR electrodes, special hybrid filter systems are being developed and investigated on the basis of the filter materials and structures generated in CRC 920. The aim is to reduce residual inclusions and inclusion formation in the ESR process and thus to produce electrodes from high-purity steels.

In addition, research into the **recycling process of aluminum-MMC alloys by means of rotation-assisted filtration** based on the filter materials and structures developed in CRC 920 is the subject of another **new transfer project** with an application partner in North Rhine-Westphalia under the direction of **Prof. Michal Szucki and Prof. Gotthard Wolf** (both Foundry Institute). By intensifying the deposition rate in the cleaning process of particle- and fiber-reinforced aluminum alloys, the aim is to save energy and reduce CO_2 emissions. ■

FURTHER TRANSFER PROJECTS APPROVED

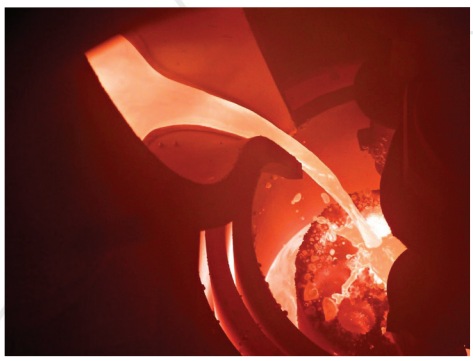


Photo: Ceramic filter developed in CRC 920 for industrial use during testing in the steel casting simulator.

In October 2022, **students of grade twelf at the Julius Motteler Gymnasium in Crimmitschau** experienced and discovered the world of ceramic materials and their various manufacturing processes at the Institute for Ceramics, Refractories and Composite Materials. During various practical sessions in the laboratories and at testing facilities, the students were able to experience for themselves how porous ceramic structures are produced using various additive manufacturing techniques and how their properties are tested, or how ceramic filters function for metal melt filtration. Also, they learned about the specifics of the experimental determination of 3-point bending strength and the influence of the pore structure on the mechanical properties of a ceramic component. The special view into the "inside of the materials" showed the investigation of the microstructure of ceramic filters with the help of scanning electron microscopy.

In carrying out the practicals and experiments on ceramics, the research assistants of the CRC 920 were able to actively pass on their knowledge and experience of their research work and arouse the students' enthusiasm and curiosity for the field of ceramic materials. ■

JUNIOR RESEARCHERS

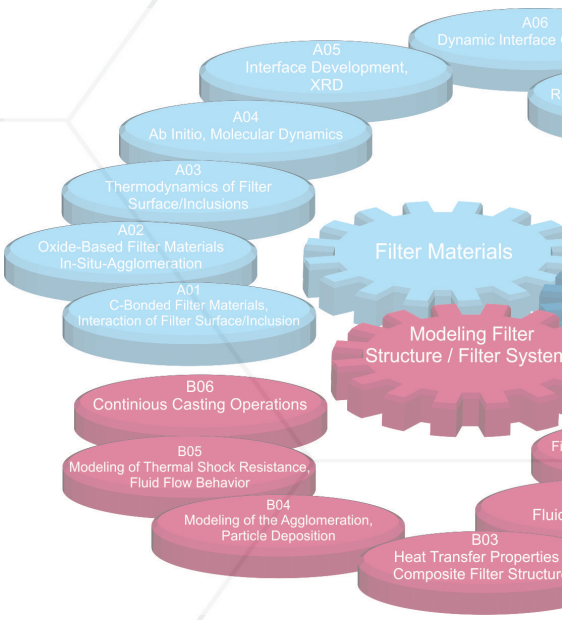
Photo: Dipl.-Ing. Benjamin Bock-Seefeld (2nd from right), PhD student in CRC 920 explains 3D printing of ceramic filter structures to students from the Julius Motteler Gymnasium Crimmitschau.

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.

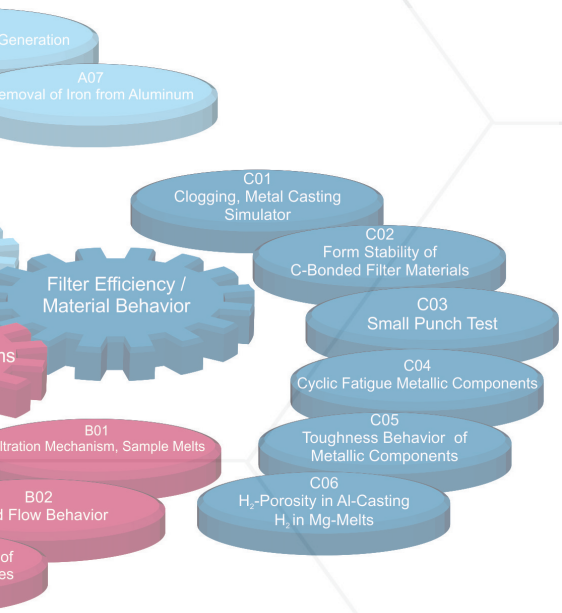
Working Group 1: „Metal melt/inclusions, active/reactive filter material, boundary surface design“ (Coordination: Dr.-Ing. Hanka Becker)

- Development of carbon-bonded calcium aluminate coatings based on the environment-friendly lactose/tannin binder system (A01),
- Investigation of the interaction of CA6 with molten steel on the high-temperature confocal laser scanning microscope (HT-CLSM) and in situ visualization of phase transformations in steel in the solid state (ferrite and pearlite transformation), (A01),
- Investigation of filter coatings by means of electrophoresis and their surface quality depending on the applied Al_2O_3 raw material, the sintering temperature, the grain size distribution and the filter substrate composition (A02),
- Study of the ternary MgO-TiO_2-SiO_2 system: liquidus projection and thermodynamic modeling (A03),
- Identification of transition states for ellagic acid pyrolysis using the NEB method (A04),
- Investigation of the influence of heating temperature and heating rate on carbon-bonded Al_2O_3 filters using Raman spectroscopy (A04),
- HTXRD study of the interface reaction between the molten Al or Al(Mg) film on TiO_2 substrate (A05),
- Verification of the evaporation of Mn during the reaction synthesis of $MnAl_2O_4$ using in situ gas phase determination with a mass spectrometer attached to the Spark Plasma Sintering device (A06),
- Interaction of manganese oxide filter material with secondary Al-Si melts (A07),
- Evaluation of the hydrogen porosity of a cast series with 50 Ma% AlSi7Mg recycled material to investigate the influence of oxidic impurities in combination with reactive filter material in the formation of hydrogen porosity (C06),
- Initial ASPEX evaluation of lab-scale filtered AZ91 samples shows a tendency towards lowered inclusion contents for inclusion sizes below 30 µm² for filter made of uncoated or coated (Al_2O_3, MgAlON, spinel) Al_2O_3-C ceramic foam filters (C06),
- Repeated casting trials regarding the application of flame-sprayed filters in industrial bottom-teeming ingot casting at Deutsche Edelstahlwerke Specialty Steel (T04).



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

- Mechanical, numerical and physical characterization of Al_2O_3-C foam filters produced by distinct routes. (A01, T01, B05, S01),
- Direct-FE^2 implementation of full micromorphic theory to model size effects (B05),
- Comparison of full micromorphic and micropolar theory for application to foams (B05)
- Strength evaluation of the immersed filter in comparison to the experimental data from transfer project T04 (B05),
- Thermomechanical tests (700 – 1500 °C) on Al_2O_3-C foam filters based on the lactose-tannin binder system (C02),
- Preparation of Al_2O_3-C compact bars based on lactose-tannin binder system via slip casting (C02),
- Investigation of various types of filter materials with the high temperature Brazilian disc test (C03),
- Determination of the room and high temperature fracture toughness of filter materials using cohesive zone models and experimental data (C03).



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

- Simulations of the filtration process to study the effect of agglomerate porosity on formation and separation of agglomerates inside composite filter structures (B02),
- Determination of a suitable isotherm model for the hydrogen solubility in metal melts (B03),
- Investigation of the applicability of the high-temperature magnetic suspension balance to analyze the gas solubility as well as the associated diffusion coefficients of other gas-metal melt systems (B03),
- Investigation of the agglomeration- and hetero-coagulation-dynamics in an aerated stirred tank (B04),
- Colloidal probe AFM investigation of the contact behavior of model inclusions interacting with hetero-coagulates (B04),
- Modeling solid alumina particle-particle interactions by the discrete element method (DEM) and investigation of mechanical properties of the agglomerates (B04),
- Studies on the influence of parameters and boundary conditions on the formation of secondary corundum for the phase-field model of a simplified filter-steel melt system (B05),
- Analysis of size effects on mechanical properties of filter structures using micropolar theory on a beam reference model (B05).

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

- Microscopic investigation of filter surfaces and chemical analysis via ASPEX of residual non-metallic inclusions after combined filtration tests, involving immersion of a coated (reactive) filter followed by casting through a second (active) filter (C01,
- Nanoindentation of sintered bulk Al_2O_3 as reference for Al_2O_3 inclusions for in-depth analysis of Al_2O_3 deformation behavior (C04),
- Analysis of non-metallic inclusions from experiments with collector filters on top of the steel melt using ASPEX and light-optical microscopy with respect to their size distribution, chemical classes and inclusion density (C04, S01),
- Investigations on the influence of non-metallic inclusions in 42CrMo4 steel on the threshold value of cyclic crack growth (C04),
- Investigations on the morphology of non-metallic inclusions after metal melt filtration by electrolytic extraction and deep etching (C04, S01),
- Statistical evaluation of the fracture mechanical properties, considering the scatter of the characteristic values using the master curve concept (C05),
- Powder metallurgical production of a reference material using hybrid sintering technology. Investigation of the effect of non-metallic inclusions with simulated alumina impurities (C05),
- Construction and start-up of a test method for determining the thermal shock resistance of ceramic foam filters on an industrial scale (S03),
- Construction and testing of a sample geometry for the targeted investigation of the filtration efficiency of dross from ductile iron melts (T07).

DEVELOPMENT OF NOVEL Al_2O_3-C FILTER FABRICATION METHOD BASED ON WATER-SOLUBLE FILTER TEMPLATES

Author: Dipl.-Ing. Benjamin Bock-Seefeld
(Subproject A01)

The subproject A01 focuses the development of Al_2O_3-C filters for the metal melt filtration. Recently, a novel approach for the manufacturing of reproducible, well-defined Al_2O_3-C filter structures based on water-soluble filter templates was investigated in cooperation with the subprojects B05 and S01.

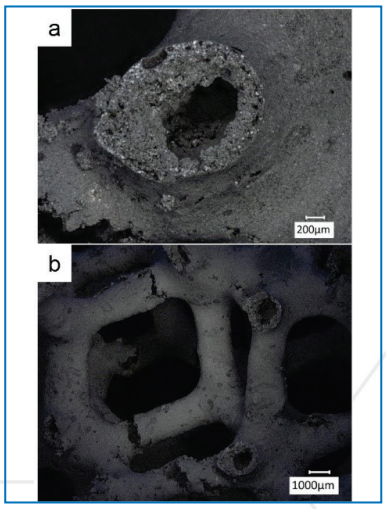


Fig. 1: Filter structure by light microscopy after removal from the cross-linking solution and drying with (a) round cavities and (b) structural defects [3].

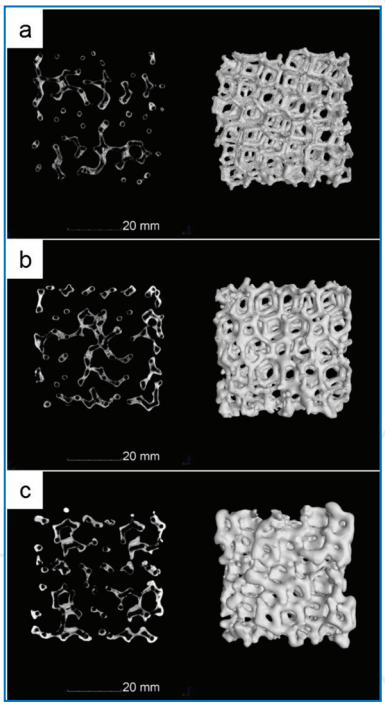


Fig. 2: Filter structure by computer tomography after (a) alginate-based, (b) first alginate-free and (c) after second alginate-free Al_2O_3-C slip coating [3].

Al_2O_3-C filter structures are commonly manufactured by the replica technique, whereby polymer foam templates are coated in a multi-stage process with Al_2O_3-C slips and pyrolized at 800 °C under reducing atmosphere [1]. The used polymer foams exhibit a random structure with triconcave, sharp-edged filter struts due to the fabrication method. As a result of the foam decomposition during the pyrolysis, cavities with the same shape are formed within the filter structure, which can encourage the growth of critical cracks and hence impair the mechanical filter properties. Additionally, environment-harmful gases are released due to the thermal foam decomposition.

In order to create reproducible Al_2O_3-C filter structures with well-defined geometry and reduced gas release, a novel filter fabrication approach based on water-soluble filter templates and alginate-based Al_2O_3-C slips was investigated. For this purpose, filter templates with round filter struts were modelled and fabricated by additive manufacturing (selective laser sintering), whereby water-soluble polyvinyl alcohol (PVA) was used as raw material. The resulting PVA filter templates exhibited a brittle and porous structure, wherefore the templates were moistened with water to form a thin PVA layer and hence to improve the template stiffness. Afterwards, the PVA filter templates were dip-coated with an alginate-based Al_2O_3-C slip and placed in a solution enriched with Ba^{2+} ions for 48 h to trigger the cross-linking of the alginate monomers. [2] After the removal from the cross-linking solution, the filters retained their structure with a coating thickness between 150 - 800 µm indicating the formation of a dimensionally stable alginate gel network. Furthermore, it was found that the PVA template was completely removed from the filter structure (cp. Fig. 1a). This observation was traced back to the infiltration of the cross-linking solution into the filter structure and the subsequent dissolution of the template. However, the dissolution was accompanied with the emergence of gas bubbles entrapped in the template porosity, which led to the occurrence of breaches and cracks in the Al_2O_3-C structure (cp. Fig. 1b).

In order to cure these defects and increase the coating thickness, the hollow filter structure was spray-coated twice with alginate-free Al_2O_3-C slips. As shown in Fig. 2, the filter macrostructure remained nearly unaltered after the first spraying procedure, whereby the majority of the defects were sealed, and exhibited a cold crushing strength of 0.04 MPa in the pyrolized state. After the second spraying procedure, the coating thickness considerably increased leading to a significant improvement of the cold crushing strength up to 0.13 MPa. However, it was observed that the spraying process led to an inhomogeneous coating application, whereby the coating thickness decreased with increasing distance from the outer filter surface. The outer filter struts obscured by the inner filter struts and impeded the slip access into the interior filter volume [3]. In order to further improve the mechanical filter properties and reach those of common Al_2O_3-C filters (0.25 - 0.30 MPa), an adjustment of the coating procedure will be examined in following investigations. Nonetheless, it was shown that the novel filter manufacturing approach offers a great potential for the metal melt filtration, since complex filter geometries can be achieved and the release of environment harmful gases due to the thermal filter template removal can be avoided. ■

[1] M. Emmel, C.G. Aneziris: Development of novel carbon boned filter compositions for steel melt filtration, Ceramics International, 38 (2012) 5165-5173.
[2] T. Wetzig, A. Schmidt, S. Dudczig, G. Schmidt, N. Brachhold, C.G. Aneziris: Carbon-bonded alumina spaghetti filters by alginate-based robo gel casting, Advanced Engineering Materials, 22 (2020) 1900657
[3] B. Bock-Seefeld, T. Wetzig, J. Hubalkova, G. Schmidt, M. Abendroth, C.G. Aneziris: Fabrication of carbon-bonded alumina filters by additive-manufactured, water-soluble polyvinyl alcohol filter templates and alginate-based slips, Advanced Engineering Materials, 24 (2022) 2100655.

TAILORED FILTERS FOR THE STEEL INGOT CASTING BASED ON SELECTIVE LASER SINTERING

The transfer project T04 investigates the applicability of the filter systems and functionalized refractory components developed in CRC 920 in industrial steel casting processes. Using a hybrid manufacturing approach, functionalized ceramic foam filters with tailored geometry were developed for the runner end piece of an bottom-teeming ingot casting unit and tested in industrial ingot casting.

Author: Dr.-Ing. Tony Wetzig
(Transfer project T04)

The presented study comprised the development and application of carbon-bonded alumina filters with tailored geometry and flame-sprayed alumina coating for active filtration in the runner of a bottom-teeming steel ingot casting system. A hybrid manufacturing approach was chosen to design and prepare the filters. First, a simulated open-celled foam structure with a pore density of 5 pores per inch and the desired sample dimensions was constructed by means of computer-aided design (CAD). Subsequently, the component was printed based on thermoplastic polyurethane (TPU) using selective laser sintering (SLS). To tightly fit the runner end piece, a cupola geometry with a height of 75 mm, a diameter of 55 mm and circumferential rounding with a radius of 20 mm was chosen as final filter geometry (Fig. 1). Besides the cupola geometry, also near-net-shape cylindrical foams (d = h = 55 mm) were prepared for preliminary tests [1].

In order to prepare the ceramic foam filters, the printed TPU templates were coated with a carbon-bonded alumina slurry following a modified replication technique. Different replication routines based on distinct coating steps, including centrifugation, rolling, dip coating, spray coating, pitch pre-coating and/or pitch reinfiltration, were investigated regarding their influence on the structural and mechanical performance of the filters. The foam was dried for 24 h after each coating step and finally fired at 800 °C under reducing atmosphere [1].

In comparison to commercial replicated Al_2O_3-C foam filters, centrifugation-based primary coating followed by dip coating and a surface finishing by spray-coating (CDS) provided the best compromise regarding the filter porosity, surface quality, homogeneity and mechanical strength as a function of the bulk density (0.29 ± 0.02 MPa at 0.34 ± 0.01 gcm^{-3}) of the resulting cylindric samples. Rolling-based primary coating turned out to be unsuitable for the special geometry due to inhomogeneous slurry distribution and resulting low absolute values of the mechanical strength (0.04 ± 0.01 MPa at 0.36 ± 0.03 gcm^{-3}). Pitch reinfiltration and refiring of the CDS filters further increased strength in line with increased bulk density by partially filling strut cavities (0.52 ± 0.01 MPa at 0.40 ± 0.01 gcm^{-3}). For special applications with higher strength requirements, this technique shows high potential and will be investigated further in the future. The effect of pitch reinfiltration was even higher for commercial reference foam filter samples showing cold crushing strength of up to 0.95 MPa [1].

Foam templates with the final cupola geometry for the industrial casting were printed via selective laser sintering, replicated with Al_2O_3-C material using the CDS coating routine, fired and finally flame-sprayed with commercial alumina by means of a flame spray gun. For the original prototype batch, pronounced spalling of the flame-sprayed coating occurred. The reason for this behavior was insufficient adhesion due to the smooth nature of the spray-coated surface. In order to address this issue, a new batch was prepared with an adjusted spray coating using a higher air-to-slurry ratio in order to induce higher surface roughness. The modified surface enabled the flame spraying with sufficient adhesion and without spalling effects (Fig. 2). The prototypes were then applied in industrial ingot casting in order to deliver proof of principle, especially regarding the thermomechanical resistance of the filter base material and the flame-spray coating. The casting tests showed that the filter prototypes are able to withstand the harsh process conditions and the melt contact without failure (Fig. 3) [1]. ■

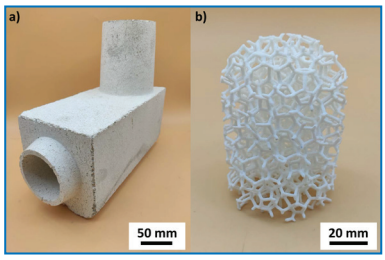


Fig. 1: Runner end piece (a) and foam template with tailored filter geometry by means of SLS (b) [1].

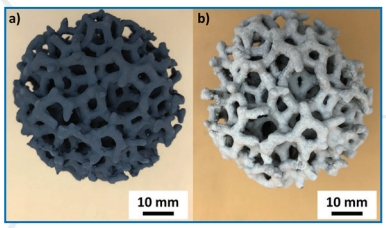


Fig. 2: Carbon-bonded alumina filter before (a) and after (b) alumina flame spraying [1].

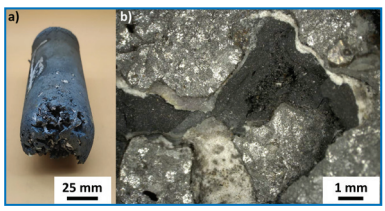


Fig. 3: Solidified steel with filter from runner (a) and light micrograph of the post-mortem filter microstructure with intact flame-sprayed coating [1].

[1] T. Wetzig, M. Neumann, M. Schwarz, L. Schöttler, M. Abendroth, C. G. Aneziris: Rapid Prototyping of Carbon-Bonded Alumina Filters with Flame-Sprayed Alumina Coating for Bottom-Teeming Steel Ingot Casting, Advanced Engineering Materials, 24(2), 2022, 2100777, DOI: 10.1002/adem.202100777.

CURRENT PUBLICATIONS (June 2022 - November 2022)

Further information about the 155 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

Bock-Seefeld, B., Wetzig, T., Hubálková, J., Schmidt, G., Abendroth, M., Aneziris, C.G.: Development of a novel approach for the manufacturing of carbon-bonded alumina filter based on water-soluble filter templates, International Conference on Refractories - ICR 2022, September 28-29, 2022, Aachen, oral presentation.

Jirickova, A., Storti, E., Aneziris, C.G., Jankovský, O.: Carbon-bonded alimina refractories reinforced with graphen oxide, XVII Conference of the European Ceramic Society - ECerS 2022, July 10-14, 2022, Krakow, Poland, oral presentation.

Luchini, B., Storti, E., Wetzig, T., Hubálková, J., Abendroth, M., Pandolfelli, V.C., Aneziris, C.G.: The importance of the ceramic strut morphology: mechanical and physical characterization of Al_2O_3-C foam filters produced by distinct processing routes, XVII Conference of the European Ceramic Society - ECerS 2022, July 10-14, 2022, Krakow, Poland, oral presentation.

Subproject A02

Bergin, A., Voigt, C., Fritzsch, R., Akhtar, S., Arnberg, L., Aneziris, C. G., Aune, R. E.: Investigation of mechanical and thermo-mechanical strength of ceramic foam filters (CFFs), Ceramics International, accepted: 26.10.2022, pp. 1-10, DOI 10.1016/j.ceramint.2022.10.320.

Voigt, C., Schramm, A., Hubálková, J., Brachhold, N., Giesche, H., Aneziris, C.G. (2022): Impact of carbon binders and carbon fillers on mercury intrusion and extrusion porosimetry of carbon-bonded alumina, Journal of the European Ceramic Society, Vol. 42, Iss. 3, October 2022, pp. 6264-6274, DOI 10.1016/j.jeurceramsoc.2022.06.043.

Voigt, C., Moritz, K., Hubálková, J., Aneziris, C.G. (2022): Influence of processing parameter on the surface quality of electrophoretically deposited alumina coatings on foam ceramics, Journal of the European Ceramic Society, Vol. 42, Iss. 13, October 2022, pp. 5874-5884, DOI 10.1016/j.jeurceramsoc.2022.06.048.

Subproject A03

Ilatovskaia, M., Fabrichnaya, O.: Developement of alumina-based thermodynamic database for al melt filtration, 18th Discussion Meeting on Thermodynamics of Alloys - TOFA 2022, September 12-16, 2022, Krakow, Polend, oral presentation.

Subproject A04

Brehm, S., Kraus, J., Himcinschi, C., Kortus, J. (2022): A Raman spectroscopic study of the pyrolysis of lactose and tannins, Journal of Raman Spectroscopy, Vol. 53, Iss. 8, August 2022, pp. 1361-1370, DOI 10.1002/jrs.6376.

Brehm, S., Himcinschi, C, Kraus, J., Kortus, J.: A Raman spectroscopic study of the pyrolysis of lactose and tannins, Verhandlungen der Deutschen Physikalischen Gesellschaft e.V DPG-Tagung 2022, September 04-09, 2022, Regensburg, poster.

Kraus, J., Kortus, J.: A theoretical investigation into gallic acid pyrolysis, Verhandlungen der Deutschen Physikalischen Gesellschaft e.V, DPG-Tagung 2022, September 04-09, 2022, Regensburg, poster.

Subproject A07

Becker, H., Hielscher, R., Leineweber, A. (2022): Interplay between habit plane and orientation relationship using the example of η'-Al8Fe3 in η-Al5Fe2: an electron backscatter analysis, Crystals 2022, 12, 813, pp. 1-24, DOI 10.3390/cryst12060813.

Becker, H., Leineweber, A.: Intermetallic phase formation in Fe-, Mn- and Cr-containing secondary Al-Si-casting alloys under different cooling rates, Materials Science and Engineering Congress - MSE 2022, September 26-29, 2022, Darmstadt, poster.

Martin, S., Sulik, D., Fang, X.F., Becker, H., Leineweber, A. (2022): Steel-Aluminum Hybrid Die Casting: Microstructures related to the applied Al–Si bond coating, Intermetallics, Vol. 151, December 2022, pp. 107712, DOI 10.1016/j.intermet.2022.107712.

Projectarea B - Modelling of filter structures/ filter systems

Subproject B02

Werzner, E., Lehmann, H., Malik, A., Abendroth, M., Jung, B., Ray, S.: Virtual Prototyping of Foam Structures for Metal Melt Filtration, 7th International Conference on Cellular Materials - CellMAT 2022, October 12-14, 2022, Dresden, oral presentation.

Subproject B04

Nicklas, J., Peuker, U.A.: Formation and stability of particle-bubble heterocoagulates containing poorly wetted alumina particles investigated by Dynamic Image Analysis and Atomic Force Microscopy, World Congress on Particle Technology - WCPT9, September 08-22, 2022, Madrid, Spain, oral presentation.

Roy, S., Prakash, A., Sandfeld, S.: Sintering of Alumina Nanoparticles: A Comparison of Interatomic Potentials by Atomistic Simulations, The 8th European Congress on Computational Methods in Applied Sciences and Engineering - ECCOMAS Congress 2022, Oslo, Norway, June 05-09, 2022, oral presentation.

Roy, S., Prakash, A., Sandfeld, S. (2022): Sintering of alumina nanoparticles: comparison of interatomic potentials, molecular dynamics simulations, and data analysis, Modelling and Simulation in Materials Science and Engineering, Vol. 30, 2022, 065009 (1-26), DOI 10.1088/1361-651X/ac8172.

Subproject B05

Seupel, A., Roth, S., Kiefer, B.: Phase Field Modeling of Chemically Reactive Multi-Component/ Multi-Phase Systems and its Application to Reactive Filtration of Steel Melt, Society of Engineering Science Annual Technical Meeting - SES 2022, Texas A&M, College Station, US, October 16-19, 2022, oral presentation.

Abendroth, M., Hütter, G., Kiefer, B., Malik, A.: A framework to describe the elastic-plastic deformation behavoir of foam-like media using neural networks, Materials Science and Engineering Congress - MSE 2022, Darmstadt, September 27-29, 2022, oral presentation.

Malik, A., Hütter, G., Abendroth, M., Kiefer, B.: Micromorphic FE² Simulation of Plastic Deformations of Foam Structures, 9th GACM - Colloquium on Computational Mechanics 2022, September 21-23, 2022, Essen, oral presentation.

Seupel, A., Roth, S., Kiefer, B.: Phase field modeling of chemically reactive multi-component/ multi-phase systems, 92nd Annual Meeting of the International Association of Appied Mathematics and Mechanics - GAMM 2022, August 15-19, 2022, Aachen, oral presentation.

Malik, A., Abendroth, M., Hütter, G., Kiefer, B.: A hybrid approach to model the three-dimensional inelastic deformation behavior of cellular media using neural networks, 92nd Annual Meeting of the International Association of Applied Mathematics and Mechanics - GAMM 2022, August 15-19, 2022, Aachen, oral presentation.

Projectarea C - Filter performance, materials properties

Subproject C01

Wei, X., Perminov, A., Ilatovskaia, M., Dudczig, S., Storti, E., Volkova, O. (2022): Refractories for the processing of Fe-TiC alloy, Ceramics International, accepted: 07.08.2022, DOI 10.1016/j.ceramint.2022.08.087.

Subproject C02

Wu, X., Bock-Seefeld, B., Weidner, A., Aneziris, C.G., Biermann, H.: Mechanical behavior of carbon-bonded alumina foam materials based on a lactose-tannin binder system at high temperatures, International Conference on Strength of Materials - ICSMA-19, June 26 - July 01, 2022, Metz, France, poster.

Subproject C03

Takht Firouzeh, S., Abendroth, M., Kiefer, B.: Application of Miniaturized Brazilian Disc Tests for the Determination of High-Temperature Strength of Ceramic Filter Materials, European Conference on Fracture 2022 - ECF23, June 25 - July 01, 2022, Madeira, Portugal, oral presentation.

Subproject C04

Wagner, R., Lehnert, R., Storti, E., Ditscherlein, L., Schröder, C., Dudczig, S., Peuker, U.A., Volkova, O., Aneziris, C.G., Biermann, H., Weidner, A. (2022): Nanoindentation of alumina and multiphase inclusions in 42CrMo4 steel, Materials Characterization, Vol. 193, November 2022, pp. 112257, DOI 10.1016/j.matchar.2022.112257.

Wagner, R., Lehnert, R., Storti, E., Ditscherlein, L., Schröder, C., Dudczig, S., Peuker, U.A., Volkova, O., Aneziris C.G., Biermann, H., Weidner, A.: Nanoindentation of alumina and multiphase inclusions in 42CrMo4 steel, Materials Science and Engineering Congress - MSE 2022, September 27-29, 2022, Darmstadt, oral presentation.

Schmiedel, A., Weidner, A., Biermann, H.: High-temperature high-cycle application materials – Ultrasonic fatigue testing at elevated temperatures, International Conference of Materials Structure & Micromechanics of Fracture - MSMF 10, September 12-14, 2022, Brno, Czech Republic, oral presentation.

Wagner, R., Lehnert, R., Storti, E., Kerber, F. Ditscherlein, L., Dudczig, S., Peuker, U.A., Aneziris, C.G., Biermann, H.: Importance of combined cleaning filter systems for removal of non-metallic inclusions in 42CrMo4 steel, International Conference on Strength of Materials - ICSMA-19, June 26 - July 01, 2022, Metz, France, oral presentation.

Wagner, R., Noack, E., Ditscherlein, R., Leißner, T., Peuker, U.A., Biermann, H., Weidner, A.: Untersuchung des Einflusses intermetallischer Phasen auf das Ermüdungsverhalten von AlSi9Cu3 mittels DVC, Thementage Digitaler Bild- und Volumenkorrelation (DIC, DVC), Chemnitzer Werkstoffmechanik GmbH, June 21-22, 2022, oral presentation.

Subproject C05

Koch, K., Henschel. S., Krüger, L.: Auswirkung des Aufschlagimpulses auf das dynamische Bruchzähigkeitsverhalten von 42CrMo4 und EN-GJS-400-18, 40. Tagung Werkstoffprüfung 2022, October 27-28, 2022, Dresden, oral presentation.

Koch, K., Henschel, S., Krüger, L.: Effect of the impact pulse on the dynamic fracture toughness behavior of high-strength steel and nodular cast iron, European Conference on Fracture 2022 - ECF23, June 25 - July 01, 2022, Madeira, Portugal, oral presentation.

Subproject C06

Scharf, C., Schramm, A., Thümmler, M., Fabrichnaya, O., Brehm, S., Kraus, J., Kortus, J., Rafaja, D., Aneziris, S.G.: Fundamental Investigation of the Technological Research on the Reaction Sintering of MgAlON at 1500 °C from Al_2O_3, MgO and AlN, 2nd International Virtual Conference on Material Science & Engineering, September 23-24, 2022, London, UK, keynote speaker.

Transfer projects

Transfer project T03

Schoß, J., Becker, H., Keßler, A., Leineweber, A., Szucki, M., Wolf, G.: Influence of different filter materials and coatings on removal of iron in a secondary aluminum-silicon alloy using a laboratory filtration apparatus, 7th International Conference on Cellular Materials - CellMAT 2022, October 12-14, 2022, Dresden, oral presentation.

Schoß, J., Keßler, A., Szucki, M., Wolf. G.: Investigations on the removal of iron-containing intermetallic phases from AlSi9Cu3 alloy by metal melt filtration in an industrial scale, Materials Science and Engineering Congress - MSE 2022, September 26-29, 2022, Darmstadt, poster.

Schoß, J.P., Baumann, B., Keßler, A., Szucki, M., Wolf, G. (2022): Filtration efficiency in the recycling process of particle-reinforced aluminum alloys using different filter materials, International Journal of Metalcasting, accepted: 05.09.2022, pp. 1-16, DOI 10.1007/s40962-022-00880-z.

Transfer project T04

Wetzig, T., Bock-Seefeld, B., Schwarz, M., Schöttler, L., Aneziris, C.G.: Additive manufacturing based hybrid processes for the development of carbon-bonded filters for steel melt filtration, 7th International Conference on Cellular Materials - CellMAT 2022, October 12-14, 2022, Dresden, oral presentation.

Wetzig, T., Aneziris, C.G.: Novel filtration approaches in steel ingot casting, International Conference on Refractories - ICR 2022, September 28-29, 2022, Aachen, poster.

WORKSHOP FOR PHD STUDENTS

The teaching of technical and methodological skills as well as relevant soft skills in workshops and training courses are important instruments for acquiring not only technical but also social competencies in the environment of interdisciplinary research work.

What does leadership in science mean? Are we a team and how is it managed? How do I interact with staff, students, colleagues and my supervisor? The doctoral students were able to familiarize themselves with these and other questions in a two-day workshop on **"Team and Leadership Competence in Science"** within the framework of the Research Training Group of the CRC 920. Under the professional guidance of the trainer Mrs. Elka Eva Baudis from elkaBeratung Meißen, they learned about the methodical approaches to leadership tasks and important leadership styles and tools. ■

Photo: Participants of the workshop "Team and Leadership Competence in Science".

AWARDS FOR JOUNG RESEARCHERS

For the eighth time the **publication award** was given to young scientists **of the CRC 920**. The award went to **Dipl.-Ing. Alina Schramm (subproject C06)** for her publication "High temperature wettability and corrosion of ZrO_2, Al_2O_3, Al_2O_3-C, MgO and MgAlON ceramic substrates by an AZ91 magnesium alloy melt".

Photo (from left to right): Prof. C. G. Aneziris, PD Dr. habil. Olga Fabrichnaya with the winner of the publication award of the CRC 920, Dipl.-Ing. Alina Schramm.

This paper describes the measurements of contact angles and the evaluation of the interfacial reactivity of ceramic substrates and the reactive magnesium alloy AZ91 at 680 °C under argon atmosphere. The ceramic material ZrO_2 is characterized as unsuitable for magnesium melt filtration due to significant wettability and reactivity, while Al_2O_3, Al_2O_3-C, MgO und MgAlON with their non-wettability and limited reactivity or inertness are shown to be promising filter materials for light metal filtration applications.

In the course of a doctoral colloquium, Professor Christos G. Aneziris, coordinator of the CRC 920, presented the awards. The publication award targets at doctoral students involved in the CRC 920 or young scientists who work in a scientific subproject of the CRC 920. The publication award aims at encoraging and motivating young scientists to publish their work obtained from the research in the subprojects of the Collaborative Research Center 920 of TU Bergakademie Freiberg. The publication award can be assigned several times a year and brings a monetary acknowlegdment.

Furthermore, **M. Sc. Jakob Kraus (subproject A04)** received the **Julius Weisbach Award** for his outstanding achievements in academic teaching at TU Bergakademie Freiberg. The Julius Weisbach Award is given for exemplary achievements in teaching by university teachers, university lecturers, academic assistants, teachers for special tasks and scientific staff and is presented once a year by the Rector of TU Bergakademie Freiberg and the Chairman of the Association of Friends and Sponsors of TU Bergakademie Freiberg (VFF). ■

Photo: M. Sc. Jakob Kraus received the Julius Weisbach Award.

CONFERENCES AND CALLS FOR PAPERS

13th Freiberg Refractory forum: December 14, 2022, TU Bergakademie Freiberg.

FILTECH 2023: The Filtration Event, February 14-16, 2023, Cologne, Germany, https://filtech.de/.

TMS 2023: 152nd TMS Annual Meeting and Exhibition, March 19-23, 2023, San Diego, California, USA, https://www.tms.org/AnnualMeeting/TMS2023.

KERAMIK 2023: 98th Annual Meeting of the German Ceramic Society (DKG), March 27-30, 2023, Ernst-Abbe-University of Applied Sciences Jena/Hermsdorf, http://www.2023.dkg.de/.

ECerS 2023: XVIII Conference of the European Ceramic Society, July 02-06, 2023, Lyon, France, https://www.ecers2023.org/.

UNITECR 2023: The Unified Technical Conference on Refractories, 18th Biennial Worldwide Congress on Refractories, September 26-29, 2023, Frankfurt on the Main, https://unitecr2023.org/.

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