SFB 920

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

NEWSLETTER 16 (1/2019)

DFG Deutsche Forschungsgemeinschaft

TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG
Die Ressourcenuniversität. Seit 1765.

DEAR READERS,

The Collaborative Research Center 920 receives further funding for a third program period. Due to excellent research results obtained throughout the last four years and an outstanding research program for the next phase the German Research Council granted an annual funding of 3.45 Mio. Euros. New subprojects and new project leaders will amend the CRC. One of the key aspects will be the testing of research results under real conditions, in order to enhance the knowledge transfer between research and industry.

The CRC aims at qualifying and promoting its young scientists. To this end, the CRC offers scholarships and awards excellent publications from young scientists with a publication award. This award intents to encourage and motivate young team members to start as early as possible to publish their work.

This new issue of our newsletter keeps you informed about the publication award and other interesting news. Further information is provided at http://sfb920.tu-freiberg.de. We hope you'll 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

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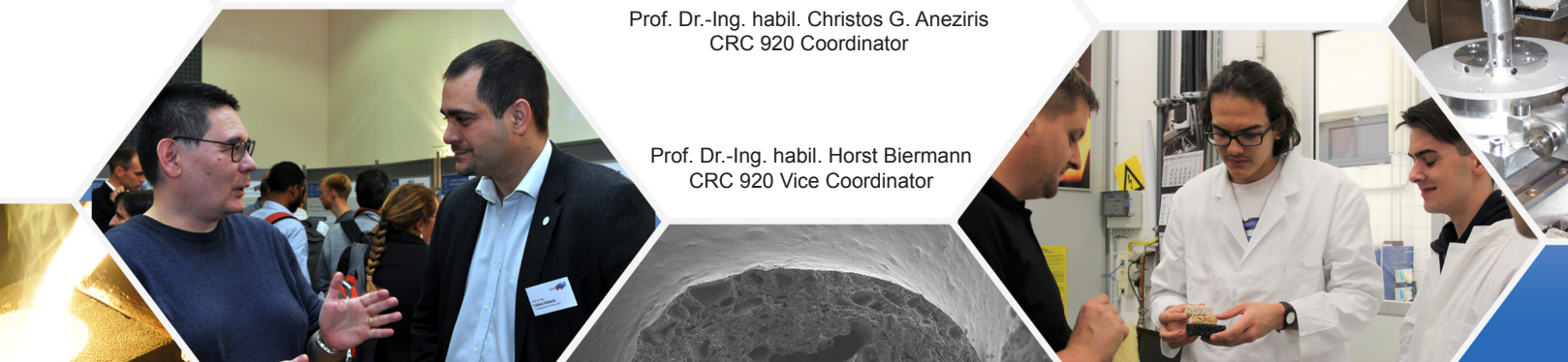


CRC 920 TO BE CONTINUED OVER THE NEXT FOUR YEARS

Funding for the Collaborative Research Center CRC 920 “Multi-Functional Filters for Metal Melt Filtration - A Contribution towards Zero Defect Materials“ will be continued for the next four years. The German Research Council DFG acknowledged both excellent research results and a high-quality research program for the next period and hence granted to fund the CRC until 2023 with approxiamtely 3.45 Mio. Euros annually. In February, a team of 14 reowned reviewers and representatives from DFG had evaluated the performance of the CRC 920.

The Collaborative Research Center CRC 920 “Multi-Functional Filters for Metal Melt Filtration - A Contribution towards Zero Defect Materials“ expands its ambitious research program to a **third program period running until 2023**. The German Research Council DFG granted 3.45 Mio. Euros annually to fund the CRC.

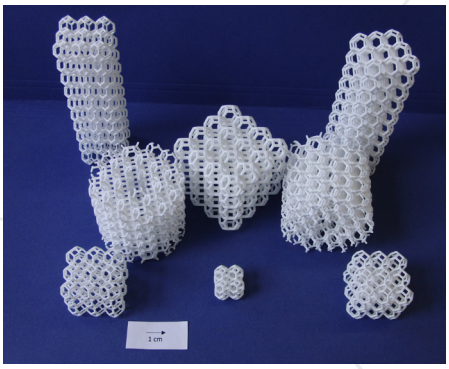


Photo: Water-soluble filter skeletons made of synthetic materials and fabricated employing 3D printing.

The CRC will be adding new subprojects. **Two additional transfer projects** have been set up to apply research results obtained by the CRC under industry-like conditions and, possibly together with external partners, develop this knowlegde into prototypes or exemplary applications. Doing so, these projects ensure an effective and mutually beneficial knowledge transfer between research and industry. Research results get tested in a real environment. In the same vein, researchers get more familiar with tasks and challenges the industry is facing.

Moreover, **new project coordinators will join the CRC**, often recruited among young scientists from institutes and faculties involved in the CRC 920. Among them, there will be three female researchers - **Prof. Dr. Olena Volkova, Dr.-Ing. Katrin Bauer as well as Dr.-Ing. Nora Brachhold.**

Since 2011, the Collaborative Research Center 920 investigates novel intelligent filter materials and filter systems as well as innovative model-based filter designs for purifying metal melts. Quality and usability of safety components, thick and thin-walled castings or forged components with high requirements regarding strength, ductility, and fatigue resistance depends inevitably on the purity of metal melts, with a minimum of non-metallic inclusions. Research done in the CRC 920 make a valuable contribution to the development of high-performance, functional and adaptive mechanical components for safety and lightweight constructions. Moreover, this research helps unlock potentials for future applications in the electronic, packaging, or filtration industry. “Our research helps achieve three important objectives: a higher material efficiency, combined with a higher recycling potential, reduced energy demand and lower CO_2 emissions,“ says Prof. Dr. Christos G. Aneziris, coordinator of the CRC 920.

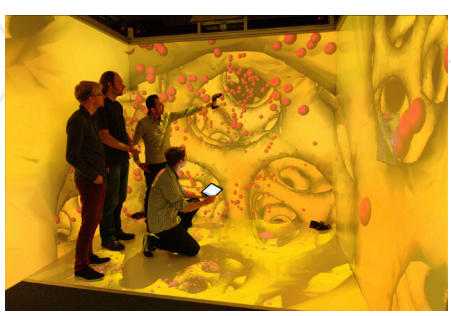


Photo: 4D Visualization of filtration procedures using a CAVE.

Until today, **nearly 400 papers in journals and proceedings** have been published. More than 80 % of these publications were produced by doctoral students as first authors. So far **12 patents have been submitted** and **three patents have been granted**.

Recently, researchers of the CRC 920 have developed a novel procedure together with a new device for purifying metal melts in an induction furnace. Deploying a coil, powered by AC, a melt flow is generated. Before casting, the melt flows through at least one carbon-containing ceramic filter. The filter initiates a chemical reaction in the melt, which removes non-metallic inclusions in a controlled manner (patent DE 11 2017 000 047).

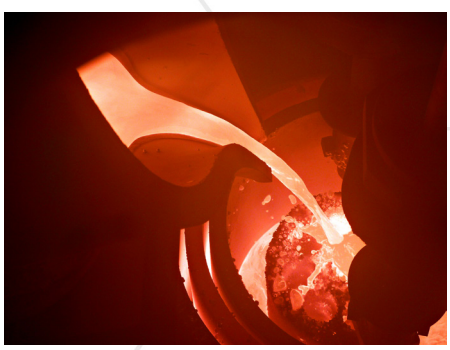


Photo: Tests of filter systems using the metal cast simulator.

“Not only does it improve the purity of the metal melt“ explains Prof. Dr. Christos G. Aneziris. “It elevates the quality and resistance of components that have been casted that way. Those who apply this procedure will enjoy lower reject rates. Moreover, this opens new pathways to the recycling of metal melts.“ Exploring the potential of this new procedure will be one key aspect of the research program defined for the upcoming four years. ■

MORE NEWS

On the occasion of the **9th Freiberg Refractory Forum**, a **poster session** coordinated **by CRC 920** subprojects informed about recent findings and innovative research approaches in the field of multifunctional ceramic filters. More than 120 national and international participants from academia, industry, and professional organizations discussed about recent developments in refractories. One of the key aspects was the role of alternative or recycled materials for steelmaking as well as the usage of novel ceramic filters for aluminum melt filtration.

The conference had been jointly organized by the CRC 920, the German Materials Society DGM, the German Ceramic Society DKG, and the association "MORE - Meeting of Refractory Experts Freiberg e. V."

As in the years before, the association "MORE – Meeting of Refractory Experts Freiberg e. V." assigned the Theodor Haase Award for oustanding master and diploma theses in the field of refractory and high-temperature applications. This year, the award was given to **Dipl.-Ing. Theresia Preisker (TU Bergakademie Freiberg)**. In her diploma thesis, she investigates to what extent the generation of a melting phase affects high temperature materials behavior and the formation of a slag layer when using refractory materials based on MgO-CMA-C in a metallurgic steel ladle. ■

CONFERENCES AND AWARDS

Photo (from left to right): Dr. P. Gehre, Prof. H. Jansen, Dipl.-Ing. T. Preisker, Prof. C. G. Aneziris, Prof. P. Quirmbach.

The CRC 920 invited **Dr. Vânia Regina Salvini** from Faculdade de Tecnologia do Estado de São Paulo, campus Sertãozinho - FATEC Sertãzinho, Brasil, as a visiting scholar to TU Bergakademie Freiberg. In a guest lecture on "Dispersion of particles and the rheology as tools for the processing of ceramic filters" she introduced her research.

Furthermore, **M. Sc. Nebahat Bulut** from Gebze-Technical University Kocaeli, Turkey, is visiting the CRC 920 for six month. She joins a research project entitled "Understanding interface reactions between rutile coatings and molten aluminium from first-principles density functional theory", which is part of the subproject A04, coordinated by Prof. Jens Kortus. Her stay is supported by the CRC 920, based on the funding from the German Research Council DFG.■

INTERNATIONAL RESEARCHERS' EXCHANGE

Photo: Attendees of the 9th Freiberg Refractory Forum.

It was already the fourth time this year that TU Bergakademie Freiberg opened its doors for high school students from schools of the national **Excellence School Network MINT-EC** to study and research at the university. The **MINT camp "Ceramics meet Steel"** invited the young visitors to explore lectures, labs, and companies and to learn more about steel, glass and ceramic materials.

The Institute of Ceramics, Glass and Construction Materials as well as the Institute of Iron and Steel Technology opened their laboratories and technical centers. In lab courses students learned how to cast and harden steel, to fabricate and test ceramics, to enamel and also to analyze material structures with the help of a scanning electron microscope or a computer tomograph

In addition, Dr.-Ing. Claudia Voigt visited the **Samuel von Pufendorf Secondaray School in Flöha**. The annual **MINT Days** offered a platform to talk to students from 10th and 12th classes about perspectives of studying engineering sciences and about her own research in the CRC 920 on ceramic materials. ■

JUNIOR RESEARCHERS

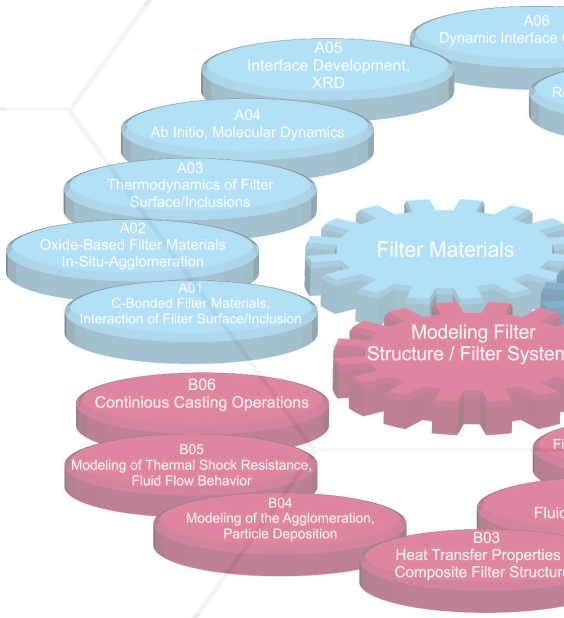
Photo (from right to left): Dr.-Ing. J. Hubálková and participants of the MINT-Camps "Ceramics meet Steel".

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.

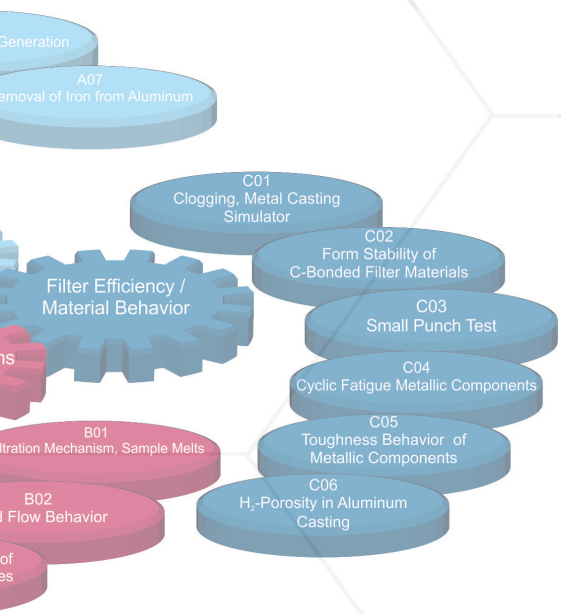
Working Group 1: "Metal melt/inclusions, active/reactive filter material, boundary surface design" (Coordination: Dr.-Ing. Claudia Voigt)

- Successful Upscaling of carbon-bonded and carbon-free alumina spaghetti filter plates for industrial application in the dimensions of 280 x 350 x 30 mm^3 with the aid of robot-assisted alginate gelcasting (T01),
- Influence of the carbon source of carbon bonded alumina samples on the results of mercury intrusion porosimetry measurements (A02),
- Investigation of the binder composition impact on Al_2O_3-C filter properties using environmentally friendly binders (A01),
- Formation of Fe-containing αc-phase particles during solidification in secondary Al–Si casting alloys and their characterization (A07),
- Physical vapor deposition of aluminum layers with a thickness of few micrometers on substrates of amorphous SiO_2 as the basis for the in situ analyses of the interactions using high temperature X-ray diffraction (A06) and in situ microstructure analysis of Al-SiO_2 interface reactions at high temperatures via X-ray diffraction (A05),
- Preparation of samples by the co-hydrolysis routine to investigate the ternary Al_2O_3-TiO_2-SiO_2 system as well as a partial verification of the binary TiO_2-SiO_2 system (A03),
- Raman spectroscopy and photoluminesce studies of environmentally friendly lactose/tannin binders show a growth in the surface area of the sp2 carbon clusters and the release of OH groups of tannin with increasing temperature due to thermal energy (A04),
- Investigations on the filter efficiency of reactive filter materials in combination with the reduction of H_2-porosity in aluminum castings (C06),
- Experimental Investigation of the influence of manufacturing techniques (rolling, centrifugation, spraycoating, inbetween coking) and their combinations, as well as slurry mixing techniques (ball mill, high shear mixer) on the microstructure and mechanical properties of carbon-bonded reticulated alumina foams (C06).



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

- Determination of theoretical Van der Waals interactions based on topographical scans (AFM) of real filter structures and rough model particles (B01),
- Investigation of the impact of dwell time on adhesion forces between inclusion and filter in the water-based model system for durations ranging from zero to one second (B01),
- In situ measurement of agglomerate size distributions for the room temperature model system via laser diffraction and filtration of tailored agglomerates with ceramic finger filters (B04, B01),
- Experimental und numerical investigation of the spatial distribution of particle separation inside open cell foam filters on the basis of high-resolution computed tomography scanning and pore-scale numerical simulations (B01, B02, S02),
- Development of an efficient numerical formulation for curved boundaries in the pore-scale filtration model using a subvoxel-accurate distance transform for simulations on coarser grids (B02),
- Analysis of mechanical and hydrodynamic characteristics for artificial foam models considering polydisperse and anisotropic pores (B05, B02),
- Extension of the code for generation of artificial foam structures regarding graded filters with varied pore size (B05, S02),
- Coupling of the CFD model for simulation of the flow inside the tundish (openFOAM) with the CALPHAD method for an improved understanding of the bubble formation in liquid steel (B06, A03, C01),
- Improved experimental setup and software automation for radiation measurements by FTIR in conjunction with the Ulbricht sphere (B03),
- Development of post-processing functions for automated analysis and visualization of filtration simulations (S02).



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

- After analyzing non-metallic inclusions in 42CrMo4 steel produced by "finger tests", new batches of 42CrMo4 steel are studied, which have been produced by filtration experiments, in which the steel melt flowed through three different types of ceramic foam filters. Carbon-bonded alumina filters were used without coating, with a coating containing nano particles (carbon nano tubes and alumina nano sheets) and with a flame-sprayed alumina coating. All batches are analyzed by means of light microscopy and by means of automated scanning electron microscopy (ASPEX). The resulting sizes, numbers and distributions of the two methods are compared and merged. A new algorithm is developed, which considers the changed chemical composition due to mullite-containing crucible and classifies the different types of inclusions (S01, C04),
- Mechanical characterization of the filtration tests with respect to strength, ductility, fracture toughness, fatigue lifetime and damage-relevant inclusions (C04, C05),
- Fatigue tests of samples from the filtration tests are performed under symmetric push-pull loading as well as with superposed tensile mean stress. The results of the fractographic investigations are analyzed with respect to the inclusion distribution obtained from light microscopy and scanning electron microscopy (C04),
- Characteristic parts of fatigue fracture surfaces are analyzed by means of transmission electron microscopy of thin lamellae produced by focused ion beam. The microstructure of the different parts (fine-granular area, smooth area, fisheye) differ from the data found in literature. The microstructure will be further analyzed by means of scanning and transmission electron microscopy (C04),
- The optical extensometer Rudolph 200XR was commissioned. With this device, the specimens deformation can be measured at tests with uniaxial and multiaxial load during quasi-static up to dynamic loading conditions (C05),
- The spatial distribution of non-metallic inclusion that promote the onset of crack growth is determined. To this end, metallographic results are further analyzed by, e.g., methods of Saltykov, fracture surface are quantified and three-dimensional models are proposed (C05),
- Extension and generalization of the procedure during dynamic calibration of the force measurement of the split Hopkinson pressure bar (C05),
- Aluminum casts (AlSi9Cu3), which were produced after melt conditioning, were hot-isostatically pressed in order to close shrinkage porosity. As a next step, the specimens are tested by applying the ultrasonic fatigue testing technique. Hence, the effect of the damage-relevant non-metallic inclusions is investigated (S03, C04).

Working Group 3: "Thermomechanical properties of the filter material and structures" (Coordination: M. Sc. Henry Zielke)

- First pressure tests on environmentally friendly filter samples up to 1500 °C (C02), including a comparison of different material behavior to the CarboresP bonded filters and optimization of the experimental procedure,
- Modelling and experimental validation of the damage behavior of Al_2O_3-C at high temperature up to 1500 °C (B05, C03),
- Mechanial, numerical and physical characterization of Al_2O_3-C foam filters produced by distinct routes (A01, T01, B05, S01),
- Production of filter samples with environmentally friendly binder system for preliminary investigations (A01),
- Evaluation of B3B experiments at 1500 °C (C03) and determination of plastic strains for carbon-bonded and non-carbon-bonded filter materials.

REMOVAL OF Fe FROM SECONDARY Al-Si ALLOYS BY MELT CONDITIONING

Author: Hanka Becker
(Subproject A07)

Subproject A07 investigates the applicability of the filters developed in the CRC 920 for the removal of Fe from secondary, i.e. recycled, Al–Si alloys by binding the Fe in primary solidified intermetallic particles. Investigations focus on the effect of Mg, Mn and Cr and the potential removal of Fe subsequent to targeted melt conditioning.

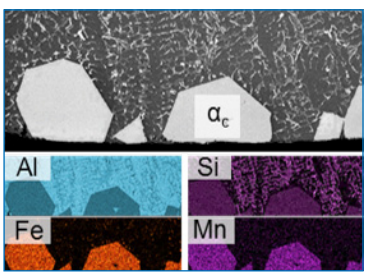


Fig. 1: SEM images and EDS maps of primary, intermetallic particles of the α_c phase after solidifaction of a Al7.1Si1.2Fe0.3Mn alloy which was conditioned for Fe removal.

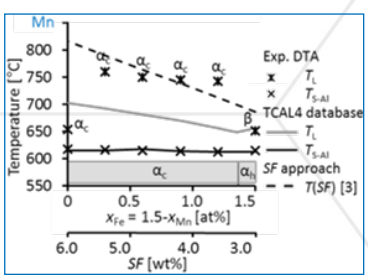


Fig. 2: Comparison of the temperatures of sludge formation TL and solidification of Al T_{S-Al} in the Mn-containing alloys from experimental differential thermal analsysis (DTA), the sludge factor (*SF*) approach and thermodynamic calculations using the TCAL4 database.

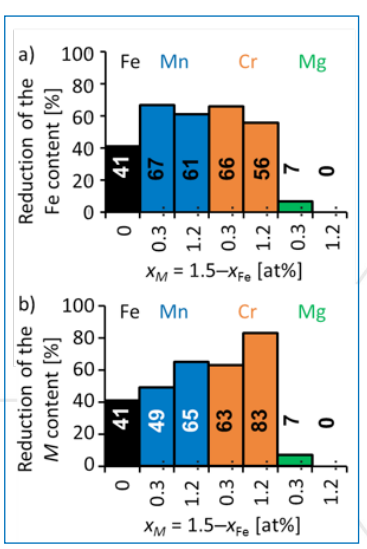


Fig. 2: Reduction of the a) Fe content and the b) transition metal content after melt conditioning.

Fe is the main metallic impurity element in secondary Al-Si casting alloys [1]. Fe can lead to the formation of Fe-containing, intermetallic phases like the β-$Al_{4.5}FeSi$ phase which forms with a plate-shaped morphology which has a detrimental effect on the mechanical and casting properties. The increasing importance of degradation-free or degradation-low recycling of Al and Al alloys in terms of a sustainable circular economy and reduced energy consumption increases the needs to deal with the Fe-impurities. Than can be achieved (1) by removal of Fe from the secondary Al-Si alloys or (2) by modification of Fe-containing intermetallic particles into a less harmful morphology. Also a synergistic use of (1) and (2) is possible. Regarding (1) (the removal of Fe) the main emphasis in the research is put on targeted melt conditioning for binding Fe in primary intermetallic, the so-called *sludge* (Fig. 1) [2].

The formation of sludge in the melt was investigated using Al7.1Si(1.5−x_M)Fe(x_M)*M* model alloys with *M* = Mg, Mn, Cr and x_M = 0, 0.3, 0.6, 0.9, 1.2, 1.5 at% and was analyzed with regard to the removal of Fe by the separation of the Fe-containing sludge from the Fe-depleted Al-melt. Mg is a typical alloying element and Mn and Cr are additions to modify the sludge.

Differential thermal analysis was used to determine the temperatures at which sludge formation T_L and solidification of the Al-solid solution T_{S-Al} begins. These temperatures were compared with the resulting temperatures of the semi-empirical sludge factor approach and from thermodynamic calculations on the basis of the TCAL4 database. Thereby, the more laborious thermodynamic calculations do not lead to better predictions of the temperatures of sludge formation than the simpler sludge factor approach (Fig. 2).

The experimentally determined temperatures that correspond to the onset of the solidification of the (Al)-solid solution deviates less than 8 K from the thermodynamically calculated temperatures. The chosen conditioning temperature of 620 °C lies for all alloy compositions slightly above this temperature. No sludge has formed at 620 °C in the alloy with x_{Mg}≥0.6 at% in contrast to all other investigated alloy compositions. The α_h-$Al_{7.1}FeSi$ phase is responsible for binding the Fe in the ternary Al7.1Si1.5Fe alloy and in the alloy with x_{Mg}=0.3 at% while the Mg remains in the melt. The α_c-$Al_{15}(Fe,Mn)_3Si_2$ phase is responsible for binding the Fe from the melts with Mn and Cr. The $(Al,Si)_2Cr$- and the $Al_{13}Cr_4Si_4$ phase additionally bind Cr. Thus, for an increasing $x_M/(x_M+x_{Fe})$ ratio with *M* = Mn, Cr up to x_M=1.2 at%, the relative Fe removal increases to 67 % while the transition metal content is reduced by 65 % or 83 % with increasing Mn and Cr content (Fig. 3). ■

[1] L. Zhang, J. Gao, L. Nana, W. Damoah, D. G. Robertson: Mineral Processing & Extractive Metall. Rev., 33 (2012), 99–157
[2] H. Becker, A. Thum, B. Distl, M. J. Kriegel, A. Leineweber: Met. Mat. Trans. A, 49 (2018), 6375–6389
[3] J. Gobrecht: Giesserei, 62 (1975), 263–266

EFFECT OF NON-METALLIC INCLUSIONS ON STRENGTH AND DEFORMATION BEHAVIOR OF STEEL 42CrMo4

In subproject C05, mechanical properties of steels are investigated that were treated with different ceramic filter structures. The studies focus on the effect of non-metallic inclusions on the temperature and loading rate dependent strength, deformation and toughness behavior.

Author: Sebastian Henschel
(Subproject C05)

The aim of the present study was to investigate the effect of ceramic foam structures, which were functionalized with different coatings, on the reduction of detrimental non-metallic inclusions. In subproject A01, the coated ceramic foam structures were produced. The steel casting simulator in subproject C01 was applied to intentionally oxidize and deoxidize the 42CrMo4 steel melt at a temperature of 1650 °C. Furthermore, the melt was then treated by immersion of ceramic foam structures with different surface functionalizations. The following coatings were used: pure alumina (+A), carbon nano tubes and alumina nano sheets (+N), calcium aluminate (+CA). For reference, the immersion was omitted (Ref.). After an immersion time of 10 s, the structure was removed and the melt solidified. Regardless of the melt treatment, the materials were hot-isostatically pressed in order to close most of the shrinkage porosity.

The effect of the remaining non-metallic inclusions on the mechanical properties strength and deformability was determined by quasi-static tensile tests at temperatures of 20 °C and −40 °C. The reduction of area served as a measure of ductility. Furthermore, the energy that was dissipated until fracture was obtained from the strength and deformation behavior.

The remaining non-metallic inclusions were measured in terms of number and size by means of metallography in subprojects S01 and C04. According to Fig. 1, dipping of the CA-coated ceramic structure leads to a significant reduction of the inclusion number in the size range of 3.5−16 µm. However, a larger number of inclusion with sizes above 30 µm is observed after application of this coating.

From the results of the tensile tests, it is derived that the reduction of area at temperatures of 20 °C and −40 °C is highest if the melt treatment was performed with the CA-coated structure (Fig. 2). This result is attributed to the lower inclusion number in the range of small sizes. Hence, the mean distance between the inclusions is increased. Furthermore, the deformability increases until the damage within the materials leads to macroscopic fracture.

The ability to dissipate energy during the deformation was derived from the experimental tensile test results. The dissipated energy was then normalized to the ultimate tensile strength. According to Fig. 3, the energy dissipation is highest after treatment with the CA-coated structure.

The few large non-metallic inclusions, which remain in the melt after application of this coating, do not negatively affect the mechanical properties during monotonous loading. In contrast, the results of the subproject C04 suggest a significant reduction of the fatigue lifetime due to these few large inclusions.

From the collaboration of the subprojects A01, C01, C04 and C05 the following aim is concluded:

- The large number of small non-metallic inclusions has to be reduced significantly. This was already achieved by the present trials.
- The few large inclusions have to be removed from the melt since these inclusions act as crack initiation sites during fatigue loading. Hence, these inclusions reduce the fatigue lifetime.
- Functional surfaces with an active filtration mechanism, i.e. carbon free surface, shall be used after reactive filtration in order to remove these large inclusions. Consequently, the potential of the material can be used under monotonous and cyclic loading conditions. ■

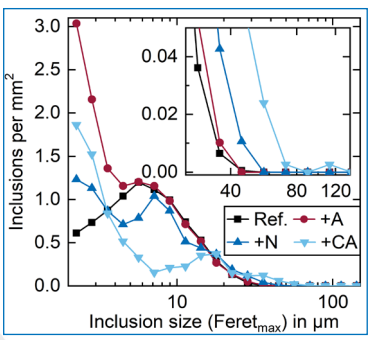


Fig. 1: Inclusion size distribution after immersion of differently coated ceramic foam structures.

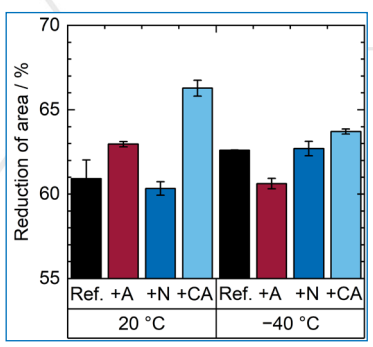


Fig. 2: Reduction of area as a function of the applied coating.

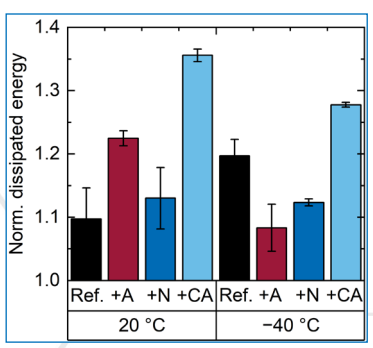


Fig. 3: Normalized dissipated energy as a function of the applied coating.

S. Henschel, J. Gleinig, E. Storti, A. Weidner, H. Biermann, C. G. Aneziris, L. Krüger: Effect of filter functionalization on strength, deformation and toughness behavior of 42CrMo4 steel, CellMAT 2018, 24.-26.10.2018, Bad Staffelstein.

DFG Deutsche Forschungsgemeinschaft
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CURRENT PUBLICATIONS (DECEMBER 2018 - JUNE 2019)

Further information about the nearly 400 publications from the second program period until June 2019 as well as about the currently 15 patents and patent applications are available at http://tu-freiberg.de/forschung/sfb920.

Projectarea A - Filter materials

Subproject A01

Aneziris, C. G., Gehre, P., Wetzig, T., Storti, E., Dudczig, S., Hubálková, J. (2019): Clean steel technology based on refractory filtering materials. REFRA Prague 2019, Czech Republic, April 24-26, keynote lecture.

Bock, B., Herdering, A., Aneziris, C. G. (2019): Additive manufacturing of polymer foams and their impact on steel melt filtration. DKG-Jahrestagung 2019, 05.-09.05.2019, Leoben, Austria, presentation No. 12509.

Bock, B., Schmidt, A., Sniezek, E., Dudczig, S., Schmidt, G., Szczerba, J., Aneziris, C. G. (2019): Impact of Spinel forming Systems (Fe-/Mg-/Mn-Al-O) as Functional Coating Materials for Carbon-Bonded Alumina Filters on Steel Melt Filtration. Ceramics International, Vol. 45, Iss. 4, pp. 4499-4508, DOI 10.1016/j.ceramint.2018.11.131.

Herdering, A., Hubálková, J., Abendroth, M., Gehre, P., Aneziris, C. G. (2019): Additive manufacturing of templates to produce functional coated carbon-bonded alumina foam filters – feasibility study. REFRA Prague 2019, Czech Republic, April 24-26, presentation.

Jankovsky, O., Storti, E., Moritz, K., Luchini, B., Jirickova, A., Aneziris, C. G. (2019): Nano-functionalization of carbon-bonded alumina. DKG-Jahrestagung 2019, 05.-09.05.2019, Leoben, Austria, presentation No. 12498.

Luchini, B., Storti, E., Wetzig, T., Settgast, C., Abendroth, M., Hubálková, J., Pandolfelli, V. C., Aneziris, C. G. (2019): Mechanical and physical characterization of Al_2O_3-C foam filters produced by distinct processing routes: the importance of the ceramic strut morphology. Journal of the European Ceramic Society, Vol. 39, Iss. 8, pp. 2760-2769, DOI 10.1016/j.jeurceramsoc.2019.02.048.

Neumann, M., Gehre, P., Kuebler, J., Dadivanyan, N., Jelitto, H., Schneider, G. A., Aneziris, C. G. (2019): Stable crack propagation in free standing thermal sprayed Al_2O_3 and Al_2O_3-ZrO_2-TiO_2 coatings. Ceramics International, Vol. 45, Iss. 7, Part A, pp. 8761-8766, DOI 10.1016/j.ceramint.2019.01.200.

Subproject A02

Grabenhorst, J., Luchini, B., Fruhstorfer, J., Voigt, C., Hubálková, J., Chen, J., Li, N., Li, Y., Aneziris, C. G. (2019): Influence of the measurement method and sample dimensions on the Young's modulus of open porous alumina foam structures. Ceramics International, Vol. 45, Iss. 5, pp. 5987-5995, DOI 10.1016/j.ceramint.2018.12.069.

Moritz, K., Dietze, C., Voigt, C., Hubálková, J., Aneziris, C. G. (2019): Porous alumina coatings on carbon-bonded foam filters by electrophoretic deposition. Ceramic International, Vol. 45, Iss. 8, pp. 10701-10706, DOI 10.1016/j.ceramint.2019.02.141.

Voigt, C., Dietrich, B., Badowski, M., Gorshunova, M., Wolf, G., Aneziris, C.G. (2019): Impact of the filter roughness on the filtration efficiency for aluminum melt filtration, TMS 2019, 148th Annual Meeting & Exhibition, Symposium: Cast Shop Technology, 10.-14.03.2019, San Antonio, TX, USA, in: Chesonis C. (eds) Light Metals 2019. The Minerals, Metals & Materials Series. Springer, Cham, pp. 1063-1069, DOI 10.1007/978-3-030-05864-7_130.

Voigt, C., Ditscherlein, L., Werzner, E., Zienert, T., Nowak, R., Peuker, U., Sobczak, N., Aneziris, C. G. (2019): Influence of the wetting behavior on the aluminum melt filtration. TMS 2019, 148th Annual Meeting & Exhibition, Symposium: Cast Shop Technology, 10.-14. März 2019, San Antonio, TX, USA, in: Chesonis C. (eds): Light Metals 2019. The Minerals, Metals & Materials Series, Springer, Cham, pp. 1071-1079, DOI 10.1007/978-3-030-05864-7_131.

Subproject A03

Ilatovskaia, M. (2019): Thermodynamic modelling of the Al_2O_3-MgO-TiO_2 system. 33rd Annual MSIT Meeting, International Seminar on Heterogeneous Multicomponent Equilibria, March 3-8, Kreuth, presentation.

Ilatovskaia, M., Fabrichnaya, O. (2019): Thermodynamic assessment of the Al_2O_3-MgO-TiO_2 system. Journal of Alloys and Compounds, Vol. 790, pp. 1137-1148, DOI 0.1016/j.jallcom.2019.03.046.

Zienert, T. (2019): cp-tools: A python library for predicting heat capacity of crystalline substances. SoftwareX, Vol. 9, pp. 244-247, DOI 10.1016/j.softx.2019.02.002.

Zienert, T., Fabrichnaya, O. (2019): Prediction of heat capacity for crystalline substances. Journal of CALPHAD, Vol. 65, pp. 177-193, DOI 10.1016/j.calphad.2019.01.017.

Subproject A04

Himcinschi, C., Rix, J., Röder, C., Rudolph, M., Yang, M., Rafaja, D., Kortus, J., Alexe, M. (2019): Ferroelastic domain identification in $BiFeO_3$ crystals using Raman spectroscopy. International Journal of Scientific Reports, Vol. 9, article number: 379, pp. 1-9, DOI 10.1038/s41598-018-36462-5.

Subproject A05

Rudolph, M., Motylenko, M., Rafaja, D. (2019): Structure model of γ-Al_2O_3 based on planar defects. Journal of Applied Crystallography IUCrJ, Vol. 6, Part 1, pp. 1-12, DOI 10.1107/S2052252518015786.

Subproject A07

Becker, H., Bergh, T., Vullum, P. E., Leineweber, A., Li, Y. (2019): β- and δ-Al-Fe-Si intermetallic phase, their intergrowth and polytype formation. Journal of Alloys and Compounds, Vol. 780, pp. 917-929, DOI 10.1016/j.jallcom.2018.11.396.

Becker, H., Bergh, T., Vullum, P. E., Leineweber, A., Li, Y. (2019): Effect of Mn and cooling rates on α, β and δ Al-Fe-Si formation in a secondary Al-Si alloy. Materialia, Vol 5, pp. 100198 (1-13), DOI 10.1016/j.mtla.2018.100198.

Becker, H., Bergh, T., Vullum, P. E., Leineweber, A., Li. Y. (2019): Intergrowth of the β- and δ-Al-Fe-Si intermetallic phase and polytypes of the β phase. German Crystallographic Society (DGK), March 25-28, Leipzig, presentation No. S08-05.

Project area B - Modeling of filter structures/ filter systems

Subproject B01

Ditscherlein, L., Knüpfer, P., Peuker, U. A. (2019): Atomic Force Microscopy – A Powerful Tool for the Quantitative Determination of Adhesive Interactions. International Congress on Particle Technology - Partec 2019, April 9-11, Nuremberg, presentation.

Subproject B02

Jorge, P., Mendes, M. A. A., Werzner, E., Pereira, J. M. C. (2019): Characterization of laminar flow in periodic open-cell porous foams. Chemical Engineering Science, Vol. 201, pp. 397-412, DOI 10.1016/j.ces.2019.02.010.

Subproject B04

Knüpfer, P., Peuker, U. A. (2019): Einfluss von Elektrolyten auf die Agglomeration hydrophober Mikropartikel. ProcessNet 2019, Annual Meeting of the ProcessNet Special Interest Group (Zerkleinern und Klassieren, Kristallisation und Grenzflächenbestimmte Systeme und Prozesse), Bamberg, March 12-13, presentation.

Subproject B05

Settgast, C., Abendroth, M., Kuna, M. (2019): Constitutive modelling of plastic deformation behavior of open-cell foam structures using neural networks. Mechanics of Materials, Vol. 131, pp. 1-10, DOI 10.1016/j.mechmat.2019.01.015.

Subproject B06

Asad, A., Schwarze, R. (2019): Numerical Investigation of Reactive Cleaning of Steel Melt in an Induction Crucible Furnace. International Workshop of Simulation Science, May 8-10, Clausthal-Zellerfeld, presentation.

Project area C - Filter performance, materials properties

Subproject C01

Fruhstorfer, J., Hubálková, J., Aneziris, C. G. (2019): Particle packings minimizing density gradients of coarse-grained compacts. Journal of the European Ceramic Society, Vol. 39, Iss. 10, pp. 3264-3276, DOI 10.1016/j.jeurceramsoc.2019.03.039.

Subproject C03

Zielke, H., Abendroth, M., Kuna, M. (2019): Determining the fracture toughness of carbon-bonded alumina using chevron-notched specimens at high temperatures. 51. Conference DVM Special Interest Group Fracture Mechanics and Component Safety, February 19-20, Aachen, presentarion.

Subproject C04

Seleznev, M., Merson, E., Weidner, A., Biermann, H. (2019): Evaluation of very high cycle fatigue zones in 42CrMo4 steel with plate-like alumina inclusions. International Journal of Fatigue, accepted: 09.05.2019, DOI 10.1016/j.ijfatigue.2019.05.011.

Seleznev, M., Gleinig, J., Wong, K. Y., Weidner, A., Biermann, H. (2018): Very high cycle fatigue behaviour of 42CrMo4 steel with plate-like alumina inclusions. Procedia Structural Integrity, Vol. 13, pp. 2071-2076, DOI 10.1016/j.prostr.2018.12.206.

Seleznev, M., Weidner, A., Biermann, H. (2019): Evaluation of very high cycle fatigue zones in 42CrMo4 steel with plate-like alumina inclusions. 29th Colloquium on Fatigue Mechanisms, Brno, Czech Republic, March 21-22, presentation.

Subproject C06

Fankhänel, B., Grötz, S., Stelter, M. (2019): Einfluss der Schmelzefiltration auf die Wasserstoffporosität in Aluminiumgussteilen. World of Metallurgy - ERZMETALL, Vol. 72, Iss. 1, S. 32-38, ISSN 1613-2394.

Schramm, A., Scharf, C., Aneziris, C. G. (2019): Filtration von Mg-Schmelzen. 36. Arbeitskreis Magnesiumrecycling, Zeidlerschloss Feucht, April 11, presentation.

Transfer projects

Transfer project T01

Neumann, S., Asad, A., Schwaze, R. (2019): Inclusion Removal in Tundish Metal Melt Flows using Active Filtration and Reactive Cleaning Contribution. International Workshop of Simulation Science, May 8-10, Clausthal-Zellerfeld, presentation.

Wetzig, T., Luchini, B., Dudczig, S., Hubálková, J., Aneziris, C. G. (2019): Industrial-scale investigation of novel carbon-bonded alumina filters for continuous casting of steel. DKG Jahrestagung, May 5-9, Leoben, Austria, presentation No. 12627.

Transfer project T02

Schmiedel, A., Weidner, A., Biermann, H. (2019): The fatigue life of AISI 4140 in the VHCF regime at high temperatures. 29th Colloquium on Fatigue Mechanisms, Brno, Czech Republic, March 21-22, presentation.

Schmiedel, A., Weidner, A., Biermann, H. (2019): The fatigue life of AISI 4140 in the VHCF regime at high temperatures. TMS 2019, 148th Annual Meeting & Exhibition, Symposium: Fatigue in Materials, March 10-14, San Antonio, TX, USA, presentation.

Service projects

Service project S01

Hubálková, J., Luchini, B., Wetzig, T., Grabenhorst, J., Fruhstorfer, J., Pandolfelli, V. C., Aneziris, C. G. (2019): Carbon-bonded alumina foam filters produced by centrifugation: A route towards improved homogeneity. REFRA Prague 2019, Czech Republic, April 24-26, presentation.

Service project S02

Lehmann, H., Jung, B. (2018): Temporal In-Situ Compression of Scientific Floating Point Data with t-GLATE. The 2018 International Conference on Computational Science and Computational Intelligence - CSCI'18, December 13-15, Las Vegas, USA, pp. 1-6.

Patents and patent applications

Subproject A01

Method of fabricating carbon-containing ceramic components, patent No.: 10 2015 221 853, publication date: 16.05.2019, patent granted: 16.05.2019.

Subproject B06

Method of purifying a metal melt in an induction furnace, patent No.: 11 2017 000 047.5, publication date: 21.12.2018, patent granted: 21.12.2018.

CRC 920 ASSIGNS PUBLICATION AWARD

For the third time, the CRC 920 assigned its publication award to young scientists. The award received **Dr.-Ing. Claudia Voigt (subproject A02), M. Sc. Lisa Ditscherlein (subproject B01), Dipl.-Ing. Eric Werzner (subproject B02) and Dr.-Ing. Tilo Zienert (MGK)** for their publication on "Wettability of AlSi7Mg alloy on alumina, spinel, mullite and rutile and its influence on the aluminum melt filtration efficiency." The paper describes wetting properties between aluminum melt and refractory materials. Both wetting properties and adhesion influence the filter efficiency when filtering aluminum melt and hence directly affect the quality of aluminium casting products.

Photo (left to right): Awardees of the CRC publication award, Dipl.-Ing. E. Werzner, Dr.-Ing. C. Voigt and M. Sc. L. Ditscherlein, together with Prof. C. G. Aneziris.

In addition, **M. Sc. Lisa Ditscherlein** received the award in her role **as co-author** of the paper on "Measuring interactions between yeast cells and a micro-sized air bubble via atomic force microscopy." The paper investigates the interrelations between a micro bubble and an immobilized cell using the atomic force microscope. In cooperation with BASF/SE GMC/O Ludwigshafen and the Institute for Mechanical Process Engineering and Mechanics a method has been developed to place a micro bubble, that is used for modelling the agglomeration behavior of non-metallic inclusions in metal melts.

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 or young scientists who work in a scientific subproject. 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 of TU Bergakademie Freiberg. The award can be assigned several times a year and brings a monetary acknowlegdment. ■

Photo (from left to right): Prof. C. G. Aneziris, Prof. A. Michaelis, Prof. Dr. D. Rafaja, Dr. A. Salomon, Prof. G. Wolf, Prof. O. Volkova, Prof. J. Heitmann.

GRADUATIONS IN CRC 920

Three doctoral students successfully finished their dissertation. In December 2018, **Dr.-Ing. Hanka Becker** defended her dissertation entitled “Intermetallic phases and phase formation during solidification related to Fe-containing Al-Si alloys with Mg, Mn and Cr.“

Photo (from left to right): Prof. H. Biermann, Prof. G. Heide, Prof. A. Leineweber, Dr. H. Becker, Prof. U. Prahl, Prof. D. Rafaja, Prof. C. G. Aneziris.

Moreover, this January Dr.-Ing. Eva Jäckel and Dr.-Ing. Anton Salomon successfully graduated. **Dr.-Ing. Eva Jäckel** investigated to what extend the macro porosity and the surface structure of a foam ceramic filter as well as its position in a casting system impacts the filter‘s effectiveness. The dissertation submitted by **Dr.-Ing. Anton Salomon** describes the investigation of interfaces between metal melt and the filter ceramic, generated by employing spark plasma sinter technology and by excluding flow effects. ■

CONFERENCES AND CALLS FOR PAPERS

XVI. ECerS Conference: June 16-20 2019, Torino/ Italy, more information available at: https://www.ecers2019.org/.

EUROMAT 2019: September 01-05 2019, Stockholm/Sweden, https://euromat2019.fems.eu/.

DGM Materials Week 2019: September 18-20 2019, Dresden, more information available at: https://2019.werkstoffwoche.de/home/.

62. International Colloquium on Refractories: September 25-26 2019, Aachen, more information available at: http://ecref.eu/index.php?id=kolloquium&L=1.

16th UNITECR 2019: October 13-16 2019, Yokohama/Japan, more information available at: www.unitecr2019.org.

10. Freiberg Refractory Forum: 11.12.2019, Freiberg.

IMPRESSUM

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

ISSUE: No. 16, Issue 01/2019
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SFB 920
Multifunktionale Filter für die Metallschmelzefiltration – ein Beitrag zu Zero Defect Materials