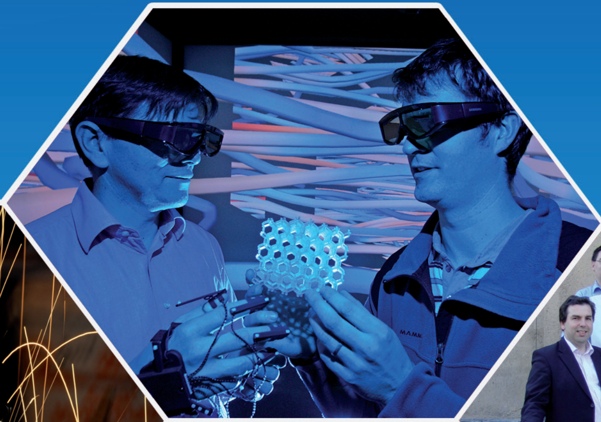
SFB 920

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

NEWSLETTER 01/2011

DFG Deutsche Forschungsgemeinschaft

Bergakademie Technische Universität Freiberg





DEAR READERS,

Safety for road and railway vehicles as well as aircrafts requires highly stressable steel, iron, aluminum and magnesium based components. The efficiency of these components is highly determined by the materials' quality and purity. During the production process an irregular distribution of the chemical elements arises. Furthermore, contaminations within the metal melt can occure resulting in defects in the form of inclusions. It is very difficult or even impossible to remove those defects. Therefore the Collaborative Research Center (CRC) 920 "Multi-Functional Filters for Metal Melt Filtration – A Contribute towards Zero Defect Materials" focuses on researching new filter materials and systems for a better cleaning of metal melts.

On behalf of the whole team, we invite you to get in touch with our research project and to pursue the development of the CRC. With this first issue of our newsletter, we want to awake your interest and curiosity about our project, our goals, our research program as well as our discoveries. From now on, we will inform you regularly about our research and our findings. We are pleased for ideas and recommendations. You will find more information about CRC 920 on our website. Visit us at http://sfb920.tu-freiberg.de. We hope you enjoy the newsletter!

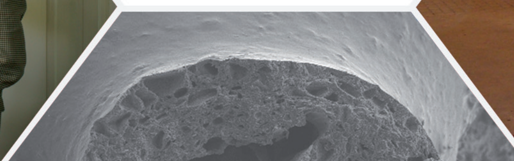
Yours sincerely,

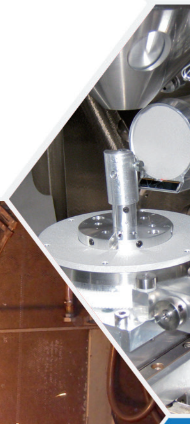
Prof. Dr.-Ing. habil. Christos G. Aneziris
CRC Coordinator

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

CONTENT







DFG APPROVED NEW COLLABORATIVE RESEARCH CENTER

On May 24, 2011, the Deutsche Forschungsgemeinschaft (DFG) approved the new collaborative research center (CRC) 920 "Multi-Functional Filters for Metal Melt Filtration - A Contribution towards Zero Defect Materials". Within the new research center 16 project partners from four different faculties work together. During the first project period between July 2011 and June 2015, they want to study intelligent ceramic filters that generate a cleaner molten metal and thus allow the production of zero-defect, weigth-reduced and safer materials.

For this first period the DFG provides 9.5 million Euro. By establishing the CRC 920 "Multi-Functional Filters for Metal Melt Filtration - A Contribution towards Zero Defect Materials" the Technical University Bergakademie Freiberg once again emphasizes its research competence in materials science.

Subproject coordinators, from left to right:
1st row: Prof. Dr.-Ing. habil. Christos G. Aneziris (CRC Coordinator), Dr.-Ing. Rhena Wulf, Prof. Dr.-Ing. Dimosthenis Trimis, Prof. Dr.-Ing. Urs A. Peuker
2nd row: Prof. Dr.-Ing. habil. Horst Biermann (CRC Vice Coordinator), Dr.-Ing. Anja Weidner, Dr. Olga Fabrichnaya, Prof. Dr. rer. nat. Karl G. van den Boogaart
3rd row: Prof. Dr. rer. nat. habil. Jens Kortus, Prof. Dr.-Ing. Bernhard Jung, Prof. Dr.-Ing. Lutz Krüger, Prof. Dr.-Ing. Klaus Eigenfeld, Dipl.-Kffr. Linda Clauß, Dr.-Ing. Undine Fischer, Prof. Dr.-Ing. habil. Ulrich Groß
4th row: Dr. rer. nat. Peter Franke, Prof. Dr. rer. nat. habil. David Rafaja

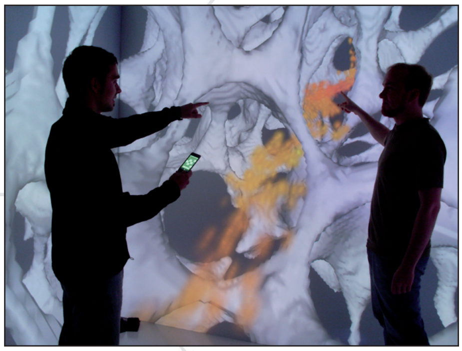
VISIONARY RESEARCH

Users and manufacturer alike ask for more quality as well as homogenity and thus efficiency of materials. Starting the new collaborative reseach center is a response to this demand.

Producing high quality and zero defect materials demands an even distribution of the materials chemical components as well as an improvement in the metals degree of purity. Therefore a remarkable reduction of inorganic nonmetallic inclusions in the metal matrix is necessary. To improve the deposition of those inclusions on the filter surface, intelligent filter material and filter systems with a functionalized filter surface based on active ceramic coatings and combined with customized compression ratios within the porous functional cavity should be used.

In addition new reactive coatings are going to be investigated in terms of a chemical reaction between the functionalized filter surface and the gases included in the metal melts. For the first time, contaminations caused by gas as well as inclusions generated below the liquidus temperature of the molten metal can be considerably reduced.

The results of researching new filter materials as well as a computer aided micro- and macrostructure filter design will lead to highly stressable components made of steel, iron, aluminum and magnesium. Realizing excellent functional and adaptive mechanical characteristics that meet the conditions to which a cast part is subjected and thus guaranteeing the safety for road and railway vehicles as well as aircrafts is the CRC's vision. In addition other applications such as the filtration of copper and silicon in the electronic industry, the aluminum foil production in the packaging industry as well as design and development of filtration systems and the conditioning of slags will profit from the scientific results. The zero defect materials the CRC 920 is striving for are nearly perfect.



4D-Visualization of a filtration process in a cave automatic virtual environment at the Department of Computer Science

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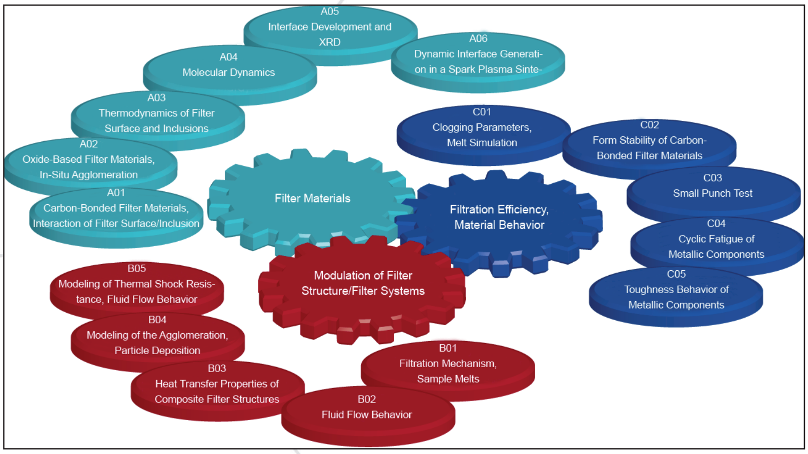
Multifunktionale Filter für die Metallschmelzefiltration –
ein Beitrag zu Zero Defect Materials



Integrated project structure in the first project period

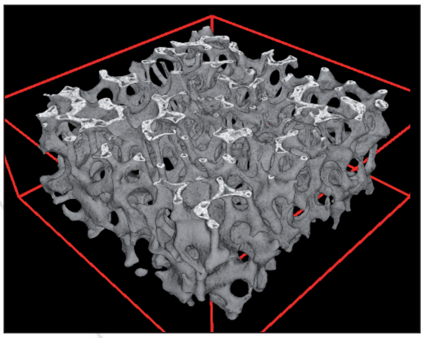
The CRC 920 is divided into three project areas: “A: Filter materials“, “B: Modulation of filter structure and filter systems“ and “C: Filtration efficiency and material behavior“. The project areas themselves include 16 scientific subprojects. There is also a graduate program, three service projects and a central administration project.

PROJECT AREA A – FILTER MATERIALS

Project area A, consisting of six subprojects, researches active and reactive filter materials. Especially, the surface tension at the junction of filter wall - solid inclusion - metallic melt is set up. The main goal is to raise the filter efficiency for primary and secondary inclusions with a size of 1 to 100 µm from currently about 70 % for steel melts and about 75 % for aluminium melts to over 90 %.

Another focus of this project area is the examination of the reaction mechanism and the filter potential of reactive filter materials. That means that the filter material reacts with the gases which are included within the melt. This can help to reduce the primary and secondary inclusions, but also can be a substantial contribution in reducing tertiary and quaternary inclusions.

Project area A is under the supervision of Prof. Dr.-Ing. habil. Christos G. Aneziris.

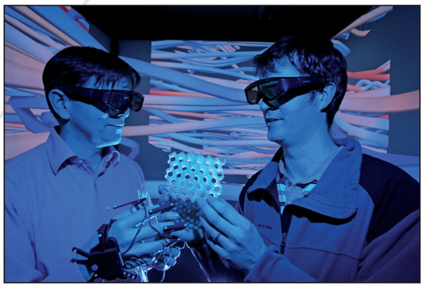

CT scan of a foam ceramic part, 3D, 2.2 magnification

PROJECT AREA B – MODELING OF FILTER STRUCTURES AND FILTER SYSTEMS

Project area B, consisting of five subprojects, is considered to be prerequisite both for a precise geometrical and material design of filter structures and the evaluation of the material behavior under operation conditions. Understanding the micro-processes of particle deposition, meaning inclusions, on an active and reactive inner surface of a functional cavity is the main focus of this project area.

To understand the effects of filter mechanisms as a function of filter structure, filter process and filter systems, physical and stochastic models are developed. Those models include deposition, agglomeration and heat conduction. Based on those models simulations are being run. The stochastic distribution of inclusions within the melt has to be determined to allow a theoretical prediction of the probability of occurence of those inclusions.

Project area B is under the supervision of Prof. Dr.-Ing. Urs A. Peuker.


Flow visualization in a Cave Automatic Virtual Environment in the Department of Computer Science

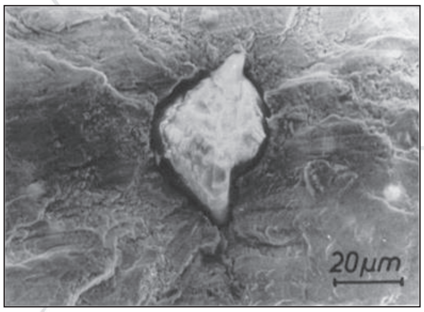
PROJECT AREA C – FILTER EFFICIENCY AND MATERIAL PROPERTIES

Project area C, consisting of five subprojects, researches the efficiency of the produced filter materials. With the now improved mechanical properties, this project area will demonstrate how these new filters will help to create new generations of highly stressable cast iron parts.

Filter technologies and efficiencies as well as the properties of the filtered end product, a metal cast iron part, will be examined extensively within the course of this project area. Based on these examinations conclusions can be drawn considering the filter materials (project area A) and structural filter design (project area B). An important aspect is the creep resistance of ceramic filter bodies in mould casting under extreme temperature changes.

This project area will also determine the necessary material parameters that are essential for the modeling in project area B and are also important for designing and dimensioning.

Project area C is under the supervision of Prof. Dr.-Ing. habil. Horst Biermann.



Non-metallic inclusion in the center of crack formation (Source: Doctoral Thesis M. Scharf, 1987, TU Bergakademie Freiberg)

LINKING SUBPROJECTS THROUGH WORK GROUPS

The three project areas of CRC 920 are constantly interacting with each other in terms of exchanging information about their results. Four work groups were created to assure a timely inter-project stream of input/output information and to support the versatile links of research activities within the subprojects.

All four work groups create an innovative cycle of research, material design and understanding of the main mechanisms of active and reactive filter materials. This cycle enables the CRC to transfer the results on other metal melts to the point of their application.

WORK GROUP 1: “METAL MELT/INCLUSIONS, ACTIVE/REACTIVE FILTER MATERIAL, BOUNDARY SURFACE DESIGN“

Work group 1 is being supervised by Dipl.-Ing. Claudia Voigt (subproject A02) and consists of members of the (main) subprojects A01, A02, A03, A04, A05, A06, C01, S01 and S03. Its purpose is to discuss the transport of inclusions in the melt and the process of deposition of the inclusions on the filter wall.

The behavior of inclusions while contacting a metal melt is being examined. Therefore, the actual surface texture of the active filter material and the forming boundary surfaces between particles and between particle and filter wall are being analyzed using sample materials from subprojects A01, A02, A06, C01 and S03. Also the wetting behavior between filter wall and metal melt / inclusions using actively and reactively coated filter substrates are analyzed. For describing non-crystalline boundary surfaces workgroup 1 develops models.

To support the choice of filter materials, the design of boundary surfaces and the subsequent research of filter materials the cooperation and exchange of the subprojects is crucial.

Dipl.-Ing. Claudia Voigt

YEAR AND PLACE OF BIRTH

Born 1980 in Karl-Marx-Stadt (now Chemnitz)

EDUCATION

- 10/1999 - 10/2004 Studies of Ceramic, Glass and Construction Materials at TU Bergakademie Freiberg

PROFESSIONAL CAREER

- 10/2004 - 02/2005 Development Engineer for Steinbeis-Transferzentrum Materials Engineering
- 03/2005 - 09/2011 Development Engineer for multifunctional ceramics at CeramTec GmbH
- since 10/2011 Research Assistant at the Department of Ceramic, Glass and Construction Materials at TU Bergakademie Freiberg

PHD THESIS TITLE

Oxidic filter materials and filter structures with active and reactive functional cavities (subproject A02)

WORK GROUP 2: “MODELING AND DESIGNING THE FILTER GEOMETRY“

Work group 2 consists of members of the (main) subprojects A01, A02, A03, A04, A05, B01, B02, B03, B04, C01, S01, S02 and S03 and is being supervised by PhD Miguel Mendes (subproject B02). This group discusses the modeling and dimensioning of the filter geometry.

All filtration models and processes developed by participating projects illustrating heat and mass transport, agglomeration and deposition and adhesion of particles to the filter wall are being merged, discussed and visualized in a Cave Automatic Virtual Environment. This visualization can help understand mechanisms of filtration in order to design active and reactive filter materials and to select proper materials precisely and use-oriented.

PhD Miguel Mendes

YEAR AND PLACE OF BIRTH

Born 1981 in Lisbon, Portugal

EDUCATION

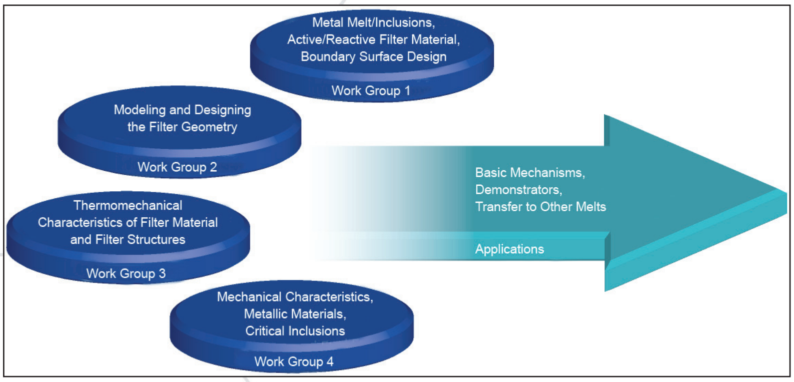
- 1999 - 2005 Studies of Mechanical Engineering at TU Lisbon
- 2011 Graduation on “Modeling and simulation of hydrocarbon oxidation processes within inert porous media” at TU Lisbon

PROFESSIONAL CAREER

- 09/2005 - 05/2011 Research Assistant at the Department of Mechanical Engineering at TU Lisbon
- 01/2008 - 03/2009 Visiting Scientist at the Department of Heat Engineering and Thermodynamics at TU Bergakademie Freiberg
- since 09/2011 Research Assistant at the Department of Heat Engineering and Thermodynamics at TU Bergakademie Freiberg

POSITION AT CRC

Research Assistant in subproject B02 “Velocity behavior – Fluid dynamics in composite filter structures”



Linking the subprojects through four work groups

WORK GROUP 3: "THERMO-MECHANICAL CHARACTERISTICS OF FILTER MATERIAL AND FILTER STRUCTURES"

Under the supervision of Dipl.-Wirt.-Ing. Yvonne Klemm (subproject C02) work group 3, consisting of the (main) subprojects A01, A02, B01, B02, B03, B04, B05, C02 and C03, discusses thermodynamic properties of filter materials and structures.

From a thermodynamical viewpoint, a ceramic filter has to withstand the thermal shock from room temperature to casting temperature. From a mechanical perspective it has to support a certain quantity of the metal melt. Furthermore, the filter must not react with the melt chemically and must not soften under load within the first 30 seconds. If the filter fails at one of those properties partially or in total, a technological damage and contamination of the melt are the results. With filters getting bigger this problem becomes even worse. Only a proper combination of filter materials and structures allow a quality-assured metal melt filtration.

Dipl.-Wirt.-Ing. Yvonne Klemm

YEAR AND PLACE OF BIRTH

Born 1984 in Freiberg

EDUCATION

- 2003 - 2008 Studies of Industrial Engineering at TU Bergakademie Freiberg

PHD THESIS TITLE

High temperature strength and form stability of carbon-bonded filter materials for steel melt filtration (subproject C02)

WORK GROUP 4: "MECHANICAL CHARAKTERISTICS, METALLIC MATERIALS, CRITICAL INCLUSIONS"

Members of work group 4, consisting of (main) subprojects A01, A02, A04, A05, B01, B02, B03, B04, B05, C04, C05, S01 and S03, discuss mechanical properties and metallic materials under supervision of Dr.-Ing. Sebastian Henkel (subproject C04). In this project, melt samples are being contaminated with non-metallic inclusions which are then being partially removed by filtration. The filter efficiency can be determined by examination of polished thin sections of the samples. Another examination focuses on the effects of non-metallic inclusions on the specific durability and toughness behavior of cast iron parts. This work group also discusses critical inclusions and determines the distribution of the failure time.

Based on that, the group can predict the reliability of the cast iron parts as a function of filter characteristics even under complex load patterns.

The findings of work group 4 enables the project to evaluate the functionality of the novel active and reactive filter material and structures. Furthermore, important information on optimization of filter materials and on design of filter structures can be determined.

Dr.-Ing. Sebastian Henkel

YEAR AND PLACE OF BIRTH

Born 1975 in Görlitz

EDUCATION

- 10/1995 - 08/2001 Studies of Material Science and Material Technology at TU Bergakademie Freiberg
- Graduation on "Contribution to cyclic planar-biaxial inspection of metallic materials" at TU Bergakademie Freiberg (2010)

POSITION AT CRC

Research assistant at subproject C04 "Experimental and stochastic investigations of the influence of the inclusions on the cyclic fatigue"

DFG Deutsche Forschungsgemeinschaft
TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG

BEHIND THE SCENES: CRC 920s INTEGRATED GRADUATE PROGRAM

Cooperating with the Centre of Advanced Study and Research of the TU Bergakademie Freiberg, the CRC 920 offers its graduates an Integrated Graduate Program. Its intention is to allow a well-structured and efficient graduation and to qualify the participants for an independent and excellent research. It also aims for educating highly qualified trainees well prepared for a career in science or management. Therefore the graduate program offers a wholistic education including expert and methodological knowledge as well as social and communicative skills.

To advance those skills the graduates are encouraged to take responsibilities in an international environment. Events as the “Schools at University“ program or the school laboratory “Science meets School“ are perfect opportunities to participate. Here they can mentor groups of pupils and aquire key qualifications and experience in the broad field of knowledge transfer.

The graduates also get many possibilities to participate in further training, conferences or field trips to partners from industry. Furthermore there are training series hosted by international visiting scientists.

Prof. Dr. rer. nat.
Georgios Kostakis

EDUCATION

- 1970 Studies of Mineralogy at Ludwig Maximilians University Munich
- 1973 Graduation on “Determination of the oxygen partial pressure over chromites and their adjoining rock in temperature ranges from 800° to 1200° C.“ at Ludwig Maximilians University Munich

PROFESSIONAL CAREER

- 1983 - 1986 Professor at the Department of Mining and Metallurgy at the National TU Athens
- since 1986 Professor at the Department of Engineering of mineral raw materials at TU Crete
- 1990 - 1993 Dean of the Department of Engineering of mineral raw materials at TU Crete
- since 2010 Guest lecturer and research assistant in the work group “Ceramic“ at the Department of Ceramic, Glass and Construction Materials at TU Bergakademie Freiberg

POSITION AT CRC

Guest lecturer for training and individual mentoring on phase analysis of solid materials

FIRST SERIES OF TRAINING PASSED

For the very first training series that took place from October until December 2011 the CRC 920 was already able to welcome Prof. Georgios Kostakis from the Technical University of Crete. He taught the graduates on X-ray powder diffraction, a method for qualitative examination of crystalline, powdery substances. Moreover, he referred to the Rietveld method that is used for quantitative interpretation. To sharpen their understanding of this method, the graduates first had to become familiar with the essential crystallographic terms. As the training continued, X-rays and their interaction with matter and different methods of powder diffraction were discussed. Finally practical examples were presented.

The goal of this training series was to communicate practical information for the graduates‘ work. Besides the theoretical training, the graduates were also able to seek individual and professional mentoring. Even after the end of this series Prof. Kostakis will provide advice on questions regarding samples that can be examined by X-rays.

Prof. Kostakis during his lecture

GRADUATE PROGRAM CHARACTERIZED BY MULTIDISCIPLINARITY AND QUALITY

Participants of the course discussing

The CRC 920s graduate program features a great amount of multidisciplinarity as it is integrated into the Departments of Mathematics and Computer Science, Chemistry and Physics, Mechanical Engineering, Mechanical Process Engineering and Energy Technology as well as Material Science and Material Engineering. Thus, many parts of the TU Bergakademie Freiberg are combined. This organization allows individual mentoring and supports and motivates graduates to bring their knowledge, ideas and creativity into the CRC 920.

To provide the quality of the graduate program an application is mandatory. As the number of possible participants is limited, the achievements of the graduates are essential.

SFB 920

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

CARBON-BONDED FILTER MATERIALS (PROJECT AREA A: FILTER MATERIALS)

Carbon-bonded alumina filters for the steel melt filtration enjoy constantly growing popularity by steel foundries. Their potential regarding the material characteristics and the filtration efficiency appears however not used in full measure up to now.

Therefore M. Eng. Marcus Emmel (subproject A01) focuses his research work on the development of novel filter materials and filter structures with which a basic understanding for innovative approaches regarding the steel melt filtration is to be created.

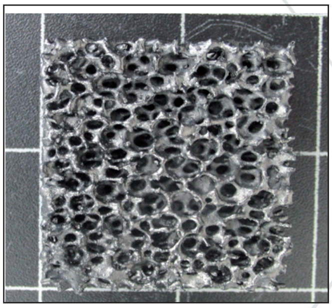


Figure 1: Carbon-bonded foam ceramic filter (50x50x20 mm, 10 ppi)

In terms of the first emphasis a new filter composition based mainly on the synthetic coal tar pitch Carbores® P as binder and carbon carrier is explored. Its compatibility with a water-based dispersing system allows by addition of carbon black, graphite and special temporary additives a residual carbon content of approximately 30 wt.%. For the determination of the characteristic values and the different factors of influence of the respective compositions, 10 ppi foam ceramic filters were manufactured via the Schwartzwalder process (Fig. 1). The evaluation of the influences of different binder contents regarding the processing properties and the mechanical characteristics of the systems is in the center of attention. Based on the new compositions higher cold crushing strengths have been achieved in comparison to the state of the art. Furthermore, the accomplishment of an impingement-test, in cooperation with service project S03 (steel casting), verified the applicability of the newly developed filter materials. Within the prementioned test, the cold filters (18° C) are impinged with steel melt (1670° C), in order to evaluate their thermal shock resistance as well as their permeability. Moreover, the essential influence of the alumina on the residual carbon content could have been detected which confirms existing theories.

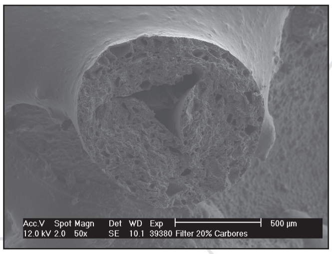


Figure 2: SEM-micrograph of the filter strut with 20 % Carbores®P (cross section area)

The second emphasis consists of the generation of cold-applied, active coatings onto the filter substrates which exhibit the same chemism like the oxidic inclusions within the steel melt. This provides an adjustment of interfacial surface tensions which should lead to improved filtration efficiencies. Therefore completely wetted filter struts have to be generated that enable tight coatings (Fig. 2), due to varying sintering temperatures. The main focal point at this is on the cause of the adherence of the oxidic coatings, which is to trace back either to potential chemical interactions, or to thermal-related mechanism. First results, won with the aid of dilatometry, verified the possibility of coating-applications, due to a higher amount of shrinkage, compared to uncoated filter substrates. Even after performance of the impingementtest, oxidic coatings are intact (Fig. 3).

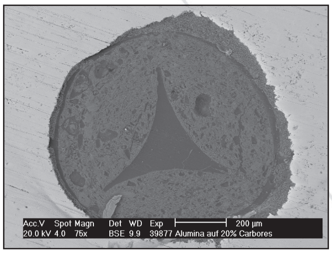


Figure 3: SEM-micrograph of the filter strut after impingementtest with steel (cross section area)

Prospective research works should identify the influence of varying carbon modifications on the filtration efficiency. Regarding this aspect, the application of Carbores®P leads to the formation of crystalline structures, whereas resins generate amorphous carbon. Therefore novel crystalline and amorphous carbon containing filter materials and structures, developed by Marcus Emmel, are analyzed currently.

M. Eng. Marcus Emmel

YEAR AND PLACE OF BIRTH

Born 1985 in Neuwied

EDUCATION

- 04/2005 - 05/2009 Studies of Material Technology, Glass and Ceramics at Fachhochschule Koblenz
- 10/2009 - 04/2011 Master study of Ceramic, Glass and Construction Materials at TU Bergakademie Freiberg

PHD THESIS TITLE

Development of carbon-bonded filter materials and filter structures with active and reactive functional cavities (subproject A01)

THE “NEW ONES“ MADE IT
FIRST CASTING EXPERIMENTS WITH STEEL MELT AND NOVEL FILTER MATERIALS AT 1600° C

Dipl.-Wirt.-Ing. Anja Stolle

YEAR AND PLACE OF BIRTH

Born 1986 in Freiberg

EDUCATION

- 2005 - 2011 Studies of Industrial Engineering at TU Bergakademie Freiberg

PHD THESIS TITLE

Active and reactive filtration of steel melts used for mold casting (subproject S03)

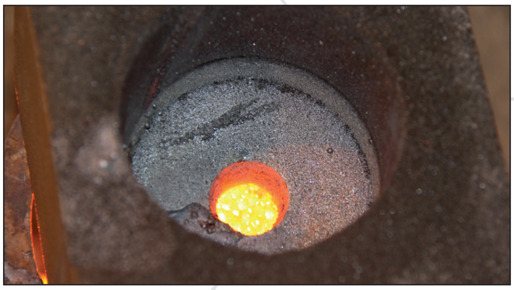
The first carbon based filters survived the heat shock from 15° C to 1600° C without any problems. For the first mutual casting experiments of the CRC 920, Dipl.-Wirt.-Ing. Anja Stolle (subproject S03, Institute of Foundry Technology) and M. Eng. Marcus Emmel (subproject A01, Institute of Ceramic, Glass and Construction Materials) charged their prototypes of novel carbon based filters for filtering steel melts with about 10 kg molten steel. After filtration the melt solidified to test samples. These samples are being used in further CRC subprojects for metallographic and mechanical examination and provide first indications for the functional and filtering efficiency of these novel filter materials and structures. Besides the filtering functionality, the thermo-shock properties are essential for the deployment in metal melt filtration. The first split of a second is crucial for the subsequent filtration process.

The quality of the casting process depends both on the correct shape and dimension of the filter and on a proper casting model. The knowledge of experienced casters and the modelling of the casting process can help design the casting system correctly. With that the chance of producing cast iron with only few bubbles is very high. With cast iron low on bubbles, material scientists from project area C can now find the reason of failure of a part caused by non-metallic inclusions by means of tiring and stress tests. The results from the first casting experiments could already be used for designing the optimal casting mould.

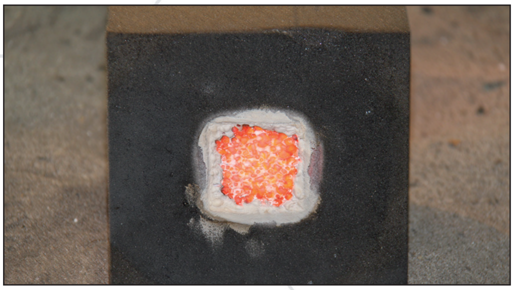
“For future casting experiments with steel melts, bigger and multi-parted casting systems are planned. They allow to filter more melt in less time.“, Dipl.-Wirt.-Ing. Anja Stolle explains. “That means that at the same time thermo-mechanical properties of these novel filter materials and structures are getting more important.“ Anja Stolle is working in subproject S03 where she attends the casting experiments with steel melt. In addition she is working on her doctoral thesis dealing with “Active and reactive filtration of steel melts used for mold casting“.

Casting experiment with a steel melt (1600° C) operated by Mr. Schlesinger

Steel melt (left) and aluminum melt (right)



Intact carbon-bonded filter within a casting system after filtration process - View from above



Intact carbon-bonded filter within a casting system after filtration process - View from below

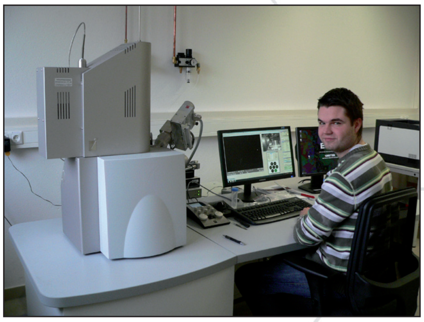
SFB 920

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

RESEARCH EQUIPMENT FOR TECHNOLOGICAL PROGRESS

High-capacity research equipment plays a significant role for constructing, characterizing and inspecting new filter materials and structures. In addition to the funding by the DFG, the TU Bergakademie Freiberg takes over a major part of required investments in those devices. A high temperature vacuum material inspection tool including a induction heating system, a ultrasound inspection tool as well as an inverted microscope with automated inspection systems for non-metallic inclusion were funded by the university. For the first project phase, the university provided funding of the CRC to the amount of 1.7 million Euro.

INSTITUTE OF MATERIALS ENGINEERING GOT OWN SCANNING ELECTRON MICROSCOPE

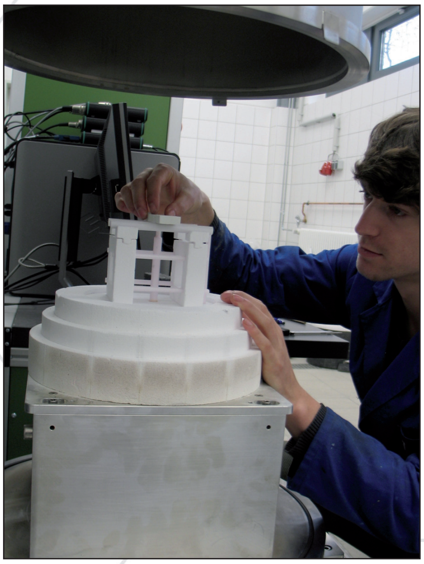

MIRA 3 XMU (TESCAN Comp., Brno)

In December 2011 the Institute of Materials Engineering received its own scanning electron microscope (SEM). Getting the high-resolution analytic SEM with low vacuum mode (MIRA 3 by TESCAN company) became more and more necessary as from now on two CRC projects (CRC 799 and CRC 920) are researching structural properties correlation demanding for high-resolution microscopic examination. The new SEM has six detectors: (1) a secondary electron detector, (2) a back-scattering electron detector, (3) a transmission electron detector, (4) an EDX detector, (5) an EBSD detector and (6) an additional secondary electron detector for the low vacuum mode. These detectors are being used for signal analysis and evaluation. An extra large sample chamber allows to hold an in-situ deformation apparatus that can be used to examine changes in the microstructure of a sample under stress.


A look inside the sample chamber

IT'S ALL ABOUT VIBRATIONS

A new tool for resonance frequency and damping analysis (RFDA) for high temperatures up to 1600° C allows scientist of the CRC 920 to examine the vibration characteristics of materials and assemblies in a non-destructive way. This analysis helps to draw conclusion on the mechanical and thermo-mechanical properties of materials before and after a mechanical and/or thermal treatment. Characteristic vibrations of the materials can be created by exciting the samples with a small amount of stress. This correlation can be illustrated for example by the different sounds of porcelain and polymer samples when jolting them. Observing Young's modulus depending on the temperature helps to understand processes within the materials during their application, e. g. phase transition and crack initiation. Furthermore, this is a non-destructive test method, i. e. that defects can be found without destroying the material. "This is a big advantage compared to the classical static Young's modulus determination by stress-drain-diagrams which will break the sample.", explains Dipl.-Ing. Jörn Werner. "In addition the RFDA is equipped with a vacuum and purge system allowing to run the oven within an inert gas atmosphere to prevent the oxidation of the samples."


Dipl.-Ing. Jörn Werner, graduating in the CRC 920s graduate program, is studying an aluminum oxide filter material sample using the RFDA-equipment

The scientists are using an essential feature of this tool. It allows a well-defined characterization of the thermo-mechanical behavior of the new filter materials at application temperature. Dipl.-Ing. Jörn Werner is graduating in the Integrated Graduate Program the CRC 920 offers. The focus of his doctoral thesis lies on the Young's modulus determination of fireproof materials. Thus, he is supporting the research work in the subprojects A01 and A02.

PUBLICATIONS

Subproject A01

Aneziris, C. G. (2011): Multifunctional carbon bonded filters for metal melt filtration. 36th International Conference and Exposition on Advanced Ceramics and Composites (ICACC), January 22-27, 2012 in Daytona Beach, FL (USA).

Emmel, M. (2011): Development of novel carbon bonded filter compositions for advanced steel melt filtration. In: Ceramics International. Submitted October, 2011.

Subprojects B01, B02

Peuker, U. A.; Aneziris, C. G.; Trimis, D. (2011): Liquid Metal Filtration - New Approaches. World Filtration Congress WFC 11, April 16-20, 2012 in Graz (Austria). Submitted August, 2011.

Subproject B03

Götze, P.; Skibina, V.; Wulf, R.; Emmel, M.; Groß, U.; Aneziris, C. G. (2011): Determination of effective thermal conductivity of open celled foam ceramics with the transient plane source technique. 10th International Symposium on Ceramic Materials and Components for Energy and Environmental Applications, May 20-23, 2012 in Dresden and May 23-24, 2012 in Munich. Abstract accepted.

Subproject C01

Aneziris, C. G.; Gehre, P.; Kratschmer, T.; Berek, H. (2011): Thermal shock behavior of flame-sprayed free-standing coatings based on Al2O3 with TiO2- and ZrO2-additions. In: International Journal of Applied Ceramic Technology, 8 (4), pp. 953-964.

Gehre, P.; Aneziris, C. G. (2011): EBSD- and CT-analyses for phase evolution and crack investigations of thermal shocked flame sprayed alumina and alumina-rich structures. In: Ceramics International, 37 (6), pp. 1731-1737.

Kratschmer, T.; Aneziris, C. G. (2011): Amorphous zones in flame sprayed alumina-titania-zirconia compounds. In: Ceramics International, 37 (81), pp. 181-188. .

Kratschmer, T.; Aneziris, C. G.; Gruner, P. (2011): Mechanical properties of flame sprayed free-standing coatings. In: Ceramics International, 37 (7), pp. 2727-2735.

Subproject Z

Aneziris, C. G.; Fischer, U. (2011): Manche mögen es heiß: Keramische Filterwerkstoffe als „Hochtemperatur Fliegenfänger“ für die Metallschmelze-Filtration. In: Jahresmagazin Ingenieurwissenschaften, Fokus Werkstofftechnologie. Submitted August, 2011.

PATENT APPLICATIONS

Subproject A01

Keramische Filter für die Metallschmelzefiltration auf der Grundlage gängiger Metallschmelze-Filtergeometrien und Verfahren zu ihrer Herstellung, Pending patent application No. 10 2011 109 681.0.

Verfahren zur Herstellung kohlenstoffhaltiger und/oder kohlenstoffgebundener keramischer Metallschmelze-Filter, Pending patent application No. 10 2011 109 682.9.

Keramische reaktive Filter für die Metallschmelzefiltration, Pending patent application No. 10 2011 109 684.5.

UPCOMING

December 9, 2011
2nd Freiberger Feuerfestforum

December 15, 2011
2nd PhDs Meeting including Workshop

December 16, 2011
3rd Members‘ Meeting

March 14-15, 2012
3rd PhDs Meeting including Workshop

March 16, 2012
4th Members‘ Meeting

July 16, 2012
4th PhDs Meeting including Workshop

July 17, 2012
5th Members‘ Meeting

CONFERENCES

January 22-27, 2012
36th International Conference and Exposition on Advanced Ceramics and Composites (ICACC), Daytona Beach, FL (USA), Conference Paper and Presentation “Multifunctional carbon bonded filters for metal melt filtration” by Prof. C. G. Aneziris.

April 16-22, 2012
11th World Filtration Congress (WFC 11), Graz (Austria), Conference Paper and Presentation “Liquid Metal Filtration - New Approaches” by Prof. U. A. Peuker, Prof. C. G. Aneziris, and Prof. D. Trimis.

May 20-24, 2012
10th International Symposium on Ceramic Materials and Components for Energy and Environmental Applications (CMCee), Dresden/Munich, Abstract for Conference Paper “Determination of effective thermal conductivity of open celled foam ceramics with the transient plane source technique” by P. Götze, V. Skibina, R. Wulf, M. Emmel, Prof. U. Groß, and Prof. C. G. Aneziris accepted.

IMPRINT

EDITOR
Prof. Dr.-Ing. habil. Christos G. Aneziris
CRC Coordinator
TU Bergakademie Freiberg
Institute of Ceramic, Glass and Construction Materials
Agricolastraße 17, 09599 Freiberg
Phone: +49 3731 39 2505
Fax: +49 3731 39 2419
E-Mail: aneziris@ikgb.tu-freiberg.de

Dr.-Ing. Undine Fischer
CRC Managing Director
TU Bergakademie Freiberg
Institute of Ceramic, Glass and Construction Materials
Agricolastraße 17, 09599 Freiberg
Phone: +49 3731 39 3324
Fax: +49 3731 39 2419
E-Mail: undine.fischer@ikgb.tu-freiberg.de

EDITORIAL OFFICE
Dipl.-Kffr. Elke Nikolai
TU Bergakademie Freiberg
Chair of Management, Leadership and Human Resources
Lessingstraße 45, 09599 Freiberg
Phone: +49 3731 39 3570
Fax: +49 3731 39 3313
E-Mail: elke.nikolai@bwl.tu-freiberg.de

DESIGN
Julia Christine Schreiber
TU Bergakademie Freiberg
Chair of Management, Leadership and Human Resources
Lessingstraße 45, 09599 Freiberg
Phone: +49 3731 39 3570
Fax: +49 3731 39 3313
E-Mail: julia-christine.schreiber@student.tu-freiberg.de

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

ISSUE: 01/2011
FREQUENCY OF PUBLICATION: twice a year

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