SFB 920

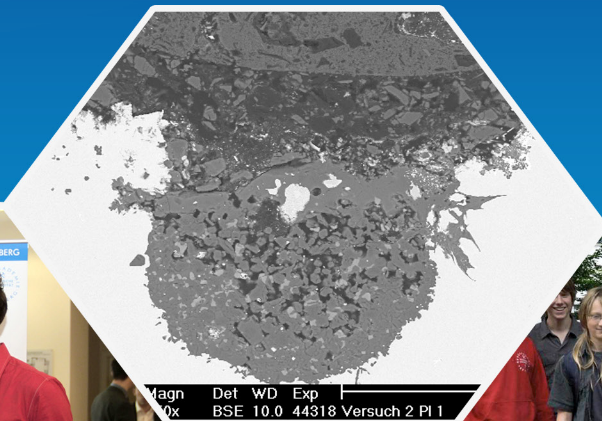
Multifunktionale Filter für die Metallschmelzefiltration – ein Beitrag zu Zero Defect Materials

NEWSLETTER

3 (2/2012)

DFG Deutsche Forschungsgemeinschaft

Technische Universität Bergakademie Freiberg



DEAR READERS,

An intensive collaboration between the CRC‘s subprojects and a vital interchange of ideas and experiences beyond national borders are drivers of the CRC‘s success. Hence, the CRC offered series of presentations and workshops with leading experts in the field of metallic and ceramic materials including Dr. Jinichiro Nakano and Prof. Paolo Colombo, thus combining experts‘ knowledge on relevant scientific fundamentals of the CRC and, moreover, offering numerous opportunities for intensive exchanges with researchers and doctoral students of the CRC.

Furthermore, the CRC welcomed research interns from four countries for short-term visits. These young researchers successfully applied for a scholarship provided by the CRC 920 and the DAAD, respectively. The internships are intended to support primarily experimental studies in several subprojects.

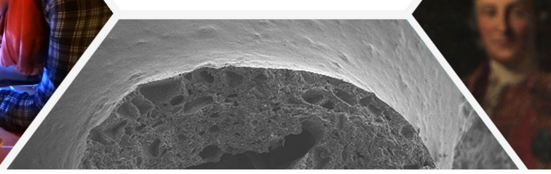
The latest activities, results and events of the CRC 920 are illustrated in this issue of our newsletter. More information is also available on our website on http://sfb920.tu-freiberg.de. We hope you‘ll enjoy the newsletter.

Yours sincerely,

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

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

CONTENT



EXPERT TALKS WITH INTERNATIONAL GUESTS

Providing series of lectures and workshops, seven internationally distinguished experts delivered insights into their research and discussed current issues and projects with CRC researchers and Ph.D. students. The expert talks took the aim of deepening Ph.D. students' professional knowledge and skills, which are required not only for advancing research on the project level but also for generating reliable and productive working relationships between the subprojects - a vital basis for the CRC's success.

Between May and December 2012 several international guests offered lectures and workshops for CRC researchers, project coordinators and, in particular, Ph.D. students. These lectures were addressing scientific fundamentals of the CRC, including relevant properties and performance of filter materials and suitable methods of analysis, such as confocal laser scanning microscopy which is currently applied in subproject TP A01 at the Institute of Iron and Steel Technology (IEST). The series of lecture comprised the following experts and topics:

- **Prof. Ik Jin Kim** (Hanseo University, South Korea): "Functional Porous Ceramics by Direct Forming,"
- **Prof. Prabal Talukdar** (Indian Institute of Technology Delhi, India): "Interaction of Conduction and Radiation within Porous Media using Finite Volume Method,"
- **Prof. Guojun Ma** (Department of Metallurgical Engineering, Wuhan University of Science and Technology, China): "Inclusion Behavior in Molten Steel & Slag and its Removal,"
- **Prof. Seshadri Seetharaman** (Royal Institute of Technology Stockholm, Sweden): "Gas Solid Reactions Leading to One-Step Production of Nano Alloys and Intermetallics,"
- **Jinichiro Nakano, Ph.D.** (US Department of Energy; National Energy Technology Lab/URS, Albany, USA): "Principal and Practice of the Measurement by the Confocal Laser Scanning Microscopy,"
- **Prof. Paolo Colombo** (Department of Mechanical Engineering, University of Padova, Italy): "Porous Materials for Filtration Processes,"
- **Prof. José de Anchieta Rodrigues** (Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, Brasil): "Elastic Moduli, Damping and Fracture Energy Measurement."

In the near future, intensive working relationships will be established with three of the international experts, namely, Prof. Colombo, Prof. Rodrigues, and Dr. Nakano. The latter, Dr. Nakano, expressed his appreciation of the CRC research program and the scientific infrastructure.

Photo (from left to right): Prof. Christos G. Aneziris (Coordinator of the CRC 920), Dr. Jinichiro Nakano (National Energy Technology Lab/URS, USA).

"We were very impressed about your work and the size of the projects! The quality and variations of experimental equipment were truly of the world-class laboratory. We were also impressed by the team efficiency in your lab as frequently noted during the tour," he said. For the future, a continuous exchange of ideas and results was agreed in order to stimulate joint research activities and publications. ■

Photo: Prof. Paolo Colombo, University of Padova, Italy.

In his presentation, Prof. Paolo Colombo, University of Padova, Italy, focused on technologically relevant parameters for the **generation and application of highly porous ceramics.** Depending on applications and materials, specific demands on materials properties and fabrication procedure are made. Moreover, Prof. Colombo pointed to the issue of recyclability of materials for the sake of resource efficiency.

Prof. Colombo is **internationally acknowledged** for his expertise on porous ceramics and structures. His work has been published in leading journals and books worldwide. His research, amongst others, inspired the CRC 920 to explore structures that are suitable for metal melt filtration.

In appreciation of the work of the CRC, Prof Colombo **invited M. Eng. Marcus Emmel, Ph.D. student in subproject TP A01**, for a three-month visit at his department at the University of Padova. This intern will be dedicated to intensive research activites on carbon-bonded filter structures. ■

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

EVIDENCE ON FILTER EFFECTIVENESS

The CRC 920 successfully developed novel carbon-bonded ceramic filters with active and reactive functional cavities. Industrial casting tests on steel melt and subsequent analyses conducted by CRC researchers revealed a satisfying filter effect: The novel filters demonstrate an improved ability to capture non-metallic inclusions from iron-containing melts.

After passing the impingement test executed by subproject S03 at the Foundry Institute, the novel carbon-bonded ceramic foam filters (10 pores per inch, 75 mm x 75 mm x 20 mm) were installed at the Edelstahlwerke Schmees GmbH in Pirna for first casting tests. These tests used approx. 70 kg of steel melt per filter at a temperature of 1644 °C. In order to ensure a sufficient amount of non-metallic inclusions present in the melt, Al_2O_3-particles with a defined particle size distribution (d_{50}= 69 µm) were added beforehand.

Subsequent to the casting tests, amongst others, the ceramic foam filters were analyzed by M. Eng. Marcus Emmel (subproject A01). His investigations focused on the separation of exogenous, non-metallic inclusions and the deposition on the filter walls. Dipl.-Ing. Dominik Krewerth (subproject C04) analyzed the casted material concerning the influence of the non-metallic incusions remained in the melt on the samples' mechanical properties.

After the infiltration of a carbon-bonded filter with **reactive functional cavities** with steel melt, a polished cross-section specimen from the filter's core was prepared and analyzed using SEM. The analysis revealed the trapping of an Al_2O_3 cluster on the surface of the reactive filter material. This cluster was verified to consist of fine, sintered Al_2O_3 particles, which have been formed in the steel melt during the filtration process (see Fig. 1).

Further evidence on the effective filtration of non-metallic inclusions is presented in Fig. 2. It shows the adherence of even larger Al_2O_3 grains onto the surface of an **active filter material**. Besides chemical interactions, a demanded roughness (visible in Fig. 1 and 2) is suspected to influence the trapping and adhesion of non-metallic inclusions onto the filter surfaces.

Previous investigations of the castings by means of metallographic micrographs, accomplished by Dominik Krewerth, have shown that none of the filter systems shows inclusions with a particle size larger than 20 µm (see Tab. 1). This induces a significant improvement of the filtration effectiveness from currently 75 % for a particle size range of 2 – 100 µm (see Fig. 4) to up to 90 % – as envisioned by the CRC 920. ■

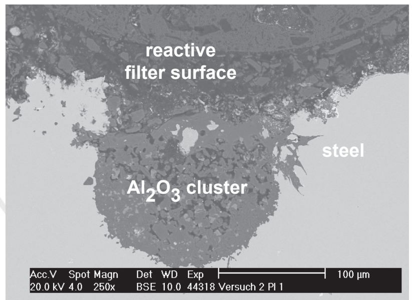


Fig. 1: Adhesion of an Al_2O_3 cluster onto the surface of the *reactive* filter material

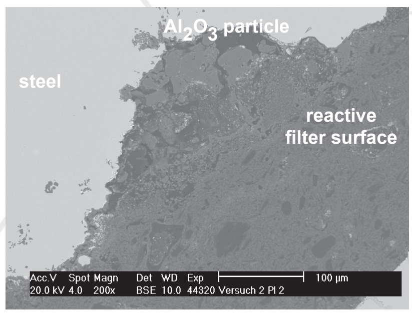


Fig. 2: Adhesion of even larger Al_2O_3 grains onto the surface of an *active* filter material

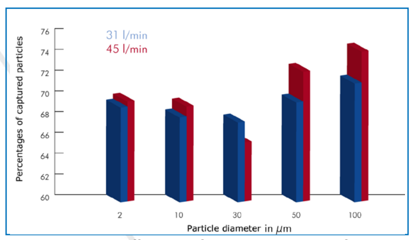


Fig. 3: Filtration efficency of the 10 ppi ceramic foam structure at two different flow rates [Dav08]

Feret Max	Feret Max	Class surface	Particle number	Normalized number
µm	*µm*	*µm²*	*Particle*	*Inclusions/ mm²*
2.00	5.00	2028.74	779.00	6.23
5.00	10.00	587.02	67.00	0.54
10.00	20.00	190.10	10.00	0.08
20.00	60.00	0.00	0.00	0.00
60.00	1000.00	0.00	0.00	0.00
1000.00		0.00	0.00	0.00

Tab. 1: Numbers of Al_2O_3 particles in the casting from cast no. 3, at Edelstahlwerke Schmees GmbH, 42CrMo4 melting, *active* filter material.

[Dav08]: DaVila-Maldonado, O.; Adams, A.; Oliveira, L.; Alquist, B.; Morales, R. D. (2008): Simulation of Fluid and Inclusions Dynamics during Filtration Operations of Ductile Iron Melts Using Foam Filters. Metall. Mater. Trans. B. 2008, 39B, pp. 818-839.

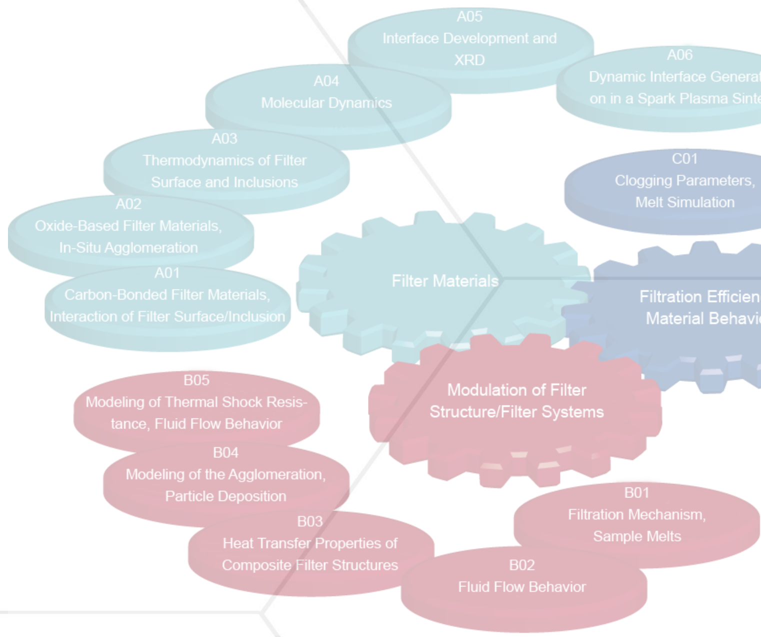
Deutsche Forschungsgemeinschaft
BERGAKADEMIE TECHNISCHE UNIVERSITÄT FREIBERG

WORKING GROUPS' REPORT

Research teams in the CRC 920 are connected in four working groups, thus ensuring targeted activities, close collaborations between subprojects, and intense 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 materials, boundary surface design" (Coordination: Dipl.-Ing. Claudia Voigt)

- High-temperature DTA analyses for gaining experimental data for thermodynamic modeling, tests for determining reactions between the ceramic filters (with varying coatings) and the metal melts (A03),
- Studies of surface energies employing density functional theory for a single or for multipe Al_2O_3 cells (A04),
- Microstructure analysis of Al_2O_3-C filters and related basic materials using XRD, XPS, and Raman spectroscopy in order to detect phase development depending on temperature (A05, A01),
- SPS experiments to form boundary surfaces between the ceramics and aluminum or steel, investigations of he boundary surfaces with SEM, EDX , and EBDS with particular emphasis on the addition of Al_2O_3 inclusions (A06),
- Casting tests with coated and uncoated nozzles deploying the metal melt simulator, analysis of clogging using computed tomography (C01, S01),
- Preparation of samples for subprojects C04 and C05 by means of die casting, continued tests of systematic metal melt impurification through the addition of oxidized chips and subsequent metallographic analysis,
- Tests for determining the heat transfer coefficient between aluminum melt and filters during castings (S03, B03).



Working Group 2: "Modeling and designing of the filter geometry" (Coordination: Miguel Mendes, Ph.D.)

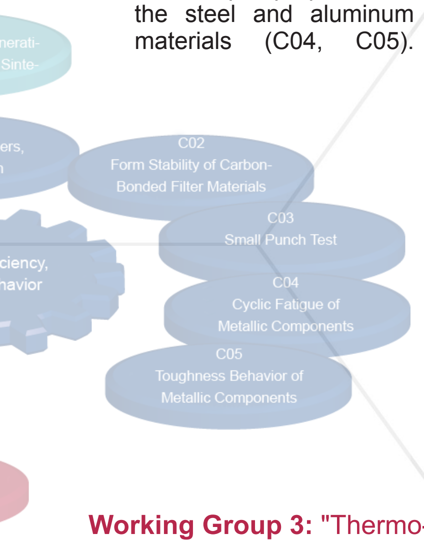
- Development of approaches for modeling inclusion particle dynamics based on Lattice-Boltzmann method for fluid dynamics (B02),
- Experimental tests for temperature measurements in the metal melt (B03),
- Development of a particle dynamics model and a mathematical model with a structure depending on the fluid flow behavior (laminar or turbulent) (B04),
- Development of a compression algorithm for simulation data (S02, B02),
- Discussion of options of using alternative experimental data of metal melt filtration efficiency (B01, B04),
- Elaboration of alternative estimations of particle velocity fluctuations (B02, B04).

SFB 920

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

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

- Fabrication of different casted steel and aluminum plates using different filter materials (S01),
- Preparation of samples and execution of static and cyclic tests for determining mechanical and fatique properties of the steel and aluminum materials (C04, C05).
- Successful HIP treatment for reducing shrinkage porosity in steel and aluminum plates (S01), Impurification of an aluminum model melt by adding oxidized chips (S03),
- Application of the PREFIL procedure for aluminum for determining the total content of non-metallic inclusions (A01, S03),
- Definition of relevant metallographic parameters for simulation using point statistics (S01, S03, C04).



Working Group 3: "Thermo-mechanical characteristics of filter materials and structures"
(Coordination: Dipl.-Wirt.-Ing. Yvonne Klemm)

- Experiments on heat transfer properties of carbon-bonded and non-carbon-bonded materials, visualization of heat conductivity (B03),
- Geometric modeling of foams for a simualtion of thermomechanical loadings during metal melt filtration (B05),
- Fabrication of bulk samples from Al_2O_3-C and tests for softening under load, cold compression strength, density, porosity, and shrinkage (C02),
- Fracture-mechanics tests of bulk samples to forecast properties of real ceramic filter materials (C03).

TRAINING AND CONSULTING FOR PH.D. STUDENTS

In July and October 2012, meetings of the doctoral students of the CRC took place. These meetings were targeting mutual information and coordination between the subprojects, the presentation of intermediate results as well as an intensive training for the Ph.D. students.

One of the issues that participants were discussing was the **evaluation of preliminary tests** designed to add non-metallic inclusions to metal melts. In cooperation with industry partners, first tests have been conducted to identify added impurities and their impact on materials properties. Additionally, filter materials which have been developed in the CRC were tested.

Furthermore, the attendees agreed on **publication strategies and important upcoming dates** within the next six month. In line with that, extended consulting and coaching activities for the CRC‘s doctoral students were announced. From now, doctoral students can enlist individual assistance of the CRC‘s coordinator Prof. Christos G. Aneziris, for instance for preparing publication schedules or for advancing one‘s academic career. ■


Photo: Attendees of the 4th Doctoral Meeting.

RESEARCH INTERNS TO SUPPORT THE CRC 920

Scholarships provided by the CRC 920 and the RISE-Program run by the DAAD provide opportunities for a research intern at the CRC for doctoral students from four countries:

- Elahe Saboor Bagherzadeh (Iran), subprojects B01/B04,
- Dig Vijay (India), subproject B03,
- Sidney Dahl (USA), subproject B03,
- Mike LeResch (USA), subproject B03.

Moreover, from March 2013 Ashish Pokhrel from South Korea will join the subprojects A01 and A02.

During their interns, these doctoral students give support to experimental studies of Ph.D. students of the CRC and to bring in new ideas and suggestions. The CRC highly values the involvement of young scientists with different national backgrounds and their contributions of ideas and experiences to the CRC‘s success. ■

MODELING FOAM STRUCTURES USING IMPLICIT FUNCTIONS

Simulations of open-cell foams require accurate geometric models. To study geometrical effects on the integrity of a foam structure computer generated models are used, which have the same geometrical properties as real foams. In the CRC 920 a new approach is developed to generate foam models by implicit functions. This approach can consider the thickness variations of the foam struts and the cavities inside the struts and nodes, which are observed for foam structures.

Dr.-Ing. Martin Abendroth
Subproject B05

M. Eng. Johannes Storm
Subproject B05

The first picture (see Fig. 1) shows a typical open cell foam structure with some geometrical details. Below, one can see the base elements generated using implicit functions and Blinn transformations. Except the close cell walls the entire foam can be modeled by a combination of these three base elements. The mathematical structure of a composed implicit function for an open cell foam looks like:

$$\sum_{i=1}^{n} \exp\{-a_i[f_i(T_i(\vec{x_i}),\vec{p_i}) - c_i]\} - n = 0$$

where *n* denotes the number of combined base elements or objects, each defined by its own implicit function *f*, which depends on the transformed (rotated and translated) coordinates *x* and a vector of object parameters *p* and a constant *c*. The Blinn factor *a* is used to control the smooth merging between neighboring objects. The surface of the foam structure is then defined by all points in space, where the implicit function has a constant value of zero. Such isosurfaces can be determined by the Marching Cubes algorithm and meshed using tools like GMSH. The meshes are then imported into finite element programs, where one can assign material properties (obtained in subprojects A01, A02, B02, B03, C02 and C03) and boundary conditions (support, loading) to the model. Using finite element methods these structures can be analyzed and optimized towards a better mechanical integrity or functionality.

The second row of pictures (see Fig. 2) shows some examples of the models. Left, a complete computer generated foam structure based on nodes and struts from Laguerre tessellations is shown. Such models are used to study the statistical influence of cell size, strut and node thickness variations on the entire mechanical response. The models can be compared with 3D CT-data of real foams, which are generated within the support subproject S01. On the right there are two unit cells of a kelvin structure having struts with varying cross sections. One is a meshed finite element model and the other a volume model with a coating. These simplified models are used to study the influence of strut thickness or node rounding and can help the manufactures to find optimal geometries for their foams. Coatings are used to improve the functionality and integrity of foam structures and are therefore also within the focus of our studies ■

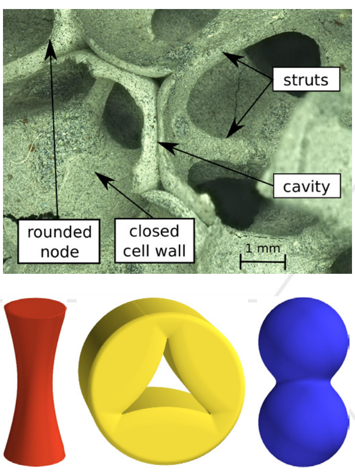


Fig. 1: Detail of a typical open cell foam structure and related geometrical details

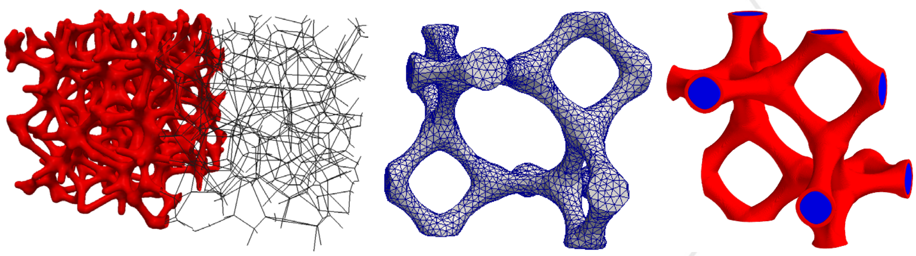


Fig. 2: Examplary models (from left to right): computer-generated foam structure, unit cells of a kelvin structure as finite element model and as volume model with a coating.

CLOGGING PARAMETERS TO DETERMINE THE FILTER EFFICIENCY OF ACTIVE AND REACTIVE FILTER MATERIALS

Employing a metal casting simulator, novel filter materials developed in the CRC are analyzed with regard to interactions with the steel melt. The test includes active, coated Al_2O_3-C filter materials using alumina, spinell, mullite and others, as well as reactive filter materials (MgO-C). The results reveal the materials' tendency of clogging, different ways of clogging and the efficiency of reactive filter materials during the casting process.

To run the tests, up to 100 kg steel ingots are melted in an inductive heated melting crucible under argon atmosphere. The temperature and the dissolved oxygen content of the steel melt can be measured by a dipping sensor. After the calibration of the desired parameters the melt is poured into the tundish. After a short time the stopper rods are lifted up and the steel melt flows through the two test zones which contain the test nozzles. After passing these zones the steel melt is solidified in water cooled copper moulds. The steel flow through the test zones can be recorded during the test by load cells which are positioned underneath the tundish and the two moulds. The test nozzle is fixed by an adaptor made of refractory castable at the tundish nozzles. Inside the adaptor a Al_2O_3-C-filter loaded with a unsintered particle mixture (alumina, spinel, mullite with maximum grain size of 100 microns) act as inclusions reservoir which impurifies the steel melt.

To date, active coated Al_2O_3-C nozzles with alumina and mullite are tested in the steel casting simulator in comparison to uncoated Al_2O_3-C nozzles. It could be observed that a Al_2O_3-coated nozzle shows a higher tendency of clogging, that means a higher built-up of a layer of intentionally added and originally included particles on the inner surface. Figure 1 show two images made by computed tomography of a Al_2O_3-coated-nozzle after the testing. Adhering particles, visible at the lower part of the nozzle, consist of steel drops (white) and oxide inclusions (grey). Investigations by secondary electron microscopy (see Fig. 2) and EDX show that two forms of clogging layers exist at the inner surface of a Al_2O_3-coated nozzle. The clogging layer could be divided in a dense and a loose coral-like layer. The clogging layers consist of the artificially added alumina, spinel and mullite particles (greater particle diameter) and naturally contained impurities (smaller particle diameter) which were identified as alumina.

Results of the experiments (computed tomography and SEM) with mullite or spinel-coating are pending. In the near future experiments are planned concerning the influence of the surface roughness on the clogging behavior of the active coating. To this end, the grain size distribution in the initial coating slurry will be varied. Furthermore, experiments with modified compositions of artificial impurities and the evaluation of alternative ways to intentionally create steel impurities will be executed.

For the submerge tests of reactive filter materials the samples were submerged in 30 kg liquid 42CrMo4 steel which was melted in an extra crucible inside the melting crucible of the metal casting simulator. The prismatic samples were dipped for 30 seconds in the molten steel at a temperature of 1650 °C, rotated with 30 rpm and removed. The content of dissolved oxygen in the melt was measured before and after each dipping step. The tests provide evidence for a decrease of dissolved oxygen content of 3 ppm after each dipping step. The investigations by SEM of samples after submersion in steel melt show that on the surface of the filter struts a new phase has been formed (see Fig. 3). This new phase could be identified as magnesium oxide. It's emergence can be explained by the reduction of magnesium oxide by carbon to carbon monoxide and gaseous magnesium which reacts with the dissolved oxygen in the melt and forms secondary magnesium oxide. The effectiveness of reactive filter materials (magnesia-carbon) finds support from the evidence of secondary magnesia and the measured decrease of the oxygen content. The formation of ternary and quaternary inclusion in steel product could be reduced by the lowering of the dissolved oxygen with the aid of reactive filter materials during the casting process. ■

Dipl.-Ing. Steffen Dudczig
Subproject C01

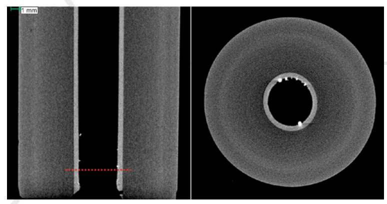


Fig. 1: CT image of a Al_2O_3-coated nozzle after testing in the metal casting simulator.

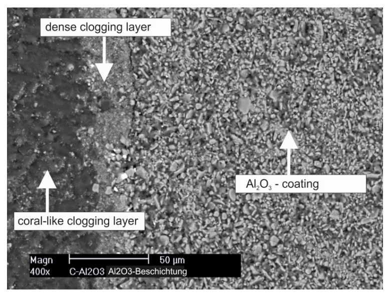


Fig. 2: SEM-image, Al_2O_3-coating (right), dense and coral-like clogging layer after testing in the metal casting simulator.

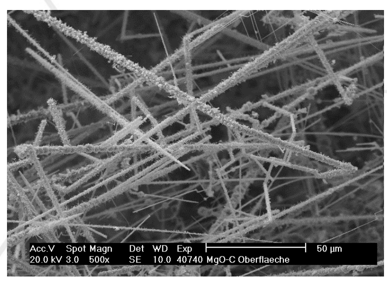
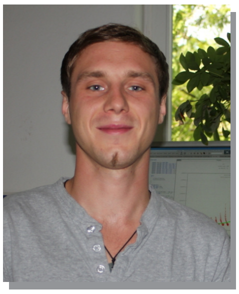


Fig. 3: Secondary magnesium oxide on the surface of a magnesia-carbon filter structure.

DFG Deutsche Forschungsgemeinschaft
BERGAKADEMIE TECHNISCHE UNIVERSITÄT FREIBERG

ANALYSIS OF LARGE-SCALE SIMULATIONS IN VIRTUAL REALITY

Research in the project S02 “VR-based Visual Analysis of Filtration Processes“ aims at the development of novel data compression and visualization methods supporting an interactive analysis of large-scale computer simulations of filtration processes. To cope with considerable data volume, data compression methods are tightly integrated into the super computing simulation (in-situ data processing). Early data reduction is also the key for later analysis tasks including high-detail visualizations in a Virtual Reality CAVE.



M. Sc. Henry Lehmann
Subproject S02

Today, visualization plays a vital role for research in natural sciences and engineering where scientists increasingly rely on simulations to verify their models, processes, and prototypes. The Virtual Reality and Multimedia Group at the Institute for Informatics operates a special visualization room, a so-called CAVE, that, due to its ultra-high resolution of 50 million pixels, is an ideal match for highly detailed visualization of simulations run on today‘s super computers. Similar to other CAVEs, interactive 3D visualizations are projected on multiple wall-sized projection screens. As distinctive feature of our CAVE, images on the projection walls are generated through the coordinated operation of 24 full HD projectors. Even in very close distance to the projection walls users experience smooth, detailed images but not individual pixels. In addition to mere visualization, intuitive user interaction capabilities are provided based on the evaluation of the user‘s body movements in 3D space and hand-held devices such as the iPad or the Flystick through which scientists can explore their simulations in innovative ways (see Fig. 1-3).

Research in the project S02 is specifically motivated by the need for visual analysis of large-scale simulations of metal melt filtration conducted in the project B02. The high-resolution Lattice-Boltzmann flow simulations easily generate data sets in the range of hundreds of gigabytes to several terabytes. These vast amounts of simulation data pose challenges not only for super computing hard- and software where I/O operations become a major bottleneck but also for later visualization and analysis. A promising novel approach is in-situ data compression which significantly reduces the amount of data needed to be written out to the file system during simulation runs.

In our research on in-situ data compression we have extended a novel compression algorithm called ISABELA to the case of porous media. Results confirm the high compression rates that can be achieved with ISABELA-like algorithms. We further investigated the loading times of in-situ compressed data sets for typical access patterns during Virtual Reality-based analysis of flow data. These results indicate a significant speed-up as compared to loading times of uncompressed data. In-situ compression is therefore seen as key feature in Collaborative Research Center 920’s evolving simulation and visualization frameworks. ■

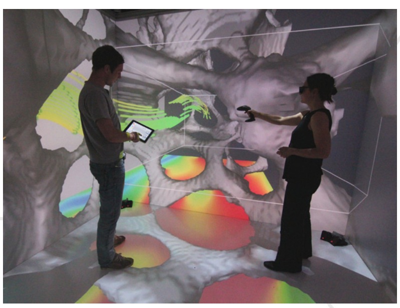


Fig. 1: Interactive flow visualization in the Freiberg XSITE CAVE. Configuration of streamlines and plane plot via iPad and Flystick.

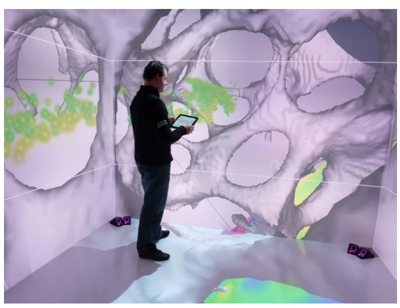


Fig. 2: Interactive flow visualization in the Freiberg XSITE CAVE. Control of tracer particles via play, plause and stop functions on iPad.

Fig. 3: The flystick provides tracking of position and orientation in 3D space and is used for navigation as well as seeding tracer particles/streamlines in the data set.

PUBLICATIONS

Project area A - Filter materials

Subproject A01

Emmel, M., Aneziris, C. G., Stolle, A. (2012): Multifunktionale kohlenstoffgebundene Filter für die Metallschmelzefiltration. Tagungsband zum 15. Werkstofftechnischen Kolloquium WTK, 20.-21. September 2012 in Chemnitz. Band 47, S. 392-396. ISBN 978-3-00-039358-7.

Aneziris, C. G., Emmel, M., Stolle, A. (2012): Multifunctional carbon bonded filters for metal melt filtration. Proceedings of the 36th International Conference and Exposition on Advanced Ceramics and Composites (ICACC), January 22-27, 2012 in Daytona Beach, FL (USA). The American Ceramic Society, Volume Editors: M. Halbig, S. Mathur. ISBN 978-1-118-49392-8.

Subproject A02

Voigt, C., Jäckel, E., Aneziris, C. G., Hubálková, J. (2012): Investigations of reticulated porous alumina foam ceramics based on spray coating techniques with the aid of µCT and statistical characteristics. Ceramics International (2012). DOI: 10.1016/j.ceramint.2012.09.001.

Voigt, C.; Aneziris, C. G. (2012): Optimierung der Herstellung von Schaumkeramikfiltern aus Al_2O_3. 15. Tagungsband zum Werkstofftechnischen Kolloquium WTK, 20.-21. September 2012 in Chemnitz. Band 47, S. 397-403. ISBN 978-3-00-039358-7.

Subproject A03

Zienert, T., Fabrichnaya, O. (2012): Thermodynamic Assessment and Experiments in the system MgO-Al_2O_3. CALPHAD. Vol. 40, March 2013, pp. 1-9. DOI:10.1016/j.calphad.2012.10.001.

Project area B: Modeling of filter structures/ filter systems

Subproject B05

Storm, J. (2012): Modelling foam structures using implicit functions. Proceedings of the Cellular Materials, CELLMAT 2012, November 07-09, 2012 in Dresden. ISBN 978-3-00-039965-7.

Storm, J., Abendroth, M., Emmel, M., Liedke, Th., Ballaschk, U., Voigt, C., Sieber, T., Kuna, M. (2012): Geometrical modelling of foam structures using implicit functions. International Journal of Solids and Structures. DOI: 10.1016/j.ijsolstr.2012.10.026.

Project area C: Filter performance, materials properties

Subproject C01

Aneziris, C. G., Dudczig, C., Emmel, M., Berek, H., Schmidt, G. (2012): Reactive Filters for Steel Melt Filtration. Advanced Engineering Materials (2012). DOI: 10.1002/adem.201200199.

Aneziris, C. G., Roungos, V., Dudczig, S., Emmel, M. (2012): Refractories with Improved Thermal Shock Performance Serving Low Carbon Economy. 6th Intern. Symposium on Refractories, 18.-21.10.2012 in Zhengzhou, China. Invited letters page 014-018. ISBN 978-7-5645-1139-5.

Aneziris, C. G., Dudczig, S., Hubálková, J., Emmel, M., Schmidt, G. (2012): Alumina coatings on carbon bonded alumina nozzles for active filtration of steel melts. Ceramics International (2012). DOI: 10.1016/j.ceramint.2012.09.055.

Subproject C02

Klemm, Y., Hampel, M., Aneziris, C. G., Biermann, H. (2012): Variation in der Rohstoffzusammensetzung und deren Einfluss auf das Gefüge und die mechanischen Eigenschaften von kohlenstoffgebundenem Al_2O_3-C. Tagungsband zum 15. Werkstofftechnischen Kolloquium WTK, 20.-21. September 2012 in Chemnitz. Band 47, S. 404-410. ISBN 978-3-00-039358-7.

Subproject C03

Soltysiak, S., Emmel, M., Behm, T., Abendroth, M, Kuna, M., Aneziris, C. G. (2012): Mechanical characterization of carbon bonded alumina using the Small Punch Test. 2nd International Conference SSTT (Small Sample Test Techniques) 2012, 02.-04-10.2012 in Ostrava. ISBN 978-3-00-039358-7.

Soltysiak, S., Dudczig, S., Abendroth, M., Kuna, M (2012): Mechanical and optical characterization of carbon bonded alumina using the Small Punch Test. Proceedings of the Cellular Materials, CELLMAT 2012, November 07-09, 2012 in Dresden. ISBN 978-3-00-039965-7.

Subproject C04

Krewerth, D., Weidner, A., Biermann, H., Emmel, M., Aneziris, C. G., Stolle, A., Eigenfeld, K. (2012): Experimentelle Untersuchungen zum Einfluss verschiedener Gefügeinhomogenitäten auf das VHCF-Ermüdungsverhalten des Stahlgusses GS 42CrMo4. Tagungsband zum 15. Werkstofftechnischen Kolloquium WTK, 20.-21. September 2012 in Chemnitz. Band 47, S. 411-421. ISBN 978-3-00-039358-7.

Subproject C05

Krüger, L., Henschel, S., Mandel, K., Radajewski, M. (2012): Studie zur Impulsformung an Split-Hopkinson-Aufbauten. Tagungsband zum 15. Werkstofftechnischen Kolloquium WTK, 20.-21. September 2012 in Chemnitz. Band 47, S. 422-427. ISBN 978-3-00-039358-7.

Complementary subprojects

Subproject S01

Hubálková, J., Voigt, C., Emmel, M., Aneziris, C. G. (2012): X-ray microtomography of ceramic foam filters for molten metal filtration. Proceedings of the Cellular Materials, CELLMAT 2012, November 07-09, 2012 in Dresden. ISBN 978-3-00-039965-7.

DATES

INVITED PRESENTATION

Entitled "Refractories Serving Low Carbon Economy," the 6th International Symposium on Refractories invited researchers, manufacturers, suppliers, and users of refractories to Zhengzhou/China to discuss latest results in research, production, and application of refractories. The meeting had been jointly organized by two leading professional organizations, namely the Chinese Ceramic Society and the Chinese Society for Metals.

Several international experts had been invited for opening speeches. Among them, Prof. Christos G. Aneziris, coordinator of the CRC 920, presented current research results on nano-engineered carbon-bonded refractory materials. Researchers at TU Freiberg successfully generated novel refractories with reduced carbon content and improved thermal shock behavior.

These results are relevant especially with regard to components for steel casting, including nozzles and filter materials. Furthermore, these results are a first step towards carbon bonded filter production with higher filtration capacities and larger dimensions. ■

Photo: Prof. Christos G. Aneziris.

HIGH-SCHOOL STUDENTS EXPLORE THE CRC

The **20th Junior College "Ceramics meet Steel"** at the Institute of Ceramics, Glass and Construction Materials in August 2012 offered a great opportunity for learning more about innovative filter materials. High-school students of the 8th to the 11th class from Germany and Poland experienced the casting of aluminium using various filters. A field trip to Fraunhofer IKTS Dresden and DURAVIT Meißen GmbH, a manufacturer of sanitary ware, illustrated the scope of ceramic products and applications.

Photo: Participants of the Junior College "Ceramics meet Steel."

Furthermore, the first **"Night Lab"** initiated by the Area of Ceramics invited to a very special tour through research facilities at the Freiberg University. Equipped with candles and headlights, 12 students and one teacher discovered research highlights in a very different way. Visits in several research labs revealed interesting facts about fabrication, processing, and application of ceramics. With assistance of CRC researchers, participants produced their own ceramic filters and witnessed the application of ceramic filters for the casting of aluminium. ■

UPCOMING CRC EVENTS

07.12.2012 **-** 3rd Freiberg Refractory Forum

18./19.12.2012 **-** 6th Member meeting

15./16.01.2013 **-** 6th Doctoral students' meeting

04.-05.02.2013 **-** Workshop "Advanced teaching skills"

KW 15/2013 - Workshop "Filter materials for steel casting"

CONFERENCES AND CALLS FOR PAPERS

DKG Annual Conference 2013, 18.-21.03.2013, Weimar: Submission of papers are due November 23rd, 2012. Further information on www.dkg-jahrestagung2013.de.

13. International Conference of the European Ceramic Society - ECERS 2013, 23.-27.06.2013, Limoge (Frankreich): Submission of abstracts is due December, 10th, 2012. Further information on www.ecers2013.fr.

13. Unified International Technical Conference on Refractories - Unitecr 2013, 10.-13.09.2013, Victoria (Kanada): Submission of abstracts is due October, 15th 2012, submission of full papers is due April, 10th, 2013. Further information: http://unitecr2013.org.

DGM Conference "Intermetallics", 30.09.-04.10.2013, Kloster Banz: Submission of abstracts is due April 15th, 2013. Accepted papers will be published in the "Intermetallics", a scopus-cited journal (IF 1.62). Further information on www.dgm-intermetallics.de.

IMPRINT

EDITOR
Prof. Dr.-Ing. habil. Christos G. Aneziris
CRC Coordinator
TU Bergakademie Freiberg
Institute of Ceramics, 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 Ceramics, 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
Prof. Dr. habil. Anja Geigenmüller
TU Ilmenau
Department of Marketing
Helmholtzplatz 3, 98693 Ilmenau
Phone: +49 3677 69 4085
Fax: +49 3677 69 4223
E-Mail: anja.geigenmueller@tu-ilmenau.de

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

ISSUE: No. 3, 02/2012 (two issues per year)