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Koblenz University of Applied Science, Department of Materials Engineering, Glass and Ceramics playing a key role in the science and education network for the refractory industry

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Abstract

Amongst the international well-recognized institutes at Bergakademie Freiberg and RWTH Aachen, the Department of Materials Engineering of Koblenz University of Applied Science in Höhr-Grenzhausen represents the third party who intensively deals with education and research for the ceramic industry. The institute is closely related to the cooperative education network, BFZK (educational and research center ceramics), which allows best utilization of the existing public education structure. Since 2010, the conversion from diploma degree program to bachelor of material science has been successfully carried out and was followed by the implementation of a master degree in cooperation with the University of Koblenz-Landau. The Department follows two major tasks: Best possible and targeted education in order to provide graduates with tailor-made abilities for the ceramic industry. For this reason the ceramic industry and the State ministry of economics of Rheinland-Pfalz funded three endowed professorships, out of which two have already been converted into regular positions. The second task is to promote science projects that are closely related to the demands of the industry. The state-of-art master and bachelor curriculum is introduced and recent research works are briefly presented in the paper.
Keywords: Refractory industry, Education, Research, Network, Refractories

KLUCZOWA ROLA WYDZIAŁU INŻYNIERII MATERIAŁOWEJ, SZKŁA I CERAMIKI UNIWERSYTETU W KOBLENCJI W NAUCE I KSZTAŁCENIU DLA POTRZEB PRZEMYSŁU MATERIAŁÓW OGNIOTRWAŁYCH

Wśród znanych międzynarodowych instytutów Politechniki we Freibergu i RWTH w Aachen, Wydział Inżynierii Materiałowej Uniwersytetu Nauk Stosowanych Koblenz w Hoehr-Grenzhausen reprezentuje trzecią instytucję, która jest mocno zaangażowana w działania edukacyjne i badawcze na rzecz przemysłu ceramicznego. Wydział ściśle współpracuje z siecią edukacji prozawodowej, BFZK (centrum szkoleniowo-badawcze ceramiki), która pozwala na najlepsze wykorzystanie istniejącej publicznej struktury kształcenia. Od 2010 r. przeprowadzono zmiany w programie uzyskiwania licencjatu w inżynierii materiałowej oraz wprowadzono stopień magistra we współpracy z Uniwersytetem Koblenz-Landau. Wydział realizuje dwa główne zadania. Jedno z nich to zapewnienie najlepszej możliwej i ukierunkowanej edukacji w celu wyposażenia absolwentów w umiejętności dostosowane do potrzeb przemysłu ceramicznego. W związku z tym przemysł i ministerstwo gospodarki Nadrenii Palatynatu ufundowało trzy profesury, z których dwie zostały już zamienione na stałe posady. Drugim zadaniem jest promowanie projektów naukowych ściśle związanych z wymaganiami kluczowych materiałów ogniotrwałych dla przemysłu. W artykule przedstawiono najnowocześniejszy program licencjacki i omówiono pokrótce ostatnie prace badawcze.
Słowa kluczowe: przemysł materiałów ogniotrwałych, edukacja, badania, sieć, materiały ogniotrwałe

1. Introduction

The Department of Materials Engineering, Glass and Ceramics looks back on an already 135 years tradition in education of ceramics. As a department of the University of Applied Science the institute is named as said since 1999. In 2010 the conversion from diploma degree program to bachelor of material science has been successfully carried out and was followed by the implementation of a master degree in cooperation with the University of Koblenz-Landau.

Within 3.5 years the students gain 210 ECTS (European Credit Transfer System) credit points and finish their degree program as bachelor of material science that enables to take up a master course of studies at any university in Europe that offers a similar apprenticeship.

2. The Network

The institute is closely related to the cooperative education network, BFZK (educational and research center ceramics), which allows best utilization of the existing public education structure. In this network research and education is closely related and well connected to the ceramic industry in order to allow a maximum of innovation.

In detail the network consists of the vocational school for apprentices of the ceramic industry, the professional school for ceramics and the Department of Materials Engineering, Glass and Ceramics. Cooperative industry related research projects are performed with the research institutes ECREF (European Centre for Refractories) and FGK (Forschungsinstitut für anorganische Werkstoffe – Glas/Keramik).

3. Entrance requirements

German students registering for the B.Eng. degree course need to reach *Fachhochschulereife* or equivalent. In terms of British qualifications, this level of attainment would normally be obtained after one year of 'A' level study in England and Wales or at Scottish Higher level.

Applicants from England and Wales would therefore need to have 'A' level qualifications, with the recommendation that Mathematics and German have been studied at this level.

Current admissions requirements of the University require that prospective students provide evidence of their language skills in German (either DSH-2; or TestDaF with TDN 4 in all parts; or Goethe-Institute Certificate C2 (ZOP)).

4. The Course

The aim of the degree course is to provide graduates with the necessary knowledge and skills to embark on a wide range of professional careers in the ceramics industry or in the development of new materials. It also opens the gateway to further qualifications, one possibility here being the Master of Engineering (M.Eng.) degree course in Ceramics Science and Engineering, which is offered in collaboration with the University of Koblenz-Landau. After accomplishing the Master course the graduates may continue with a doctoral fellowship without any supplementary qualifications.

5. Occupational Fields

The Department of Materials Engineering, Glass and Ceramics decided to offer a bachelor degree where the students can graduate within seven semesters as bachelor of material science. In the first six semesters they are educated in basic natural science (mathematics, physics, chemistry and mineralogy/crystallography). Courses in engineering science are electrical engineering, measuring engineering,technical thermodynamics, fluid dynamics, engineering mechanics, mechanical engineering, refractory materials and thermal engineering. The scientific focus lies on special courses in ceramics, as there are refractory ceramics, silicate fine ceramics, structural ceramics and functional ceramics. The students learn in theory and praxis raw materials conditioning, mixing and compilation of bulk material in order to obtain distinct material properties, all procedures of molding and shaping and in detail strategies how to optimize the thermal process. In further the students are educated in operative economics, environmental management and employment protection.

The seventh semester is reserved for the elaboration of the bachelor thesis. About 98% of all bachelor theses are compiled in cooperating industrial undertakings.

The concept of the bachelor degree course is lined to enable graduates to join companies of the ceramic industry as full-fledged staff members in the fields of production control and in research and development departments.

After the bachelor degree a consecutive master degree can be achieved within further three semesters, where the third semester is reserved for the master thesis. In more detail the master students are educated in the glass materials (Univ. Appl. Sci.), structural – and functional ceramics (Univ. Appl. Sci.), silicate ceramics (Univ. Appl. Sci.), bio ceramics (Univ. Appl. Sci.), materials for aviation and spacecraft (Univ. Appl. Sci.), thermochemistry (Univ. Koblenz-Landau), materials design (Univ. Appl. Sci.), materials physics (Univ. Koblenz-Landau) and materials chemistry for metals (Univ. Koblenz-Landau).

6. Educational Objectives in refractories

The main objectives in the education in refractories are characterisation and manufacturing of refractory materials.

Specific testing methods for refractory materials are introduced and their significance is evaluated. In particular testing methods to estimate the corrosion resistance of refractory materials are discussed with special regard to the scale-up issue under real working conditions in the industrial application.

Manufacturing technologies of refractory materials (shaped and monolithics) are educated with special regard to mixing, shaping of coarse grained bulk materials.

Of certain concern are the application and functionality of additives, and binders.

In further installation methods on site for shaped and monolithic refractory materials are discussed in detail.

The corrosion process during service and the use of refractory products is educated in detail for the major areas of use in the industry (pigiron/steel, cement, glass, waste incineration etc.).

7. Major tasks in refractories research

The major aim of the research work carried out in the field of refractory materials at the Department of Materials Engineering is to support the materials development of SME's that predominantly produces monolithic materials. Therefore the research work focuses on these materials.

In the following the most important projects are briefly summarized.

The influence of mixing energy on the rheological properties of LC castables is investigated in a two years lasting

project, which is funded by the state of Rhineland-Palatinate. In this project, enterprises of the German refractory industry are involved.

This project was initiated due to the fact that the mixing conditions are believed to play a key role in the molding of highly dispersed refractory castables. To date there exists only limited understanding how the mixing energy interacts with micro fillers of the dispersing agents.

The influence of different types of dispersing agents and their concentration is thoroughly investigated.

It can be shown that the viscosity of the readily mixed castables can be reduced up to a half of the original viscosity if the mixing process is optimized. As a consequence the mechanical properties can be improved significantly[1].

A further key issue in the manufacturing and installation of monolithics is the setting and hardening behaviour after installation. In cooperation with Forschungsgemeinschaft Feuerfest e. V., Instytut Ceramiki i Materiałów Budowlanych (ICIMB), Poland, and the refractory industry a CORNET project was initiated. The general purpose of this project is to attain a deeper understanding of the interaction properties of cement lime (CAC) with other aggregates in the formulation. This knowledge is indispensable to understand or predict the performance of refractory castables. This topic has already been a priority field of investigation ever since hydraulic bond systems have been in use. However most research work published in literature put focus on details (e.g. solely the temperature dependence of the setting velocity, the setting velocity strength evolution as a function of time etc.). Very often the basic conditions how the tests were performed are not commented. Therefore the objective of this project is to control all known influences that affect the setting behaviour, the strength evolution, the drying behaviour and the high temperature performance. Beside the typical parameters temperature, relative humidity, workability (viscosity, compactibility), and CAC-microfines-additive combinations the key issue of this project is how the water-to-cement ratio (wcr) affects the strength evolution and in consequence the material performance at service conditions. The wcr is a key value for calcium silicate products from the civil engineering industry but the influence was never evaluated for CAC containing refractory castables. This is because the CAC in refractory castables loses its functionality after the first heat-up and therefore is always seen as a temporary binder. The importance for the high temperature performance was always neglected or even worse in that case that it is often accused to reduce the refractoriness of the product.

At present a further CORNET Project is in Progress in cooperation with FGF, Centre de Recherches de l'Industrie Belge de la Céramique (CRIBC), Belgium, and industrial partners, where the optimisation of high-temperature thermal shock resistance of alumina-based refractory monolithics is the key issue. This project is divided into three corresponding fields of investigation. While the major task of FGF is to develop a device to test the high temperature thermo shock resistance, CRIBC is engaged to analyse and to classify the impact of thermo shock on the microstructure of refractory products. Department of Materials Engineering, Glass and Ceramics at Koblenz University is engaged in the material development and is mainly seeking for additives that enhance the thermo shock performance for refractory castables between 1000 °C and 1700 °C.

8. Conclusion

The Department of Materials Engineering, Glass and Ceramics at Koblenz University of Applied Science offers a broad range of education and research in all fields of ceramic science. Education and research work is fully industry oriented and provides well-educated graduates who are enabled to actively participate in the daily tasks of the ceramic industry from the first day on.

The Department of Materials Engineering, Glass and Ceramics at Koblenz University of Applied Science is very open towards national and international research projects.

References

[1] Kasper, J., Krause, O.: Mixing Optimization of an Alumina Based LC-Castable by Applying Variable Power Inputs, *Proceedings of UNITECR*, 2013.

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