31. ročník odborného semináře doktorandů
31st annual Doctoral Students‘ Seminar

# ANORGANICKÉ NEKOVOVÉ MATERIÁLY

# INORGANIC NON-METALLIC MATERIALS

5. – 6. února 2026
February 5-6, 2026

Ústav skla a keramiky, VŠCHT Praha
Department of Glass and Ceramics, UCT Prague

Department of Glass and Ceramics
UCT PRAGUE
Praha 2026

Publikace neprošla jazykovou ani odbornou úpravou.

Za obsah příspěvků odpovídají autoři.



ISBN 978-80-7592-330-1

# Úvod

Programem semináře jsou odborné přednášky doktorandů různých akademických pracovišť působících v oblasti chemie a technologie anorganických nekovových materiálů.

### Organizátor semináře

Ústav skla a keramiky, Vysoká škola chemicko-technologická Praha (VŠCHT Praha)

### Webové stránky

https://sil.vscht.cz/o-ustavu/ANM

### Kontakt

Ing. Petra Špringer Šimonová, Ph.D., *simonovb@vscht.cz*
Ing. Lucie Kotrbová, *kotrbovl@vscht.cz*

### Poděkování

Ústav skla a keramiky děkuje všem zaměstnancům a doktorandům VŠCHT Praha, kteří se na přípravě semináře podíleli. Dále děkujeme nadačnímu fondu prof. Rudolfa Bárty, firmě Glass Service, Silikátové společnosti České republiky z.s. a České sklářské společnosti za poskytnuté ceny pro soutěžící.

---

# Introduction

The program of the seminar consists of specialized lectures given by PhD students from various academic institutions working in the field of chemistry and technology of inorganic non-metallic materials.

### Seminar Organizer

Department of Glass and Ceramics, University of Chemistry and Technology Prague (UCT Prague)

### Website

https://sil.vscht.cz/about/INM

### Contact

Ing. Petra Špringer Šimonová, Ph.D., *simonovb@vscht.cz*
Ing. Lucie Kotrbová, *kotrbovl@vscht.cz*

### Acknowledgments

The Department of Glass and Ceramics expresses gratitude to all employees and PhD students of the University of Chemistry and Technology Prague who contributed to the preparation of the seminar. Additionally, we would like to Prof. Rudolf Bárta's Foundation, company Glass Service, The Czech Ceramic Society and The Czech Glass Society for providing prizes for the participants.

Department of Glass and Ceramics
UCT PRAGUE

THE CZECH CERAMIC SOCIETY

ČSS

GS GLASS SERVICE

# Program semináře 2026 / Seminar programme 2026

## Čtvrtek 5. února 2026 / Thursday 5th February 2026

### Úvodní slovo / Opening remarks (9:30–9:40)

### 1. Blok / 1st session (9:40–12:10)

*Chairman: Ing. Jan Hostaša, Ph.D.*

*Ing. Daniel Valášek (9:40–10:00)*
Comparison of sintering techniques for high entropy carbides derived from high entropy alloys

*Ing. Lucie Kotrbová (10:00–10:20)*
Temperature dependence of the thermophysical properties of alumina-silica refractories for thermal energy storage

*Ing. Marek Rotter (10:20–10:40)*
Sintering aid for HEC with luminescent properties

*Přestávka / Coffee break (10:40–11:00)*

*Cheikh Omar Ndao (11:00–11:20)*
Electrospinning of $SiO_2$ micro/nanofibers for All-Solid-State Batteries

*Mgr. Marianna Hodorová (11:20–11:40)*
High-entropy perovskites as prospective materials for lithium-ion batteries

*Ing. Lukáš Mauermann (11:40–12:00)*
Carbonation of a three-component clinker-free binder 3C

*Ing. Petra Špringer Šimonová, Ph.D. (12:00–12:10)*
Opportunities for young scientists in the worldwide ceramics community

*Pauza na oběd / Lunch break (12:10–13:00)*

## 2. Blok / 2nd session (13:00–16:00)

*Chairman: doc. Ing. Jaroslav Kloužek, CSc.*

*Ing. Tomáš Hostinský, Ph.D. (13:00–13:20)*
Pushing limits of mixed glass former effect in lithium borophosphate glasses

*Mina Abdolmaleki, MSc. (13:20–13:40)*
Bismuth-doped 1393-B3 bioactive glass/PEEK coating deposited on titanium implant by electrophoretic deposition for biomedical applications

*Ing. Filip Šimíček (13:40–14:00)*
Investigation of the influence of dopping tellurite glasses with CoO, $NiCl_2$ and CuO as colorants for direct laser writing.

*Jiayan Yu , MSc. (14:00–14:20)*
In-situ formation of TiC from recycled MgO-C refractories and structural characterization by Rietveld Refinement

*Přestávka / Coffee break (14:20–14:40)*

*Ing. Tereza Přívracká (14:40–15:00)*
Study of the initial glass–solution interaction of sodium glass at various pH levels

*Ing. Roman Fialka (15:00–15:20)*
Biocompatibility and mechanical properties of hydroxyapatite–talc composites for bone tissue applications

*Ing. Tatiana Sivčáková (15:20–15:40)*
Preparation and biological response of iron (III) phosphate ceramics

*Ing. Jan Hrabovský, Ph.D. (15:40-16:00)*
LOMS.cz: Classical and Combinatorial Judd-Ofelt analysis

***Kreativní večer / Creative evening (17:30, Uhelna))***

# Pátek 6. února 2026 / Friday 6th February 2026

## 3. Blok / 3rd session (9:20–12:20)

*Chairman: Ing. Eva Bartoníčková, Ph.D.*

*Till M. J. Stadtmuller, M.Sc. (9:20–9:40)*
Sustainable MgO-C refractories based on improved eco-friendly lignin/collagen-binder system

*Ing. Ondřej Kunovský (9:40–10:00)*
Synthesis and structural characterization of calcium silicate hydrate gels synthetized by sol-gel method

*Luyao Pan, M.Sc. (10:00–10:20)*
Influence of sample preparation and processing procedures on the thermal diffusivity of MgO-C refractories

*Ing. Vojtěch Nečina, Ph.D. (10:20–10:40)*
Densification of quartz sand by cold sintering process

*Přestávka / Coffee break (10:40–11:00)*

*Ing. Herbet Kindl (11:00–11:20)*
Growth and characterization of $Y_2SiO_5$:Ce,Mg single crystals

*Ing. Kateřina Maxová (11:20–11:40)*
Stabilization of toxic ions on manganese-modified sorbents

*Ing. David Nováček (11:40–12:00)*
Aluminosilicates from Deep-sea nodules

*Ing. Vojtěch Ševčík (12:00–12:20)*
Carbonate-free $BaHfO_3$ as a pinning phase in bulk REBCO superconductors

***Vyhlášení výsledků a ukončení semináře /***
***Winner announcement and end of the seminar (12:40)***

# Soutěže

V rámci semináře se uskuteční tři soutěže, které jsou sponzorovány Nadačním fondem prof. Rudolfa Bárty, Silikátovou společností České republiky z.s. a Českou sklářskou společností. Soutěže budou hodnoceny odbornými komisemi.

Členové komisí:

- doc. Ing. Jaroslav Kloužek, CSc. – Vysoká škola chemicko-technologická v Praze
- Ing. Eva Bartoníčková, Ph.D. – Vysoké učení technické v Brně
- Ing. Jan Hostaša, Ph.D. – CNR-ISSMC Italy
- Ing. Jan Macháček, Ph.D. – Vysoká škola chemicko-technologická v Praze

---

# Competitions

As part of the seminar, three competitions will be held, sponsored by the Prof. Rudolf Bárta Foundation, the Czech Ceramic Society and the Czech Glass Society. The competitions will be evaluated by expert committees.

**Members of the committees:**

- doc. Ing. Jaroslav Kloužek, CSc. – University of Chemistry and Technology Prague
- Ing. Eva Bartoníčková, Ph.D. – Brno University of Technology
- Ing. Jan Hostaša, Ph.D. – CNR-ISSMC Italy
- Ing. Jan Macháček, Ph.D. – University of Chemistry and Technology Prague

Department of Glass and Ceramics
UCT PRAGUE

THE CZECH CERAMIC SOCIETY

ČSS

GS GLASS SERVICE

Prof. Rudolf Bárta Foundation

# List of Abstracts

# ABSTRAKTY
# ABSTRACTS

# Comparison of sintering techniques for high entropy carbides derived from high entropy alloys

Daniel Valášek[1], Vladimír Prajzler[1], Dawid Kozien[2], David Salamon[1]

[1]*Department of Advanced Multifunctional Ceramics, CEITEC Brno University of Technology, Purkyňova 123, Brno, Czech Republic*

[2]*AGH University of Science and Technology, Faculty of Materials Science and Technology, Av. Mickiewicza 30, Krakow, Poland*

xcvalasek@vutbr.cz

High Entropy Ceramics (HECer) are an emerging class of advanced ceramic materials that incorporate at least five various metallic elements and one non-metallic element. The choice of the non-metallic element (such as oxygen, carbon, nitrogen or boron) has a direct effect on the properties of separate HECer groups, such as high entropy carbides or high entropy oxides. Among them, High Entropy Carbides (HEC) are particularly attractive due to their high hardness and oxidation resistance.

The preparation of HEC is an elaborate process, involving the selection and optimization of several steps including milling and sintering techniques. For HEC, high temperature, pressure-assisted techniques are usually the preferred method of sintering to densify these materials. The first-choice sintering method for HEC is the spark plasma sintering method. The selection of starting materials, together with milling and sintering conditions, directly determines the microstructure and properties.

This work presents a comparison of three sintering techniques using temperatures above 1900 °C for the preparation of HEC. The selected techniques are the pressure-assisted spark plasma sintering method, the conventional pressureless sintering method and the relatively new ultra-fast high temperature (UHS) sintering method. These sintering methods were tested on a HEC composition containing niobium, tantalum, molybdenum, tungsten and vanadium. The selected starting materials for preparation of this carbide were high entropy alloy and graphite. This is the first comparative study of these sintering techniques for HEC derived from high-entropy alloy and graphite precursors.

The sintered high entropy carbides were characterized using scanning electron microscopy, energy-dispersive X-ray spectroscopy, and X-ray diffraction. The selected samples were examined using Vickers hardness testing and nanoindentation to determine their mechanical properties. The influence of the different sintering techniques on densification behavior and microstructure is discussed, providing insight into suitable processing routes for HEC derived from alloy–carbon precursor systems.

# Temperature dependence of the thermophysical properties of alumina-silica refractories for thermal energy storage

Lucie Kotrbová[1], Cristina Ramírez[2], Manuel Belmonte[2], Petra Špringer Šimonová[1], Mária Kolářová[1], Willi Pabst[1]

[1]*Department of Glass and Ceramics, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

[2] *Instituto de Cerámica y Vidrio (ICV), CSIC, Kelsen 5, Cantoblanco, 28049, Madrid, Spain*

lucie.kotrbova@vscht.cz

Knowledge of thermal properties (including thermal conductivity and heat capacity) is essential in the case of materials intended for thermal energy storage (TES). Of particular importance is the stability or controllability of the thermal behavior across the entire operating temperature range and after thermal cycling. In this work, an alumina–silica refractories of different composition and microstructure were investigated as potentially promising candidates for high-temperature TES, not only due to their relevant thermophysical properties but also due to their simple preparation and economic feasibility.

A broad group of materials with varying $Al_2O_3$ content (ranging from fireclay refractories to high-alumina refractories based on andalusite/sillimanite, mullite, bauxite, and pure alumina) was characterized in detail. Their phase composition was determined by X-ray diffraction (using the Rietveld method, including the quantification of the glass phase by the internal standard method). Based on this information, analytical predictions of effective thermal properties and density (true density) were calculated for the dense materials (i.e. without porosity) at room temperature and, based on the bulk density obtained via the Archimedes method, the total porosity was obtained. Based on this information, analytical predictions of the effective thermal conductivity of the material for the material as a whole (i.e. including porosity) at room temperature were obtained.

These predictions were compared with experimentally determined thermal conductivity values derived from the thermal diffusivity measured by the laser flash method (LFA 1000, Linseis, Germany), including corrections for surface roughness, and for high temperatures also the temperature dependence of the specific heat capacity determined by differential scanning calorimetry / DSC (Discovery DSC, TA Instruments, USA), and density changes obtained from dilatometric measurements (DIL 402 C, Netzsch, Germany). Laser flash measurements were performed both at room temperature and during thermal cycling (heating and cooling) with a maximum temperature of 800 °C. Additionally, high-speed heating to the same maximum temperature followed by free cooling, recorded using a high-temperature camera (FLIR A325sc, FLIR, USA), was used to determine the rate of heat accumulation and the subsequent heat release as a function of time after the end of the heating stage.

**Acknowledgement:** The authors are grateful to the JECS Trust for financial support through a travel grant enabling a research stay at Institute of ceramics and glass (Instituto de Cerámica y Vidrio, ICV), CSIC, Madrid, Spain from 04/10/25 to 21/12/25 (Contract No. 2025 459). This work was also supported from the grant of Specific university research – grant No. A1_FCHT_2025_009 and No. A1_FCHT_2026_009.

# Sintering aid for HEC with luminescent properties

Marek Rotter[1,2], Jan Hostaša[5], Monika Michálková[3], Karel Maca[1,4], Róbert Klement[2], Katarína Drdlíková[1]

[1]*CEITEC - Central European Institute of Technology, Brno University of Technology, Brno, Czech Republic*

[2]*FunGlass - Centre for Functional and Surface Functionalized Glass, Alexander Dubček University of Trenčín, Trenčín, Slovakia*

[3]*Joint Glass Centre of the IIC SAS, TnUAD, FChPT STU, FunGlass, Trenčín, Slovakia*

[4]*Faculty of Mechanical Engineering, Brno University of Technology, Brno, Czech Republic*

[5]*CNR-ISSMC, Institute of Science, Technology and Sustainability for Ceramics, Faenza, Italy*

Marek.Rotter@ceitec.vutbr.cz

High Entropy Ceramics (HECs) are a group of materials that have recently attracted significant interest from the research community. The multicomponent compositions and advanced entropy level of these materials offer superior properties in comparison to conventional ceramics. Although numerous studies have reported enhanced thermal stability and improved mechanical properties of HECs, only a limited number of works have attempted to prepare transparent HEC. Furthermore, the role of multicomponent composition on the luminescent properties remains largely unexplored.

The present study focuses on the research of a suitable sintering aid for the fabrication of transparent HEC with luminescent properties via solid-state synthesis. Potential applications of this material include head-up displays and luminescent solar concentrators. To achieve both transparency and luminescence, precise control of the chemical composition is essential. Consequently, the selection of elements is guided by the following criteria: (i) the ability to form a single-phase structure and (ii) the provision of favourable luminescent properties, specifically avoiding luminescence quenching caused by multiple luminescent activators or excessive luminophore concentrations. These requirements were satisfied by the $Er_{0.02}(Y_{0.58}Lu_{0.5}Gd_{0.5}La_{0.3}Yb_{0.1})Zr_2O_7$ composition adopting the pure defect fluorite phase. Additionally, compared with a conventional ceramic ($Er_{0.02}$:$(Y_{1.88}Yb_{0.1})Zr_2O_7$), the HEC exhibits a higher luminescent intensity.

$Al_2O_3$, $B_2O_3$, and MgO were selected as potential sintering aids for the proposed high-entropy composition. Each additive was introduced at two concentrations to assess the influence of sintering aid content. All samples were thermally treated at 1550 °C for 4 h in an ambient atmosphere. Microstructural analysis indicated that the most promising results were obtained following the addition of $B_2O_3$. However, the concentration of 1 wt.% $B_2O_3$ was found to be excessive, as residual secondary phase remained visible along the grain boundaries. Conversely, the addition of 0.25 wt.% $B_2O_3$ exhibited no density enhancement. Consequently, further optimisation of $B_2O_3$ concentration is necessary.

**Acknowledgement:** We acknowledge CzechNanoLab Research Infrastructure supported by MEYS CR (LM2023051). The authors are grateful to the JECS Trust for funding the visit of Faenza to CNR-ISSMC (Contract No. 2025 469).

# Electrospinning of $SiO_2$ micro/nanofibers for All-Solid-State Batteries

Cheikh Omar Ndao[1], Martin Havlík Míka[1], Kristýna Jílková[1]

[1]*Department of Glass and Ceramics, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

*ndaoc@vscht.cz*

Traditionally, the energy industry worldwide depends on power from the utilization of fossil fuels, which release a significant amount of greenhouse gas ($CO_2$). Moreover, this energy resource is limited and predicted to be exhausted in the next century as a result of its present excessive usage. Thus, it is critical to find alternative renewable, eco-friendly forms of energy to power the global enterprises of the future. Furthermore, energy storage technologies that are both efficient and cost-effective are urgently needed, given that many types of clean energy are primarily intermittent. In recent years, the need for high-capacity lithium batteries (LIBs) has rapidly increased, making their many features and applications common knowledge. Energy storage is a real issue right now because people need to move everywhere and use energy for cars, planes, cell phones… Our work is to try to increase the capacity to store more energy in safe conditions and produce All-Solid-State Batteries (ASSBs) with high energy density, safer, and less expensive. For this reason, we are trying to use silica micro/nano fiber composites doped with Si and NMC (Ni, Mn, Co) spinels for battery anodes and cathodes respectively. For cost effective anodes, we want to use the silicon recycled from photovoltaic panels. Many results show that silicon has much higher theoretical capacity to store lithium, 10 times greater than a traditional graphite anode. Despite many advantages of Si-based anodes, such as high theoretical capacity and low price, their widespread use is hindered by two major issues: charge-induced volume expansion and unreliable solid electrolyte inter-phase propagation. We want to mitigate these problems by using $SiO_2$ micro/nanofibers. The silica micro/nanofibers were prepared using electrospinning system (E-Fiber EF050) based on TEOS solution that was heat treated at 80 °C for 3 hours. The fibers were characterized with SEM-EDS, XRF and XRD analyses. In the next step we plan to dope these fibers with recycled silicon to prepare our new Si anodes for safe and affordable All-Solid-State Batteries.

# High-entropy perovskites as prospective materials for lithium-ion batteries

Marianna Hodorová[1,2], Alena Fedoročkova[2], David Csík[1], Katarína Gáborová[2], Róbert Džunda[1], Gabriel Sučík[2], Dana Ivánová[2], František Kromka[1], Karel Saksl[1,2]

[1]*Institute of Materials Research, SAS, Watsonova 47, 040 01 Košice, Slovakia*

[2]*Faculty of Materials, Metallurgy and Recycling, TUKE, Letná 9, 042 00 Košice, Slovakia*

*marianna.hodorova@tuke.sk*

The growing need for safer and higher energy density cathode materials for lithium-ion batteries (LIBs) is driving research toward the revolutionary concept of entropy stabilization [1]. Leveraging the $ABO_3$-type perovskite structure — a highly flexible framework for various functional materials — provides an ideal platform for implementing this strategy. High configurational entropy, significant lattice distortion, and the "cocktail effect" in these high-entropy materials profoundly influence their structural and chemical stability, relaxation, and thermal conductivity [2].

In this study, five different cations were incorporated in equimolar ratios exclusively into the B-site of the perovskite lattice, resulting in the composition $La(Co_{0.2}Mn0.2Fe_{0.2}Ni_{0.2}M_{0.2})\ O_3$ (where M= Cu,Cr). Powder precursors synthesized via spray drying were optimized across four calcination temperatures, with 1100 °C yielding phase purity and homogeneous elemental distribution. Analytical results confirmed stable perovskite structures: trigonal for the Cu-containing sample and orthorhombic for the Cr-containing sample.

Electrochemical characterization demonstrated that this approach enables the design of advanced lithium-storage electrodes with high reversibility and minimal capacity fading. The Cu-containing sample achieved specific capacities exceeding 500 $mAh.g^{-1}$, while the Cr-containing sample exhibited excellent stability over 300 cycles due to gradual material activation. These findings confirm high-entropy perovskites (HEPOs) as a highly promising class of materials for next-generation batteries, allowing for cost-effective metal substitution while maintaining superior performance.

**Acknowledgement:** This work was supported by the Slovak Research and Development Agency under Contract no. VV-MVP-24-0264, project no. APVV-23-0030, VEGA project No. 1/0122/25 and KEGA project No. 011TUKE-4/2025. This research was funded in part by the international project M-ERA.NET 3/2022/235/H2MobilHydride.

**References:**

[1] A. Sarkar, L. Velasco, D. Wang, Q. Wang, G. Talasila, L. de Biasi, C. Kübel, T. Brezesinski, S. S. Bhattacharya, H. Hahn & B. Breitung, *High entropy oxides for reversible energy storage*, Nat. Commun. 9, 3400 (2018). doi:10.1038/s41467-018-05774-5.

[2] J. Ma, T. Liu, W. Ye, Q. He & K. Chen, *High-entropy perovskite oxides for energy materials: A review*, J. Energy Storage 90, 111890 (2024). doi:10.1016/j.est.2024.111890.

# Carbonation of a three-component clinker-free binder 3C

Lukáš Mauermann, Klára Betáková, Martina Šídlová

*Department of Glass and Ceramics, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

*Lukas.mauermann@vscht.cz*

This work deals with the study of carbonation of a new three-component binder 3C based on calcined clays, anhydrite II, and lime. For the measurements, 10 mixtures of 3C binders were prepared. Half of them were produced by firing the three components in a static kiln, and the other half in a rotary kiln. The firing was carried out in three ways: (1) separately, (2) by combining two components together, and (3) all components together. Carbonation measurements were performed on test specimens—cubes—with dimensions of 20 × 20 mm, which were made from a mixture of the binder and water. The measurements were conducted in a climatic chamber with a controlled $CO_2$ content of 3%. The carbonation depth was measured after 7, 14, and 28 days using the phenolphthalein test. In addition, compressive strength, phase composition, and porosity were measured. The phenolphthalein test results showed that carbonation caused a dramatic decrease in pH in the binders after only 7 days. The effect of binder carbonation reduced the compressive strength to less than half of the original binder strength. XRD measurements showed that carbonation leads to the decomposition of the main phase, ettringite, into gypsum phases. Porosimetry showed that carbonization led to increased porosity of the samples.

**Acknowledgement:** This work was also supported from the grant of Specific university research – grant No. A1_FCHT_2026_009 and No. A2_FCHT_2025_054.

# Pushing limits of mixed glass former effect in lithium borophosphate glasses

Tomáš Hostinský, Petr Mošner, Ladislav Koudelka

*University of Pardubice, Faculty of Chemical Technology, Department of General and Inorganic Chemistry, Studentská 573, Pardubice 532 10, Czech Republic*

*tomas.hostinsky@upce.cz*

The mixed glass former effect (MGFE) offers a promising strategy for tailoring the structure and functional properties of amorphous solids. In this study, we explore its limits through systematic compositional tuning of lithium borophosphate glasses within the $40Li_2O{-}zWO_3{-}[(60{-}z)/4*(3P_2O_5{-}\ 1B_2O_3)]$ system. By progressively substituting borate and phosphate units with tungsten oxide while maintaining a fixed $P_2O_5$:$B_2O_3$ ratio, we investigate how such dual substitution influences structural evolution and ionic conductivity.

Comprehensive characterization using density and thermal analysis, Raman spectroscopy, and advanced 1D and 2D MAS NMR techniques reveals a gradual transformation from a phosphate-borate to a tungstate dominated glass network. This shift is accompanied by significant structural depolymerization, including the formation of isolated phosphate and borate units, emergence of W−O−W linkages, and the growth of mixed tungstate species such as $Q^0$, $Q^1$, and B−O−W environments.

Impedance spectroscopy measurements show a remarkable three order of magnitude increase in room temperature DC conductivity (from $10^{-9}$ to $10^{-6}$ $\Omega^{-1}{\cdot}cm^{-1}$) across the compositional series. This enhancement is directly linked to the evolving glass structure, which facilitates lithium ion mobility through the disruption of rigid phosphate and borophosphate networks and the formation of more accessible conduction pathways.

Our findings confirm that strategic control over glass former composition enables continuous and predictable optimization of ionic transport. These results not only extend the conceptual framework of the MGFE but also demonstrate a viable path for developing high performance solid electrolytes based on borophosphate glasses.

# Bismuth-doped 1393-B3 bioactive glass/PEEK coating deposited on titanium implant by electrophoretic deposition for biomedical applications

Mina Abdolmaleki[1], German Andres Clavijo-Mejía[1], Aldo R. Boccaccini[2], Martin Michálek[1]

[1]*FunGlass, Alexander Dubček University of Trenčín, Študentská 2, 911 50 Trenčín, Slovakia*

[2]*Institute of Biomaterials, Department of Material Science and Engineering, University of Erlangen-Nuremberg, 91058 Erlangen, Germany*

*mina.abdolmaleki@tnuni.sk*

In this project a novel coating was developed for Ti-based implants to enhance their bioactivity, improve biological responses, and combat infection. Borate bioactive glasses (BG) have been recently used in biomedical applications due to their rapid apatite ability formation in the physiological body fluids. 1393-B3 BG, in particular, with nominal composition in wt. % of 56.6 $B_2O_3$, 18.5 CaO, 11.1 $K_2O$, 5.5 $Na_2O$, 4.6 MgO, and 3.7 $P_2O_5$ is a highly bioactive borate BG that has recently attracted attention [1]. Furthermore, incorporation of therapeutic ions is a common way to enhance the biological properties of BGs [2]. In this study, $Bi_2O_3$ was aimed to be added to the 1393-B3 BG to enhance the potential radiopacity and antibacterial properties.

Although BG-based coatings provide promising bioactivity, they usually exhibit a higher Young's modulus compared to bone, leading to stress shielding. Therefore, it is preferable to composite them with other materials, like polymers, to overcome these limitations. Thus, polyether-ether-ketone (PEEK) with appropriate mechanical properties was incorporated alongside the BG to improve the adhesion and reduce stress shielding.

All BGs including 1393-B3 (Bi0) and Bi-doped BGs (Bi1, Bi2, and Bi3 with 5, 10, and 20 wt.% $Bi_2O_3$, respectively), were firstly synthesized and characterized through the melt-quenching technique. Then, PEEK/BG coatings were obtained via electrophoretic deposition (EPD) and were thermally treated at 350 ˚C subsequently in order to densification of BGs, crystallization of PEEK polymers, and enhancement of adhesion.

The indirect antibacterial assessment revealed that BG-containing coatings significantly inhibited the growth of both Gram-positive and Gram-negative bacteria stains. The viability of MG-63 cells was also assessed in direct contact with the coatings after 2 days and 7 days of immersion. Although the results showed around 60 % of cells could survive on the surface of Bi-doped BG-based coatings, the fluorescent images showed the cells preferentially attached and spread on intact regions of the BG coating.

**Acknowledgement:** This research work was supported by the Slovak Research and Development Agency under the contract No. APVV-22-0036.

**References:**

[1 ] N. Mutlu, F. Kurtuldu, I. Unalan, Z. Neščáková, H. Kaňková, D. Galusková, M. Michálek, L. Liverani, D. Galusek, A.R. Boccaccini, Effect of Zn and Ga doping on bioactivity, degradation, and antibacterial properties of borate 1393-B3 bioactive glass, Ceram. Int. 48 (2022) 16404–16417. https://doi.org/10.1016/J.CERAMINT.2022.02.192.

[2] U. Pantulap, M. Arango-Ospina, A.R. Boccaccini, Bioactive glasses incorporating less-common ions to improve biological and physical properties, J. Mater. Sci. Mater. Med. 33 (2022) 1–41. https://doi.org/10.1007/s10856-021-06626-3.

# Investigation of the influence of dopping tellurite glasses with CoO, $NiCl_2$ and CuO as colorants for direct laser writing

Filip Šimíček[1], Petr Knotek[1], Jiří Schwarz[1], Jan Smolík[2], Petr Kutálek[2], Roman Yatskiv[3], Ondřej Augustin[1], Adéla Vanická[1], Petr Kostka[4,5]

[1]*Dep. of General and Inorganic Chemistry, Faculty of Chemical Technology, University of Pardubice, Studentská 573, 53210 Pardubice, Czech Republic*

[2]*Center of Materials and Nanotechnologies, Faculty of Chemical Technology, Cs. Legií 565, 530 02 Pardubice, Czech Republic*

[3]*Institute of Photonics and Electronics, Czech Academy of Sciences, Chaberská 57, 18251 Prague, Czech Republic*

[4]*Laboratory of Inorganic Materials, Institute of Rock Structure and Mechanics of the Czech Academy of Sciences, V Holešovičkách 41, 182 09 Prague, Czech Republic*

[5]*Laboratory of Inorganic Materials, University of Chemistry and Technology Prague, Technická 5, 166 28 Prague, Czech Republic*

st63556@upce.cz

This work deals with the preparation, characterization, and direct laser writing on the surface of tellurite glasses with the composition $80TeO_2$–(20–x)ZnO–xY, where Y represents CoO, $NiCl_2$ or CuO in the concentration range x = 0–4 mol%. The aim was to evaluate the influence of these color modifiers on the structural, physical, and especially optical properties of the glasses and their behavior when exposed to different laser beams at different wavelengths.

The prepared samples were polished to optical quality, as verified by digital holographic microscopy (DHM). Bulk elemental composition was determined using X-ray fluorescence (XRF) analysis. In addition, density and thermomechanical properties were measured. Surface morphology and local chemical composition were examined using SEM–EDX.

The laser writing was performed using continuous lasers with wavelengths of 455, 785, 1064 nm, and 10.6 µm. Only the 10.6 µm laser was able to write onto undoped colorless glass. The addition of a dopant, leading to the formation of color centers in the glass significantly increased the material sensitivity to laser irradiation at the other wavelengths. New absorption bands were created with maxima at 600 nm for CoO-doped glasses, 430, 720, and 810 nm for $NiCl_2$-doped glasses, and 380 and 810 nm for CuO-doped glasses. Exposure caused surface modification and the formation of microlenses with the height up to 7 µm and craters with the depth > 6 µm on the surface of $80TeO_2$-16ZnO-4CuO, induced by 1064 nm laser.

In conclusion, the study demonstrates that the incorporation of CoO, $NiCl_2$, and CuO into tellurite glass significantly modifies its optical absorption behavior and enhances its interaction with laser beams. The formation of distinct absorption bands enables effective laser writing at wavelengths that do not interact with undoped glass. These modifications lead to controlled surface heating and structuring, including microlenses and craters formation, which highlights the potential of doped tellurite glasses for advanced photonic applications, such as integrated IR optics and microfabrication.

**Acknowledgement:** This work was supported by the CAS project 25-15635S.

# In-situ formation of TiC from recycled MgO-C refractories and structural characterization by Rietveld Refinement

Jiayan Yu, Christian Schimpf, Stefan Martin, David Rafaja

*Institute of Materials Science, TU Bergakademie Freiberg, Gustav-Zeuner-Str. 5, D-09599 Freiberg, Germany*

*jiayan.yu@iww.tu-freiberg.de*

Recycled MgO-C refractory materials and titanium (Ti) powder were applied to fabricate TiC-reinforced MgO composite ceramics via spark plasma sintering (SPS), aiming at high-performance inert anodes for operation in aggressive fluoride-rich electrolyte at high temperatures. Prior to the SPS process, 25 g MgO-C recyclate (RefraTechnik, grain size < 125 µm) containing 19.0 ± 0.4 wt.% C and 19.3 g Ti powder (AEE, fresh, 99.7% purity, < 45 µm, hexagonal) were mixed in a planetary ball mill for 60 minutes. The molar ratio of Ti to C was set as 1:1 for TiC formation. The powder mixture was sintered for 30 minutes at different temperatures in SPS.

The structure and microstructure analyses using XRD and SEM/EBSD confirmed the formation of the TiC/MgO composites, and revealed the presence of some additional phases, which are the products of the reaction between the impurities in the recyclate (mainly $Mg(OH)_2$, $CaMgSiO_4$, $SiO_2$ phases) and titanium. The solid-state reaction between Ti and C atoms was initiated already at 900 °C. At 1500 °C, supplied Ti reacted almost fully with carbon. The TiC formation was affected by the local microstructure. TiC grew rapidly in the regions, where Ti and C were in a direct contact. The presence of obstacles like MgO or pores hindered the TiC formation. A detailed analysis of the X-ray diffraction lines confirmed the presence of composition gradients in $TiC_{1-x}$, which extent varied with the sintering temperature.

# Study of the initial glass–solution interaction of sodium glass at various pH levels

Tereza Přívracká, Karolína Pánová, Dana Rohanová

*Department of Glass and Ceramics, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

*Tereza.Privracka@vscht.cz*

Glass corrosion, influenced by factors such as pH, temperature, and solution composition, represents a complex set of processes that significantly affect the chemical stability and functional properties of both utility and special glasses. In all these applications, it is essential to understand the interaction between the glass material and the solution from the very first moments of exposure. A detailed understanding of these primary processes enables precise modifications of the chemical composition of glass to meet specific application requirements. It is necessary to focus not only on the analysis of the glass material itself (SEM/EDS, XRF), but also on the chemical composition of the eluates from the very beginning of the glass–solution interaction, which can be effectively analysed using ICP–OES.

This work aims to study the initial dissolution of sodium glass over a wide pH range. Demineralized water was used as the leaching medium, and the pH was maintained using TRIS–HCl buffer. The sodium glass was tested in the form of grit under static–dynamic conditions with agitation, with the solution being replaced every 24 hours. The concentrations of elements in eluates were analysed using ICP–OES, and pH measurements were performed at laboratory temperature. The solution analyses were complemented by material analyses using SEM/EDS and XRF.

This study confirmed that glass interacts with an aqueous solution within the first minutes of contact, indicating a fast initiation of the glass–solution interaction. The dissolution behaviour of sodium glass strongly depends on pH, with clear differences in the release of individual elements across the studied pH range. These results highlight the importance of analysing eluates from the earliest stages of interaction and provide a useful experimental basis for developing more general mathematical models of glass corrosion under different chemical conditions.

**Acknowledgement:**
This work was supported from the grant of Specific university research – grant No A1_FCHT_2025_009.

# Biocompatibility and mechanical properties of hydroxyapatite–talc composites for bone tissue applications

Roman Fialka[1], Zuzana Varchulová Nováková[2], Zdeněk Chlup[3], Peter Veteška[1], Ľuboš Danišovič[2], Ľuboš Bača[1], Marián Janek[1]

[1]*Department of Inorganic Materials, Faculty of Chemical and Food Technology, Slovak University of Technology, Radlinského 9, 81237 Bratislava, Slovakia*

[2]*Institute of Medical Biology, Genetics and Clinical Genetic, Faculty of Medicine, Comenius University, 81108 Bratislava, Slovakia*

[3]*Institute of Physics of Materials, Czech Academy of Sciences, Žižkova 513/22, 61600 Brno, Czech Republic*

roman.fialka@stuba.sk

Hydroxyapatite ($Ca_5(PO_4)_3OH$) (HA) is a basic inorganic component of bones and teeth and is one of the most studied materials for bone tissue replacement. Its chemical similarity to the mineral phase of bone and its excellent osteoconductivity make it a suitable material for bone substitutes. [1] Talc ($Si_4Mg_3O_{10}(OH)_2$) is a layered silicate used as a filler in ceramics, polymers and composites to improve strength and elasticity. Several works show that the addition of talc can improve the mechanical properties of HA without negatively affecting biocompatibility. [2] This study investigated hydroxyapatite-based composites containing varying concentrations of talc as a potential sintering additive for hydroxyapatite in bone tissue applications. Samples were prepared by pressing homogenized HA powders with 1, 5, and 10 wt.% talc admixtures. Following sintering at 1300 °C, cytotoxicity and mechanical testing were performed. Biocompatibility was evaluated using MTS assay with adipose tissue-derived stromal cells (ATSCs), demonstrating no cytotoxic effects and no adverse impact on cell proliferation, while an LDH test confirmed no negative effect on membrane integrity after 48 hours. Mechanical characterization was conducted using the Vickers hardness test on samples stored for 0, 3, and 6 weeks with ATSCs in cultivation media. The results indicated that composites containing 1 wt.% talc exhibited hardness comparable to pure hydroxyapatite, while a decrease was observed at 5 wt.%, followed by an increase at 10 wt.%. These findings suggest that hardness was influenced more strongly by talc concentration than by exposure to living cells and that hydroxyapatite–talc composites retain biocompatibility, highlighting their potential for use in biomedical scaffold applications.

**Acknowledgement:** The financial support of Slovak Grant Agency VEGA (grant No. VEGA 1/0070/22) and of the Slovak Research and Development Agency under Contract No. APVV-21-0173 and the support by the project Advancing University Capacity and Competence in Research, Development, and Innovation ("ACCORD") ITMS2014+: 313021X329, co-financed by resources of the European Regional Development Fund are greatly acknowledged.

**References:**

[1] Tavafoghi, M. et al. 'Silicon-Doped Hydroxyapatite Prepared by a Thermal Technique for Hard Tissue Engineering Applications'. Ceramics International, vol. 44, no. 15. (2018).

[2] Moreira Mota, L. et al. 'Soapstone reinforced hydroxyapatite coatings for biomedical applications', Surf Coat Technol, vol. 397 (2020).

# Preparation and biological response of iron (III) phosphate ceramics

Tatiana Sivčáková[1], Zuzana Varchulová Nováková[2], František Čacho[3], Peter Veteška[1], Marián Janek, Ľuboš Bača[1]

[1]*Department of Inorganic Materials, Faculty of Chemical and Food Technology, Slovak University of Technology, Bratislava (STU), Radlinského 9, 812 37, Slovakia*

[2] *Institute of Medical Biology, Genetics and Clinical Genetics, Faculty of Medicine, Comenius University, Sasinkova 4, 811 08 Bratislava, Slovakia*

[3]*Institute of Analytical Chemistry, FCHPT STU, Radlinského 9, Bratislava, Slovakia*

tatiana.sivcakova@stuba.sk

Iron phosphates are structurally diverse materials that typically exist as a trigonal α-quartz structure at atmospheric pressure, undergoing phase transitions to hexagonal β- and γ-phases at elevated temperatures [1]. In biological sciences, they serve as effective biomimetic models and electrode substrates for enzyme immobilization, enabling the development of stable biosensing platforms for applications like hydrogen peroxide detection [2], [3]. Furthermore, fluoridized forms of these materials have demonstrated excellent biocompatibility and the ability to selectively adsorb specific proteins, such as cytochrome c, from human blood without altering their natural structure [4].

Heating microscopy of iron (III) phosphate (FeP) powder was first used to determine the sintering conditions. Based on the obtained sintering profile, samples sintered at temperatures 800 °C and 850 °C for one hour were used for further characterization. X-ray phase analysis, microstructure monitoring, determination of bulk density, and solubility testing in distilled water and DMEM were then performed. Human gingival fibroblasts (GF1) were applied to investigate cytotoxicity behaviour of prepared samples for 96-hour period. An MTS test was performed to evaluate the viability and potential cytotoxicity of the tested materials. MTS testing demonstrated that FeP samples sintered at 850 °C showed no cytotoxic effects on cell proliferation, with a value of 90 %.

**Acknowledgement:** The financial support of the Slovak Grant Agency VEGA (grant number VEGA 1/0070/22) and the Agency for Research and Development Support under contract No APVV-21-0173 and the support of the project Increasing the Capacities and Competences of Universities in Research, Development and Innovation ("ACCORD") ITMS2014+:313021X329, co-funded by the European Regional Development Fund, is gratefully acknowledged.

**References:**

[1] ALIOUANE, N., et al. Synthesis and phase transitions of iron phosphate. *Ferroelectrics*, 2000, 241.1: 255-262.

[2] REN, Tong, et al. Selective oxidation of benzene to phenol with N2O by unsupported and supported $FePO_4$ catalysts. *Applied Catalysis A: General*, 2003, 244.1: 11-17.

[3] YIN, Yajing, et al. Iron phosphate nanostructures synthesized by microwave method and their applications inbiosensing. *Nanotechnology*, 2010, 21.42: 425504.

[4] TANG, ShiSong, et al. Fluoridized iron phosphate as a novel adsorbent for selective separation/isolation of cytochrome c. *Analytical and bioanalytical chemistry*, 2011, 401.10: 3283-3292.3.

# LOMS.cz: Classical and Combinatorial Judd-Ofelt analysis

Jan Hrabovsky[1], Petr Vařák[2], Robin Kryštůfek[3]

[1]*Charles University, Faculty of Mathematics and Physics, Ke Karlovu 5, 121 16 Prague, Czech Republic*

[2]*Department of Inorganic Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Prague, Technicka 5,166 28 Prague, Czech Republic*

[3]*Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences, Flemingovo n. 2, Prague 6 16610, Czech Republic*

*Jan.hrabovsky@fulbrightmail.org*

The Judd-Ofelt (JO) theory, introduced by B.R. Judd and G.S. Ofelt in 1962, has been pivotal in rare-earth optical spectroscopy for over six decades, describing intra 4f ↔ 4f transitions with three intensity JO parameters. Subsequently, numerous fundamental and experimental studies have explored its physical origins and proposed various extensions/corrections to enhance the original model, solidifying its status as a cornerstone in rare-earth ions absorption/emission spectroscopy. Here we present a comprehensive review of the current state of JO analysis and its systematic step-by-step experimental procedure for researchers with no previous experience with JO analysis calculations. For this purpose, the LOMS (Luminescence, optical and magneto-optical software) tool [1] was developed which allows interactive online calculation of JO parameters and radiative material characteristics of transition probabilities, branching ratios and theoretical radiative lifetimes. This free to use and online available software with integrated database of JO parameters then allows to process information from both unpolarized or polarized optical absorption spectra. Based on the newly introduced Combinatorial Judd-Ofelt analysis (Fig.1), it is also possible to identify critical absorption band combinations necessary for accurate JO analysis ensuring consistent and reliable outcomes. Combinatorial JO analysis was therefore performed for all rare-earth ions in various types of host materials. The LOMS software is accessible via https://www.loms.cz web browser interface.

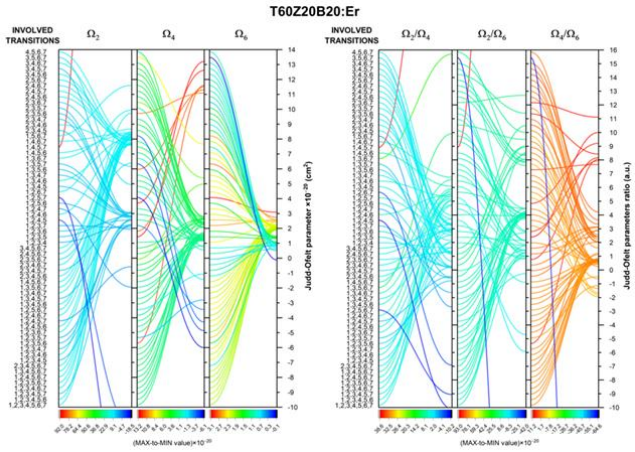


Fig.1. Combinatorial analysis of Judd-Ofelt parameters using various number of involved transition bands for sample of tellurite glasses doped with $Er^{3+}$ ions [2]

**References:**

[1] J. Hrabovsky *et al. Sci Rep* 15, 28945 (2025). DOI: 10.1038/s41598-025-13620-0.

[2] J. Hrabovsky *et al J. Phys. Photonics* 7 (2025). DOI: 025006 10.1088/2515-7647/adb115.

# Sustainable MgO-C refractories based on improved eco-friendly lignin/collagen-binder system

Till M. J. Stadtmüller[1], Florian Kerber[1], Kirsten Moritz[1], Patrick Gehre[1], Jana Hubalkova[1], Thomas Schemmel[2], Christos G. Aneziris[1]

*[1], Institute of Ceramics, Refractories and Composite Materials, TU Bergakademie Freiberg, Agricolastraße 17, 09599 Freiberg, Germany*

*[2]Refratechnik Steel GmbH, Am Seestern 5, 40547 Düsseldorf, Germany*

*till-manon-jannis.stadtmueller@ikfvw.tu-freiberg.de*

This study investigates sustainable binders based on lignin and collagen hydrolysate as substitutes for conventional binders in MgO-C refractories, with a particular focus on volume stability after thermal treatments. Collagen hydrolysate undergoes thermally induced decomposition of peptide chains while simultaneously forming a crosslinked network, accompanied by the release of $H_2O$, $CO_2$, and $NH_3$. During coking this network forms a partially ordered carbon network that provides high oxidation resistance, bulk density, and strength both at room and elevated temperatures, comparable to resin-bonded references. However, the combination of gas formation and crosslinking leads, in small laboratory samples, to a volume increase without structural damage. In large-format bricks the longer diffusion paths cause an increase of internal gas pressure, resulting in macroscopic cracking. By varying graphite morphology, MgO-C recyclate content, and lignin addition reveals that porous channels facilitate gas release and thereby significantly improve volume stability.

**Acknowledgement:** These investigations were funded by the German Research Foundation (DFG) - Project-ID 461482547 (GRK 2802).

**References:**

[1] Aneziris, C.G., Volkova, O., Gehre, P., Hubálková, J.. Graduiertenkolleg GRK 2802: Feuerfest Recycling. ACAMONTA 2022;:73–76.

[2] https://www.healthwebmagazine.com/beauty-skincare/collagen-and-its-types/

[3] Becker, Judith & Wittmann, Christoph. (2019). A field of dreams: Lignin valorization into chemicals, materials, fuels, and health-care products. Biotechnology Advances. 37. 10.1016/j.biotechadv.2019.02.016.

[4] Aneziris, C.G., Gehre, P., Veres, D., Dudczig, S., Hubálková, J., Stadtmüller, T.M.J.. Feuerfeste Erzeugnisse aus der Basis von umweltfreundlichen Bindemitteln und Feuerfest-Rezyklaten. German Patent application DE 10 2023 002 367.1. 2023.

[5] Yang, Na & Shao, Rong & Zhang, Zhengping & Dou, Meiling & Niu, Jin & Wang, Feng. (2021). Gelatin-derived carbon: Carbonization mechanism and application in K-ion storage. Carbon. 178. 775–782. 10.1016/j.carbon.2021.03.059.

[6] Zhao, Zilong & Cannon, Fred S. & Nieto-Delgado, Cesar & Pena, Leidy. (2016). Lignin/collagen hybrid biomaterials as binder substitute for specialty graphites and electrodes. Carbon. 108, 303–317. https://doi.org/10.1016/j.carbon.2016.07.026.

[7] Jansen, H., Aneziris, C., & Stein, P. (2017). Graphite powder mixture and method for its production (German Patent No. DE 10 2013 008 854 B9). German Patent and Trade Mark Office. Publication date: May 4, 2017.

# Synthesis and structural characterization of calcium silicate hydrate gels synthetized by sol-gel method

Ondřej Kunovský[1], Tomáš Opravil[2], Eva Bartoníčková[1]

[1]*Institute of Materials Science, Faculty of Chemistry, Brno University of Technology, Brno (BUT), Purkyňova 464, 612 00 Brno, Czech Republic*

[2]*Material Research Centre, Faculty of Chemistry, Brno University of Technology, Brno (BUT), Purkyňova 464, 612 00 Brno, Czech Republic*

*Ondrej.Kunovsky@vut.cz*

Portland cement is the most widely used binder in the world, and calcium silicate hydrate (C-S-H) gels are the main binding phase within hydrated cement. A comprehensive understanding of C-S-H gel formation mechanisms is essential for predicting the material's mechanical properties. In this study, C-S-H gels were synthesized via the sol-gel method, employing calcium nitrate as the calcium source and various silicon precursors, including tetraethyl orthosilicate (TEOS), sodium metasilicate pentahydrate, aqueous potassium silicate (commonly known as "potassium water glass"), and colloidal silica. The syntheses were performed under various conditions, including varying initial pH in an unbuffered system and different aging temperatures. An inert atmosphere was maintained throughout the procedures to inhibit the formation of undesired carbonate species. Fourier-transform infrared (FT-IR) spectroscopy served as the principal characterization technique to differentiate between bridging and non-bridging Si–O bonds. The aim of this work is to elucidate the correlation between synthesis parameters and the molecular structure of the resulting synthetic C-S-H gels, thereby advancing understanding of hydration processes and primary C-S-H formation within cementitious systems.

**Acknowledgement:** This research was funded by the Czech Science Foundation under the project number GA25-16766S: "*Engineering spatial distribution of hydrates in low-carbon cements* ".

# Influence of sample preparation and processing procedures on the thermal diffusivity of MgO-C refractories

Luyao Pan[1], Rhena Wulf[1], Till M.J. Stadtmüller[2], Christos G. Aneziris[2], Tobias M. Fieback[1]

[1]*Institute of Thermal Engineering, Faculty of Mechanical, Process and Energy Engineering, TU Bergakademie Freiberg, Freiberg, Gustav-Zeuner-Straße 7, 09599, Freiberg, Germany*

[2]*Institute of Ceramics, Refractories and Composite Materials, Faculty of Mechanical, Process and Energy Engineering, TU Bergakademie Freiberg, Freiberg, Agricolastraße 17, 09599, Freiberg, Germany*

luyao.pan@ttd.tu-freiberg.de

Reliable measurement of thermal diffusivity of MgO-C refractories is impeded by diverse sample preparation and processing procedures. In this study, the impacts of coking sequence, machining conditions, microstructural inhomogeneity, and graphite coating on the results obtained using the laser flash apparatus at room temperature are systematically evaluated. Specifically, machining samples after coking prevents surface oxidation compared with machining before coking. Mechanical damage is reduced by water-assisted machining, resulting in increased thermal diffusivity. However, when applied before coking, water-assisted machining leads to brucite formation, and thermal diffusivity is consequently decreased. Furthermore, uniaxial pressing induces microstructural inhomogeneity, with finer grains on the surface, thereby lowering thermal diffusivity. Uncoated samples overestimate thermal diffusivity compared with graphite-coated ones due to MgO translucency. To clarify these mechanisms, complementary analyses including phase, microstructural, and compositional characterization were performed to support these findings. The results demonstrate that the optimal preparation of MgO-C samples for measurements using the laser flash apparatus involves coking first, followed by water-assisted machining, and subsequent graphite coating. Such a preparation procedure enhances measurement reliability, providing practical guidance for standardized thermophysical property evaluation of MgO-C refractories.

# Densification of quartz sand by cold sintering process

Vojtěch Nečina, Willi Pabst

*Department of Glass and Ceramics, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

necinav@vscht.cz

The cold sintering process offers a low-temperature alternative to energetically demanding conventional sintering. This is enabled due to the presence of transient liquid phase which facilitates diffusion via mechanism of pressure solution (dissolution-diffusion-precipitation). Due to the reduced processing temperature, this method is suitable for the preparation of materials exhibiting phase transitions. In the present contribution, densification of α-$SiO_2$ (quartz) samples is investigated under various processing conditions: temperature of 200–400 °C, pressure of 300–500 MPa, dwell time of 0–360 min and concentration of liquid phase (2 M NaOH) of 0–30 vol.%. The samples are characterized in terms of bulk density, thermal conductivity and shear modulus. The lowest porosity of 5.5 % is attained for sample prepared at 300 °C, 500 MPa, 60 min and 20 vol.% of liquid phase. It is observed that all samples are characterized by relatively low values of thermal conductivity and shear modulus, thus indicating the presence of amorphous $SiO_2$.

**Acknowledgement:** This contribution was created as part of the project No. CZ.02.01.01/00/22_008/0004631 Materials and technologies for sustainable development within the Jan Amos Komensky Operational Program financed by the European Union and from the state budget of the Czech Republic.

# Growth and characterization of $Y_2SiO_5$:Ce,Mg single crystals

Herbert Kindl[1,2], Jan Pejchal[2], Kateřina Rubešová[1]

[1]*Department of Inorganic Chemistry, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

[2]*Institue of Physics of the Czech Academy of Sciences, Prague, Cukrovarnická 10/112, 162 00, Czech Republic*

kindlh@vscht.cz

Scintillators are materials capable of converting ionizing radiation into electromagnetic radiation in the near-UV, visible, or near-infrared spectral range. They are widely used in fields such as high-energy physics, medical imaging, and oil well logging. Silicate-based scintillators were extensively studied in the 1990s and several systems, including $(Lu,Y)_2SiO_5$:Ce (LYSO:Ce) and $(La,Gd)_2Si_2O_7$:Ce (LaGPS:Ce), are now well-established and commercially employed. Nevertheless, the growing demands of modern detection technologies continue to motivate the search for new or rediscovered materials with improved performance.

In this work, we investigate Mg co-doping in Ce-doped yttrium orthosilicate ($Y_2SiO_5$:Ce, YSO). Previous studies have shown that the presence of bivalent cations, such as $Ca^{2+}$ or $Mg^{2+}$, can enhance the scintillation performance of Ce-activated materials (e.g., LYSO or GGAG) by partially stabilizing the $Ce^{4+}$ charge state. In the case of YSO, however, only $Ca^{2+}$ co-doping has been reported so far, without interpretation of $Ce^{4+}$ formation or evaluation of scintillation efficiency. This gap presents an opportunity to revisit YSO as a potentially competitive scintillator material.

Two series of YSO:Ce and YSO:Ce,Mg single crystals were grown using the micro-pulling-down (μ-PD) technique. Despite considerable challenges during the growth optimization, samples of good optical quality were obtained. The optical, luminescent and scintillation properties of YSO:Ce and YSO:Ce,Mg were measured and directly compared in order to reveal the influence of Mg co-doping on the performance of YSO:Ce.

# Stabilization of toxic ions on manganese-modified sorbents

Kateřina Maxová, Barbora Doušová, Eva Bedrnová

*Department of Solid State Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

maxovak@vscht.cz

Filtration is one of the basic methods of water treatment. In this process, water flows through columns filled with special materials – sorbents, which have the ability to capture ions we want to remove from water. The most common issue in water treatment is the content of dissolved metals, which enter the water from both the subsoil and industrial wastewater. There are many sorbents for water treatment such as sand, zeolite, clay, activated carbon or other materials. The material for sorption can be used in initial or modified form, which depends on the technical possibilities, the quality of the raw water and the resulting level of water purity that the customer wants to achieve.

One of the most common methods of modification is to cover the surface with manganese oxides ($MnO_x$), which increase the specific surface area and the number of active sites for ion capture, but also improve capture through their oxidizing effect.

This study was focused on assessing the effect of modification on the adsorption capacity of zeolite sorbents. For this purpose, natural and $MnO_x$-modified clinoptilolites were used, modified and its adsorption efficiency to selected metals was measured. The results were compared with commercial adsorbents.

The adsorption experiments were performed on a model solution simulating a severely contaminated system with a concentration of 0.5 mmol $L^{-1}$ of $Zn^{2+}$, $Cd^{2+}$, $Pb^{2+}$ and $Al^{3+}$. The suspension of a defined amount of sorbent (5–20 g $L^{-1}$) and 25 mL of model solution was shaken for 24 hours at laboratory temperature (20 °C). Subsequently, vacuum filtration was performed, and the residual cation concentrations were analyzed. The experimental data were fitted with the Langmuir adsorption isotherm to determine the adsorption parameters. The contents of selected ions were determined by the method of Atomic Absorption Spectrometry and UV-Vis Spectrophotometry.

**Acknowledgement:** This work was supported from the grant of Specific university research – grant No. A1_FCHT_2025_009. This work was carried out with the contribution of Vodaservis s.r.o. (Žďár nad Sázavou, Czech Republic).

# Aluminosilicates from Deep-sea nodules

David Nováček[1,2], Hong Nguyen Vu[3]

[1]*Interocenmetal Joint Organization, Szczecin, Cyryla I Metodego 9, 71-524, Poland*

[2]*Department of Sustainability and Product Ecology, Faculty of Environmental Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

[3]*Department of Metals and Corrosion Engineering, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

novacekd@vscht.cz

Deep-sea nodules, primarily composed of ferromanganese oxides, hold significant potential due to their high content of cobalt, copper, nickel, and minor elements such as rare earth elements (REEs). [1, 2] Given the changing geopolitical landscape and diminishing terrestrial deposits, deep-sea nodules have become a primary focus in the renewed race to secure critical resources in international waters. Despite being a landlocked country Czechia participates in the research of deep-sea resources trough Interoceanmetal Joint Organization (IOM) based in Szczecin, Poland since before the end of Cold war.

Although numerous processing technologies have been proposed over the decades, they predominantly concentrate on extracting currently most valuable metals [3] and often overlook the potential by-products, such as high-quality manganese or aluminosilicates.

This presentation discusses the potential of hydrometallurgical processing of nodules and the resulting aluminosilicates by-product. Aluminosilicates in nodules, commonly found as fine-grained detrital minerals such as quartz, feldspar, and phillipsite [4-6], play a significant role in the overall geochemistry of deep-sea nodules. The aluminosilicate content affects various geochemical processes, including the adsorption of trace metals and the structural integrity of the nodules [7-10].

This contribution will briefly cover the potential uses of aluminosilicates, which are by-products of deep-sea nodule mining. Aluminosilicates can be utilized in various industrial processes, such as producing ceramics, glass, and construction materials. The extraction and processing of these materials may increase the efficiency and lower environmental impacts of deep-sea mining operations by reducing waste and optimizing resource use.

**Acknowledgement:** This work was supported by the Interoceanmetal Joint Organization.

**References:**

[1] J. R. Hein; F. Spinardi; N. Okamoto; K. Mizell; D. Thorburn; A. Tawake. Critical metals in manganese nodules from the Cook Islands EEZ, abundances and distributions. Ore Geology Reviews, 68 (2015) 97-116.

[2] T. Kuhn; A. Wegorzewski; C. Rühlemann; A. Vink. Composition, Formation, and Occurrence of Polymetallic Nodules. In Deep-Sea Mining: Resource Potential, Technical and Environmental Considerations, R. Sharma Ed.; Springer International Publishing, 2017; pp 23-63.

[3] G. W. Moore. Handbook of Marine Mineral Deposits. Eos, Transactions American Geophysical Union, 81 (36) (2000) 411-413.

[4] C. H. L. Lee, Sung-Rock. Authigenic Phillipsite in Deep-sea Manganese Nodules from the Clarion-Clipperton Fracture Zones, NE Equatorial Pacific. Economic and Environmental Geology, 29 (4) (1996) 421-428.

[5] Y. H. Li; J. E. Schoonmaker. 7.01 - Chemical Composition and Mineralogy of Marine Sediments. In Treatise on Geochemistry, H. D. Holland, K. K. Turekian Eds.; Pergamon, 2003; pp 1-35.
[6] J. Li; X. Wu; X. Zhou; L. Zeng; S. Wu; M. Wang; W. Guan; Z. Cao; Q. Li; G. Zhang. A near-zero waste process for the full-component utilization of deep-sea polymetallic nodules based on reductive leaching with SO2 followed by separation and recovery. Hydrometallurgy, 223 (2024) 106207.
[7] S. E. P. Calvert, N. B.; Heath R.; Moore T. C. Relationship between ferromanganese nodule compositions and sedimentation in a small survey area of the equatorial Pacific. Journal of Marine Research, 36 (1) (1978) 161-183.
[8] P. Halbach; R. Giovanoli; D. von Borstel. Geochemical processes controlling the relationship between Co, Mn, and Fe in early diagenetic deep-sea nodules. Earth and Planetary Science Letters, 60 (2) (1982) 226-236.
[9] B. Nagender Nath; V. Balaram; M. Sudhakar; W. L. Plüger. Rare earth element geochemistry of ferromanganese deposits from the Indian Ocean. Marine Chemistry, 38 (3) (1992) 185-208.
[10] R. Hesse; U. Schacht. Chapter 9 - Early Diagenesis of Deep-Sea Sediments. In Developments in Sedimentology, H. HüNeke, T. Mulder Eds.; Vol. 63; Elsevier, 2011; pp 557-713.

# Carbonate-free $BaHfO_3$ as a pinning phase in bulk REBCO superconductors

Vojtěch Ševčík[1]

[1]*Department of Inorganic Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, 166 28, Czech Republic*

*sevcikj@vscht.cz*

Among high-temperature superconductors, the REBCO (RE-Ba-Cu-O, RE= Y, Gd, Nd) systems are perhaps the most technologically developed, finding application both in research and commercially as thin films or bulk crystals. One avenue to improve the resilience and performance of these materials in magnetic fields is the introduction of non-superconducting pinning phases into their structure. $BaHfO_3$ has been shown to be effective in this role in thin films, however its usage as an additive in bulk melt-growth processes requires the material to fulfil strict criteria. The additive must have a small grain size to facilitate its integration in the crystal during the growth process, as well as contain no components the decomposition of which could result in the formation of undesirable defects in the crystal. Synthesizing fine-grain $BaHfO_3$ powder which fulfils these requirements is therefore difficult, especially as barium has a high affinity to forming carbonate that decomposes well below the temperatures necessary for melt-growth.

In this work, $BaHfO_3$ powder with minimal contamination was prepared using reverse coprecipitation. Several approaches to the synthesis were compared with the focus of preventing the formation of $BaCO_3$ and minimizing grain size. The phase composition was determined using XRD and Raman spectroscopy, and the grains were characterized using transmission electron microscopy.

**Sborník příspěvků**

**Anorganické nekovové materiály**

**Inorganic non-metallic materials**

**2026**

---

Vydavatel: Vysoká škola chemicko-technologická v Praze
Technická 5, 166 28 Praha 6 – Dejvice
Editoři: Petra Špringer Šimonová, Lucie Kotrbová
Rok vydání: 2026
Počet stran: 33
Elektronická verze publikace ve formátu PDF.