

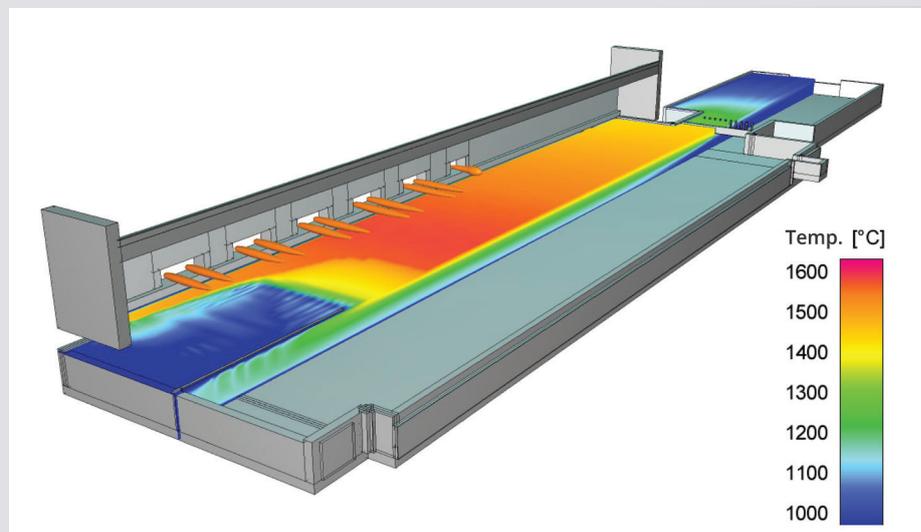


DEPARTMENT OF MATERIAL STRUCTURE AND PROPERTIES

LABORATORY OF INORGANIC MATERIALS

THEMATIC RESEARCH FOCUS

- MELTING PROCESSES AND THEIR MODELLING
- VITRIFICATION OF NUCLEAR WASTE
- THE DEVELOPMENT OF NEW TYPES OF GLASS
- MATERIALS FOR PHOTONICS AND OPTOELECTRONICS



Temperature distribution in the melting space on the top melt level

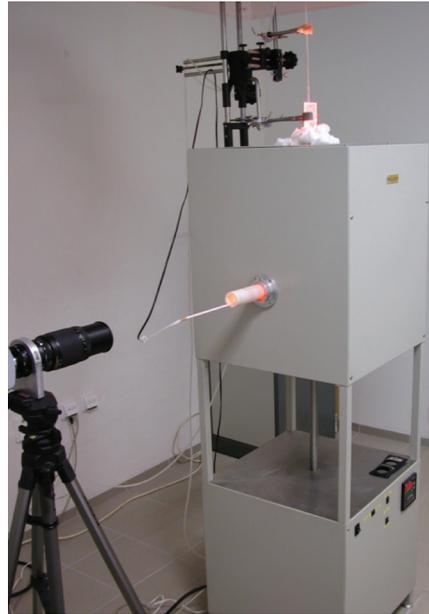
MAIN SCOPE OF RESEARCH

The Laboratory of Inorganic Materials is the successor of the Laboratory of Chemistry and Technology of Silicates of the Czechoslovak Academy of Sciences and Institute of Chemical Technology, Prague, founded in 1961. In 2012, the laboratory was transformed into a joint workplace of the University of Chemistry and Technology, Prague and the Institute of Rock Structure and Mechanics of the Czech Academy of Sciences.

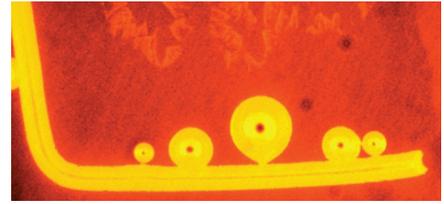
- Mathematical modelling using a Computational Fluid Dynamics (CFD) simulation to calculate velocity and temperature distribution in a melting space.
- Quantitative evaluation of the main melting processes in a continuous melting space.
- Optimization of the glass melting process by influencing the chemical reaction of sulphur compounds.
- Observation of bubble nucleation in glass melts.
- Description of bubble behaviour in a viscous fluid under the action of a centrifugal force.
- Development of new types of glasses, eliminating heavy metal oxides, particularly lead and barium.
- Research of vitrification processes to immobilise nuclear waste.
- Corrosion tests of refractories by molten glasses.
- Research and development of special glasses for photonics.

KEY RESEARCH EQUIPMENT

- Preparation of glasses under defined conditions.
- Visual observation and image analysis processes in glass melts.
- Determination of the solubility of gases in glass melts (GC-MS).
- Evolved gas analysis (EGA).
- Determination of oxygen partial pressure in glass melts.
- Thermal analysis (DTA / TG / DSC).
- Polarization microscopy.
- Measurement of glass transmission in the UV / VIS and IR regions.
- Feed volume expansion test.



High temperature observation furnace



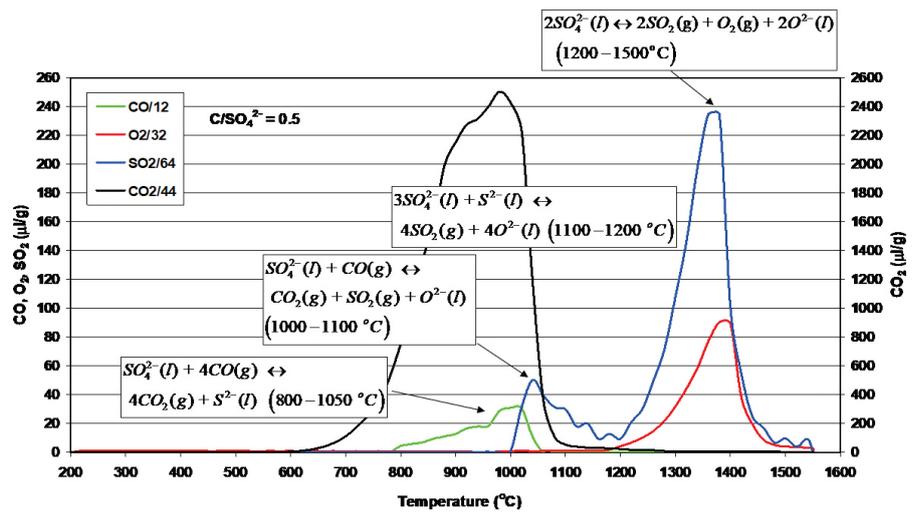
Nucleation of bubbles on a platinum wire immersed in a glass melt



Using image analysis to measure bubble size



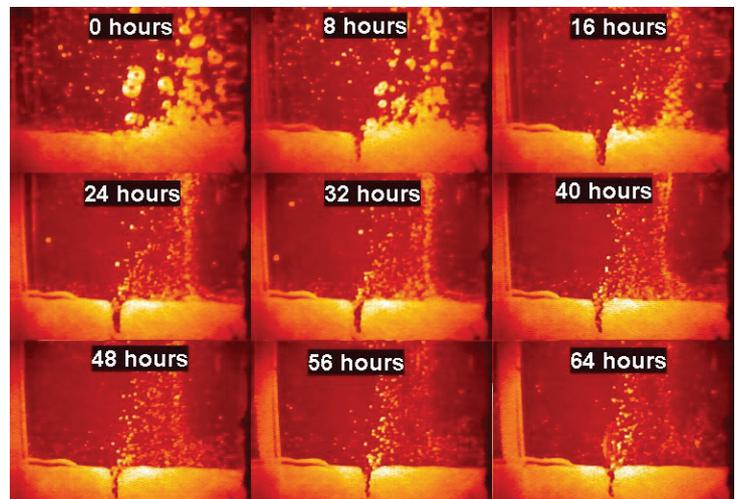
Static plate corrosion test – crucible with refractory material corroded by glass melt



Analysis of gases (EGA) evolved from a glass batch containing sodium sulphate and carbon



Laboratory furnaces for glass preparation



Identification of bubble sources during glass melting

ACHIEVEMENTS

● Vitrification of nuclear waste

Podor R., Lautru J., Pokorný R., Nabyl Z., Schuller S. (2025): High temperature environmental scanning electron microscopy characterization of transient phase formation during conversion of simulated nuclear waste. feed to glass. *Materials Letters* 379, 137619, doi: 10.1016/j.matlet.2024.137619

Rigby J., Marcial J., Pokorný R., Kloužek J., Han K., Washton N., Ferkl P., Hrma P., Scrimshire A., Bingham P., Hall M., Eaton W., Kruger A. (2024): Boron nitride: Novel ceramic reductant for low-activity waste vitrification. *Journal of the American Ceramic Society*, doi: 10.1111/jace.20192

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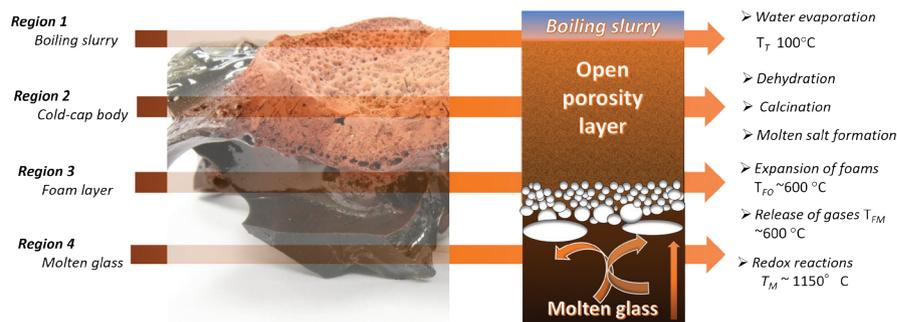
Eret M., Löwy L., Kloužek J., Cincibusová P., Vernerová M., Lhotka M., Kohoutková M., Michalcová A., Brus J., Hrma P., Kruger A., Pokorný R. (2024). Effect of alumina source on the retention of rhenium during low-activity waste feed conversion to glass. *Ceramics International* 50, Issue 21, 42229-42236, doi: 10.1016/j.ceramint.2024.08.067

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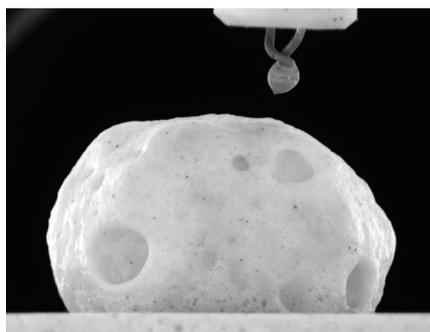
Hrma P., Ferkl P., Pokorný R., Kruger A. (2024): Glass production rate in an electric melter: Melting rate correlation and primary foam stability. *Materials Letters*. 369, 136689, doi: 10.1016/j.matlet.2024.136689

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Ferkl P., Hrma P., Kloužek J., Kruger A.A., Pokorný R. (2023): Cold-cap structure in a slurry-fed electric melter. *International Journal of Applied Glass Science*, 15, 73-87, doi: 10.1111/ijag.16645.



Cold cap – a reacting material floating on the top of molten glass and schematic illustration of a cold cap

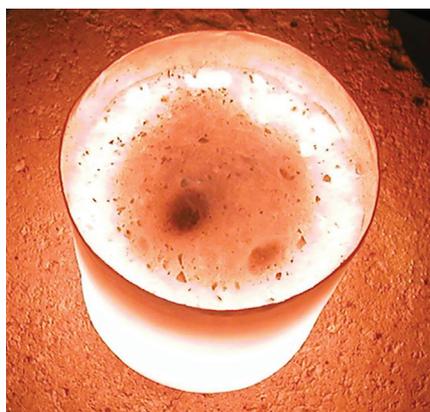


Feed volume expansion test

Khawand J., Kloužek J., Vernerová M., Cincibusová P., Hrma P., Kruger A., Pokorný R. (2023): Effect of sucrose on the oxidation-reduction conditions and retention of rhenium during vitrification of low-activity waste. *Journal of Nuclear Materials*. 573, 154155, doi: 10.1016/j.jnucmat.2022.154155.

Marcial J., Luksic S., Kloužek J., Vernerová M., Cutforth D., Varga T., Hrma P., Kruger A., Pokorný R. (2022): In-situ x-ray and visual observation of foam morphology and behavior at the batch-melt interface during melting of simulated waste glass. *Ceramics International*. 48, 7975-7985, doi: 10.1016/j.ceramint.2021.11.344

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Glass melting

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Pokorný R., Hrma P., Lee S., Kloužek J., Choudhary M. K., Kruger A.A. (2020). Modelling batch melting: Roles of heat transfer and reaction kinetics. *Journal of the American Ceramic Society*, 103, 701-718, doi: 10.1111/jace.16898

● Glass melting processes

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Pereira L., Kloužek J., Vernerová M., Laplace A., Pigeonneau F. (2020). Experimental and numerical investigations of an oxygen single bubble shrinkage in a borosilicate glass-forming liquid doped with cerium oxide. *Journal of the American Ceramic Society*, 103, 6736-6745, doi: 10.1111/jace.17398

Ueda N., Vernerová M., Kloužek J., Ferkl P., Hrma P., Yano T., Pokorný R. (2021). Conversion kinetics of container glass batch melting. *Journal of the American Ceramic Society*, 104, Issue 1, 34-44, doi: 10.1111/jace.17406

● Materials for photonics and optoelectronics

Kostka P., Jílková K., Bošák O., Kubliha M., Michalcová A., Kudrnová M., Bártová K., Dománková M., Kolářová M., Míka Havlík M. (2024): Electrical properties of PbO-Bi₂O₃-Ga₂O₃ glasses with addition of Ag₂O and Sb₂O₃. *Ceramics International* 50, 10 098-10 107, doi: 10.1016/j.ceramint.2023.12.319

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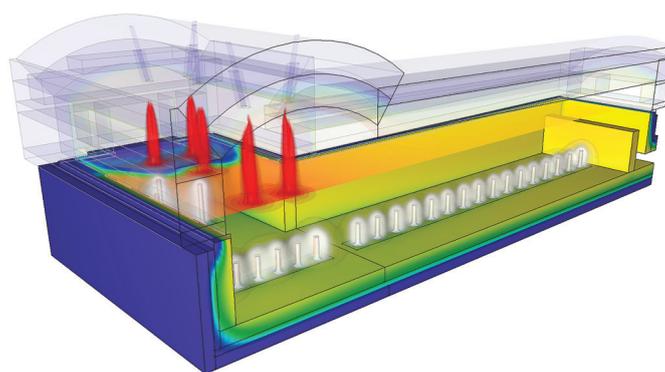
Ersundu Çelikkbilek M., Ersundu A.E., Bošák M., Kostka P. (2023): Thermal, optical, structural, and electrical properties of ZnO-MoO₃-TeO₂ glasses. *Ceramics International* 49, 12 950-12 958, doi: 10.1016/j.ceramint.2022.12.166

Yatskiv R., Kostka P., Grym J., Zavadil J. (2022): Temperature sensing down to 4 K with erbium-doped tellurite glasses. *Journal of Non-Crystalline Solids* 575, 121183, doi: 10.1016/j.jnoncrsol.2021.121183

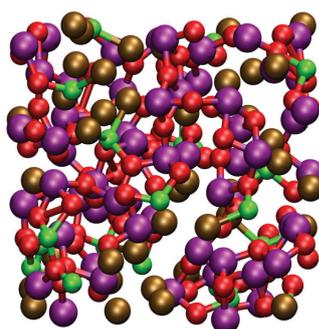
Bošák O., Kubliha M., Kostka P., Minárik S., Dománková M., Le Coq D. (2021): Electrical and dielectric properties of Sb₂O₃-PbCl₂-AgCl glass system. *Russian journal of electrochemistry* 57, 681-687, doi: 10.1134/S1023193521070041

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Design of new glass melting furnace; mathematical model



Snapshot of the 3D structure of the ZnBr₂-Sb₂O₃ glass modelled using FP MD. Colour legend: Sb (violet), Zn (green), O (red), Br (brown)



Feed – simulated nuclear waste and glass forming/modifying chemicals.



Feed melting in the laboratory furnace

MAIN COLLABORATING PARTNERS

- University of Chemistry and Technology, Prague, (Czechia)
- Pacific Northwest National Laboratory, (USA)
- Idaho National Laboratory, (USA)
- CEA Marcoule, (France)
- International Partners in Glass Research, (Switzerland)
- Glass Service a.s., (Czechia)
- AGC Inc., (Japan)
- Preciosa a.s., (Czechia)
- Institute of Photonics and Electronics of the CAS, (Czechia)
- University of Pardubice (Czechia)
- University of Rennes, (France)
- Yildiz Technical University, (Turkey)
- Sirmak University, (Turkey)
- University of Montenegro, (Montenegro)
- University of Chemical Technology and Metallurgy (Bulgaria)

