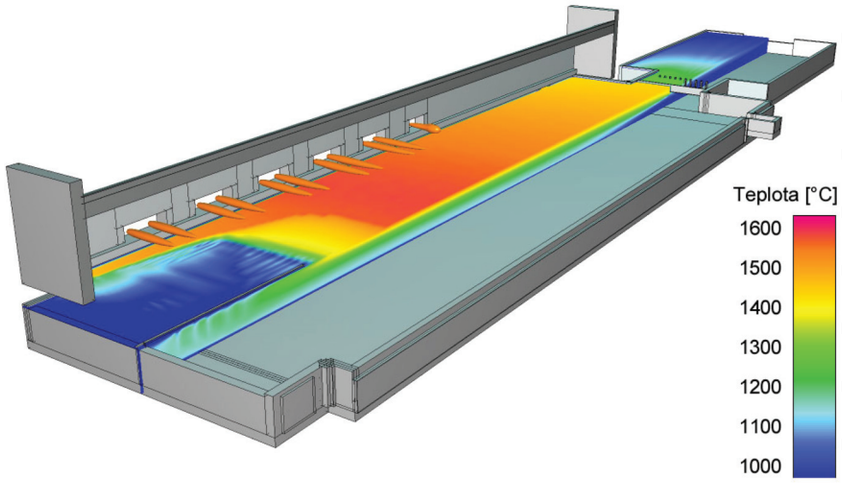
LABORATORY OF INORGANIC MATERIALS

INSTITUTE OF ROCK STRUCTURE AND MECHANICS
of the Czech Academy of Sciences

THEMATIC RESEARCH FOCUS

- **MELTING PROCESSES AND THEIR MODELING**
- **CHEMICAL REACTIONS DURING GLASS MELTING**
- **THE DEVELOPMENT OF NEW TYPES OF GLASSES**
- **MATERIALS FOR PHOTONICS AND OPTOELECTRONICS**



Temperature distribution in the melting space on the top melt level

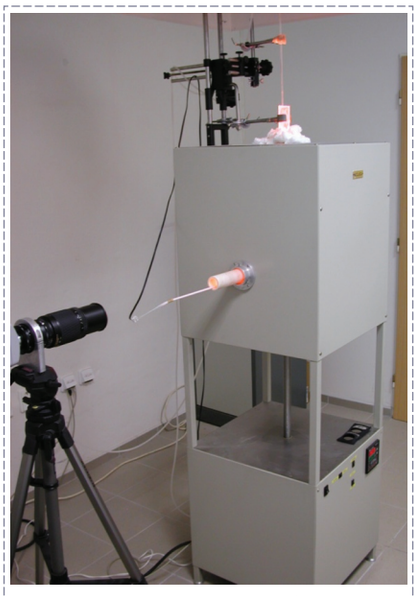
MAIN RESEARCH SUBJECTS

The Laboratory of Inorganic Materials is a successor for 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 Institute of Chemical Technology, Prague and the Institute of Rock Structure and Mechanics ASCR, v. v. i.

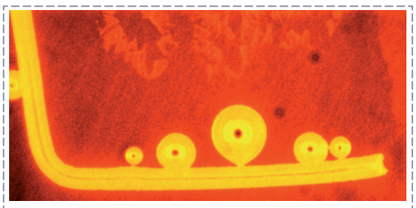
- Mathematical modeling using a Computed Fluid Dynamics (CFD) simulation to calculate the velocity and temperature distribution in the melting space.
- Quantitative evaluation of the main melting processes in a continuous melting space.
- The behavior of bubbles in the viscous fluid under the action of centrifugal force.
- Optimization of the glass melting process by influencing the course of the chemical reaction to sulphur compounds.
- Corrosion of refractories by molten glasses.
- The development of new types of glasses, eliminating heavy metal oxides, particularly lead and barium.
- Preparation and development of special glasses for photonics.

KEY RESEARCH EQUIPMENTS

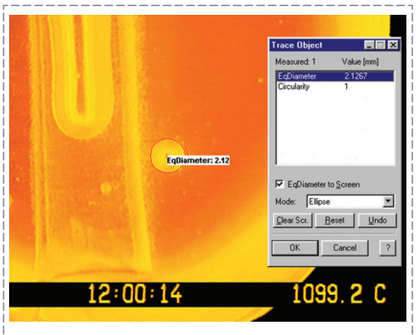
- Preparation of glasses under defined conditions
- Visual observation and image analysis processes in glass melts
- Determination of the solubility of gases in the melts (GC-MS)
- Analysis of the evolved gases (EGA)
- Determination of the oxygen partial pressure in glass melts
- Thermal analysis (DTA / TG / DSC)
- Polarizing microscopy
- Measurement of glass absorption in the UV / VIS and IR regions



High temperature observation furnace

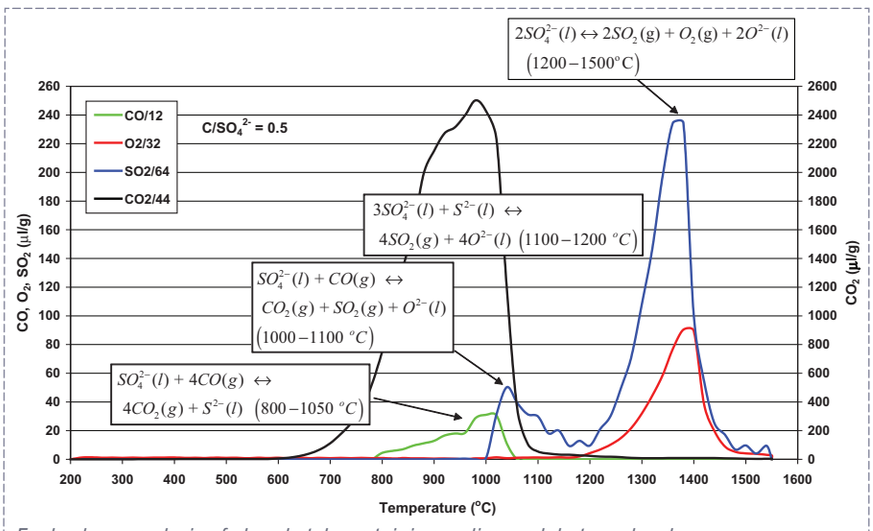


Nucleation of bubbles on Pt wire



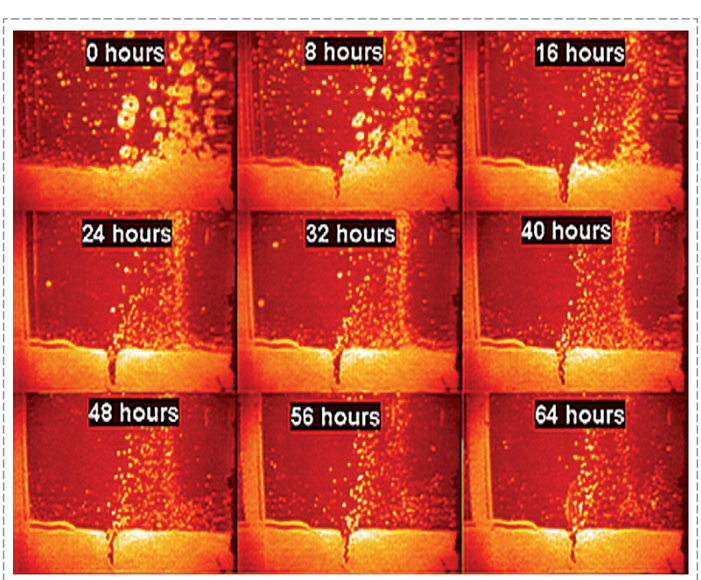
Bubble size measured by image analysis

Crucible with refractory material corroded by glass melt



Evolved gas analysis of glass batch containing sodium sulphate and carbon

Laboratory furnaces for glass preparation



Glass melting processes - Experimental observation of bubble sources

ACHIEVEMENTS

Glass melting processes

L. Němec, P. Cincibusová, 2009. *Glass melting and its innovation potentials: The potential role of glass flow in the sand-dissolution process.* Ceramics-Silikáty 53, 145–155.

M. Polák, L. Němec, 2011. *Glass melting and its innovation potentials: The combination of transversal and longitudinal circulations and its influence on space utilisation.* Journal of Non-Crystalline Solids 357, 3108–3116.

M. Jebavá, L. Němec, 2011. *Bubble removal from glass melts with slow vertical circulations.* Ceramics-Silikáty 55, 232–239.

M. Polák, L. Němec, 2012. *Mathematical modelling of sand dissolution in a glass melting channel with controlled glass flow.* Journal of Non-Crystalline Solids 358, 1210–1216.

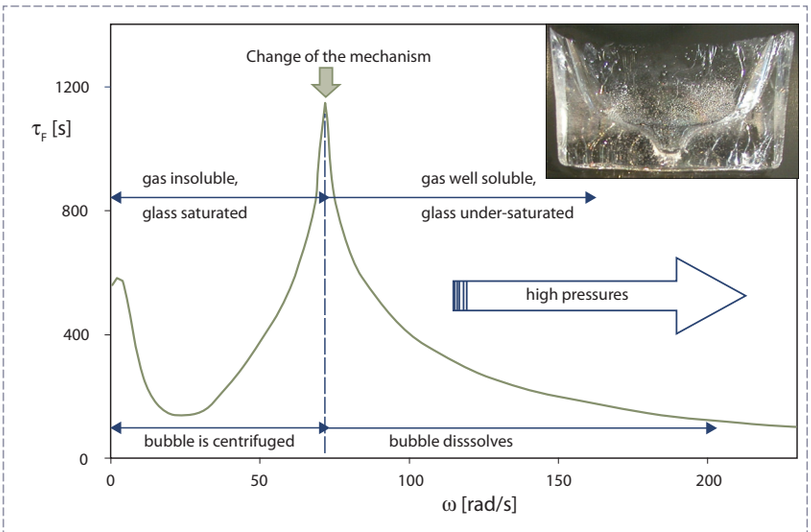
P. Cincibusová, L. Němec, 2012. *Sand dissolution and bubble removal in a model glass-melting channel with a melt circulation.* Glass Technology: European Journal of Glass Science and Technology, Part A 53, 150–157.

L. Němec, P. Cincibusová, 2012. *Sand dissolution and bubble removal in a model glass-melting channel with a uniform melt flow.* Glass Technology: European Journal of Glass Science and Technology, Part A 53, 279–286.

M. Jebavá, L. Němec, 2012. *The fining performance under the effect of physico-chemical parameters.* Ceramics-Silikáty 56, 286–293.

L. Němec, M. Vernerová, P. Cincibusová, M. Jebavá, J. Kloužek, 2012. *The semiempirical model of the multicomponent bubble behaviour in glass melts.* Ceramics-Silikáty 56, 367–373.

M. Jebavá, L. Němec, 2013. *Numerical study of glass fining in a pot melting space with different melt-flow patterns.* Journal of Non-Crystalline Solids 361, 47–56.



The effect of rotational velocity on bubble removal time.

L. Němec, M. Jebavá, P. Dyrčíková, 2013. *Glass melting phenomena, their ordering, and melting space utilisation.* Ceramics-Silikáty 57, 275–284.

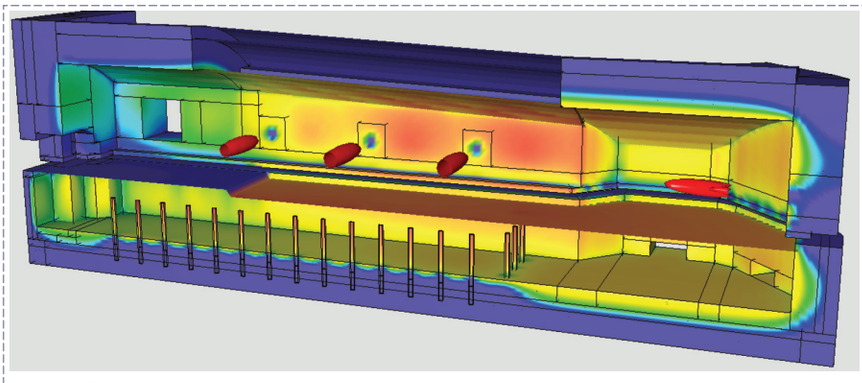
New melting concepts

V. Tonarová, L. Němec, M. Jebavá, 2010. *Bubble removal from glass melts in a rotating cylinder.* Glass Technology: European Journal of Glass Science and Technology, Part A 51, 165–171.

V. Tonarová, L. Němec, J. Kloužek, 2011. *The optimal parameters of bubble centrifuging in glass melts.* Journal of Non-Crystalline Solids 357, 3785–3790.

L. Němec, J. Kloužek, V. Tonarová, M. Jebavá, 2013. *The method of glass fining by centrifuging.* Patent No. CZ 304044.

L. Němec, J. Kloužek, V. Tonarová, M. Jebavá, 2014. *The device for glass-melt fining by centrifuging.* Patent No. CZ 304299.

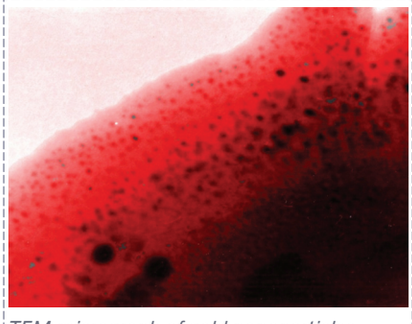


Longitudional section of glass melting space

Development of new types of glasses

J. Kloužek, L. Němec, J. Tesař, M. Hřebíček, K. Kaiser, 2010. *Ruby glass coloured by gold.* Patent No. CZ 302143.

J. Kloužek, L. Němec, J. Tesař, M. Hřebíček, K. Kaiser, 2010. *Crystal glass without content of lead and baryum compound.* Patent No. CZ 302142.

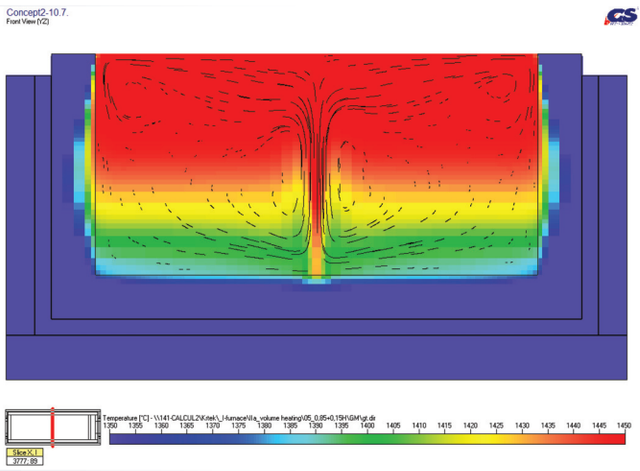


TEM micrograph of gold nanoparticles in ruby glass.

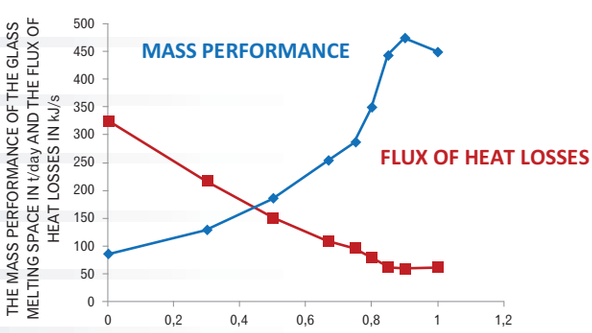
J. Kloužek, L. Němec, J. Tesař, M. Hřebíček, K. Kaiser, 2010. *Coloured glasses without content of lead and baryum compound.* Patent No. CZ 302144.

J. Kloužek, M. Polák, M. Hřebíček, K. Kaiser, V. Tonarová, 2011. *Crystal non-lead and non-baryum glass with content of lanthanum and niobium oxides.* Utility model No. CZ 22399.

J. Kloužek, M. Polák, M. Hřebíček, K. Kaiser, V. Tonarová, 2012. *Crystal non-lead and non-baryum glass with content of lanthanum and niobium oxides.* Patent No. CZ 303117.



The cross section through the modelled glass melting space showing the arisen helical flow of the melt which allows the high melting performance and restricts heat losses of the melting space.



The increasing mass performance and decreasing flux of heat losses as a function of energy transferred to promote the helical melt flow.

MAIN COLLABORATING PARTNERS

- Institute of Chemical Technology, (Prague, Czech Republic)
- International Partners in Glass Research, (Switzerland)
- Glass Service B.V., (Netherland)
- Asahi Glass Co., Ltd., (Japan)
- Slovak Technical University, (Slovakia)
- UMR 6226, Université de Rennes 1, (France)
- Technical University Istanbul, (Turkey)
- Harran University, Sanliurfa, (Turkey)
- Preciosa a.s., (Czech Republic)

Materials for photonics and optoelectronics

J. Zavadil, P. Kostka, J. Pedlíková, K. Ždanský, M. Kubliha, V. Labaš, J. Kalužný, 2009. *Electro-optical characterization of Ge–Se–Te glasses.* Journal of Non-Crystalline Solids 355, 2083–2087.

J. Kalužný, J. Pedlíková, J. Zavadil, M. Kubliha, V. Labaš, P. Kostka, 2009. *Electrical methods for optimization of structural changes and defects in sulphide glasses.* Journal of Optoelectronics and Advanced Materials 11, 2053–2057.

J. Kalužný, J. Pedlíková, J. Zavadil, M. Kubliha, V. Labaš, P. Kostka, 2009. *Investigation of electrical and dielectric properties of Ge20Se80-xTex glasses doped by Er, Ho, Pr.* Journal of Optoelectronics and Advanced Materials 11, 2063–2068.

J. Zavadil, P. Kostka, J. Pedlíková, ZG. Ivanova, K. Ždánský, 2010. *Investigation of Ge based chalcogenide glasses doped with Er, Pr and Ho.* Journal of Non-Crystalline Solids 356, 2355–2359.

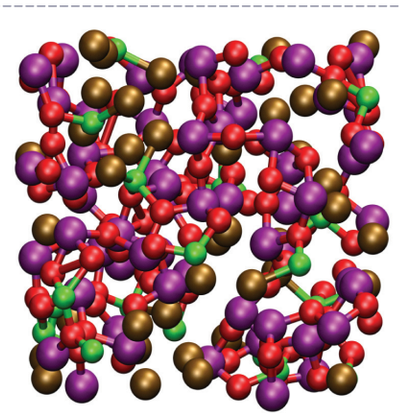
J. Macháček, P. Kostka, M. Liška, J. Zavadil, O. Gedeon, 2011. *Calculation and analysis of vibrational spectra of $PbCl_2$–Sb_2O_3–TeO_2 glass from first principles.* Journal of Non-Crystalline Solids 357, 2562–2570.

P. Kostka, J. Zavadil, J. Pedlíková, M. Poulain, 2011. *Preparation and optical characterization of $PbCl_2$–Sb_2O_3–TeO_2 glasses doped with rare earth elements.* Physica Status Solidi A – Application and Materials Science 208, 1821–1826.

J. Zavadil, M. Kubliha, P. Kostka, M. Iovu, V. Labas, Z.G. Ivanova, 2013. *Investigation of electrical and optical properties of Ge–Ga–As–S glasses doped with rare-earth ions.* Journal of Non-Crystalline Solids 377 (SI), 85–89.

O. Bošák, P. Kostka, S. Minárik, V. Trnovcová, J. Podolinčiaková, J. Zavadil, 2013. *Influence of composition and preparation conditions on some physical properties of TeO_2–Sb_2O_3–$PbCl_2$ glasses.* Journal of Non-Crystalline Solids 377 (SI), 74–78.

M. Kubliha, P. Kostka, V. Trnovcová, J. Zavadil, J. Bednarčík, V. Labaš, J. Pedlíková, A. C. *Dippel, H.P. Liermann, J. Psota, 2014. Local atomic structure and electric properties of Ge20Se80-xTex (x=0, 5, 10 and 15) glasses doped with Ho.* Journal of Alloys and Compounds 586, 308–313.



Snapshot of the 3D structure of the $ZnBr_2$-Sb_2O_3 glass modeled by using FP MD. Colour legend: Sb (violet), Zn (green), O (red), Br (brown).

USMH

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