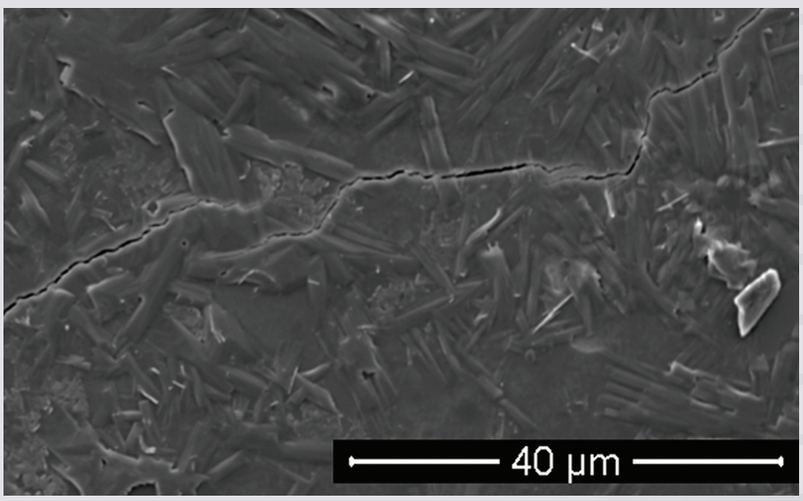
INSTITUTE OF ROCK STRUCTURE AND MECHANICS
The Czech Academy of Sciences

DEPARTMENT OF MATERIAL STRUCTURE AND PROPERTIES

LABORATORY OF ENVIRONMENTAL TECHNOLOGIES

THEMATIC RESEARCH FOCUS

- PROCESSING OF BIOMASS, WASTE PLASTICS, SEWAGE SLUDGE AND COAL
- USE OF DIFFERENT ASHES
- GEOPOLYMER COMPOSITES
- MINERAL PROCESSING OF RAW MATERIALS
- INSTRUMENTAL ANALYSES AND MOLECULAR MODELLING



SEM photomicrograph: A detailed view of area C (2000× magnification), with crystals in the geopolymer surroundings

RESEARCH ACTIVITIES

The Laboaratory of Environmental Technologies, Department of Material Structure and Properties studies relations between the structure and properties of inorganic and organic materials as well as the methods used for their preparation. It develops energy efficient production processes and environmental technologies. Research fields with application potential are focused on (a) recovery of waste materials (b) the properties and use of alumino-silicates and preparation of geopolymers, (c) carbonaceous materials, their characteristics and use, and (d) materials with magnetic properties and their use in mineral engineering. The most recent field of study is the processing of sewage sludge. Pyrolysis of coal, biomass and waste plastics comprises a traditional field of research.

MAIN SCOPE OF RESEARCH

- **Chemistry and technology of geopolymers:** preparation of new geopolymer materials; research of the structure and mechanical properties of geopolymer composites; material assessment of historical mortars and plasters for restoration.
- **Environmental technologies:** organic waste characterization and treatment; co gasification of coal with organic waste; sewage sludge processing; catalytic methanization of carbon dioxide; use of bioashes from biomass combustion for the enrichment of soils with nutrients.
- **Magnetic materials:** creation of strong magnetic fields using Nd-Fe-B permanent magnets for applications in mineral engineering; construction of highly efficient filters and magnetic separators for mineral processing. The magnetic filters and separators assembled are implemented in technological lines in Czech industrial plants.

KEY RESEARCH EQUIPMENT

- A SPECTRO IQ X-ray fluorescence analyzer for elemental analysis of solid and liquid materials.
- Agilent 6890N gas chromatographs with FID and TCD detection.
- A SETARAM Setsys Evolution 18 thermal analyzer with an Omnistar GSD 320 O3 Mass Spectrometer 1–300 amu.
- A Perkin-Elmer thermal analyzer.
- A TERI-MOM thermal analyzer.

Thermal analyzers work both in inert and in oxidizing atmospheres and are used mainly to characterize polymers, coal, inorganic substances and thermal decomposition reactions of materials.

- A fully automatic testing device Vicatronic for determination of the setting time.
- A Haake Viscometer for determining the viscosity of both Newtonian and non-Newtonian fluids.
- A CECIL CE-7500 UV-VIS double-beam spectrometer.

- A CILAS 920 laser particle-size analyzer with a range of 0.7–400 µm.
- Fixed and moving bed furnaces with the continuous monitoring of gas components, the volume of the gases generated, pressure and temperature.
- A material-firing furnace, a material-strength testing machine, friction mills, a vibration screen grader, a jaw crusher, a vibration mill, a disintegrator, and a programmable drying oven with a maximum temperature of 300 °C.

Fixed-bed pressure equipment for the thermal degradation of organic materials under pressure

Haake viscometer for determining the viscosity of tars, oils and non-Newtonian liquids

SETARAM Setsys Evolution 18 thermal analyser with an OMNISTAR GSD 3200 Mass Spectrometer

ACHIEVEMENTS

● Equipment for mineral processing

Straka P., Žežulka V.: *Linear structures of Nd-Fe-B magnets: Simulation, design and implementation in mineral processing – A review*. Minerals Engineering 143 (2019), 105900–105921.

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An industrial magnetic filter

● Practical application of geopolymers

Perná I., Hanzlíček T., Boura P., Lučaník A.: *Application of a clay-slag geopolymer matrix for repairing damaged concrete: Laboratory and industrial-scale experiments*. Materials Testing 59 (2017), 929–937.

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● Geopolymer properties

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● Materials characterization

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Kroulíková S., Mercl F., Száková J., Perná I., Tlustoš P.: *Chemical Properties of Flue Gas Desulphurization Gypsums from Different Energy Sources*. Conference: 23rd International Conference on Reasonable Use of Fertilizers (2017), 95–98.

Hanzlíček T., Perná I., Uličná K., Římal V., Štěpánková H.: *The Evaluation of Clay Suitability for Geopolymer Technology*. Minerals 10 (10) (2020), 852.

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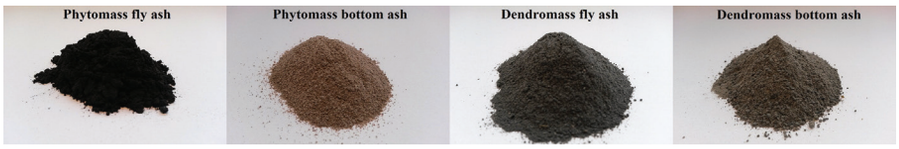

Fly and bottom ash from incineration of biomass

● Environmental studies

Řimnáčová D., Vorokhta M., Vörös D., Borecká L., Bičáková O.: *Adsorption study of waste materials as potential adsorbents for pollutant removal and storage*. 7th ICCT. Czech Society of Industrial Chemistry in cooperation with Czech Chemical Society, Prague (2019), 324–328.

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● Environmental technologies

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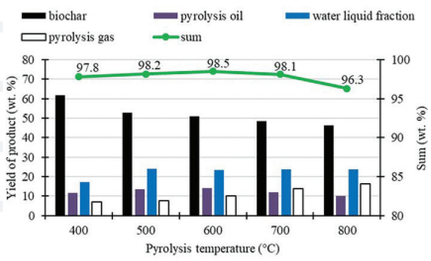

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Rotary kiln for the large-scale processing of polyethylene waste

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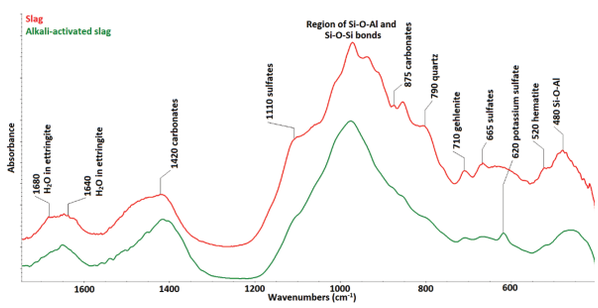

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MAIN COLLABORATING PARTNERS

- University of Chemistry and Technology Prague
- Institute of Chemical Process Fundamentals of the CAS
- Institute of Plasma Physics of the CAS
- Institute of Macromolecular Chemistry of the CAS
- Academy of Arts, Architecture & Design in Prague
- University of Pardubice
- Czech University of Life Sciences Prague
- Czech Geological Survey

V Holešovičkách 94/41,
182 09 Praha 8, Czech Republic
www.irsm.cas.cz

Assoc.Prof. Jaroslav Kloužek, PhD
Head of Department
Phone: +420 266 009 422
E-mail: jaroslav.klouzek@irsm.cas.cz

Ing. Olga Bičáková, Ph.D.
Head of Laboratory of Environmental Technologies
Phone: +420 266 009 251, 321, 403
E-mail: bicakova@irsm.cas.cz