



AKTION ÖSTERREICH - TSCHECHISCHE REPUBLIK

AKTION ČESKÁ REPUBLIKA - RAKOUSKO

Final Report – Závěrečná zpráva – Abschlussbericht

Characterization of hydrogels systems by advanced macro-rheological, micro-rheological and spectroscopic techniques (AKTION No. 76p5)

Participants of the project:

Scientists: Prof. Ing. Miloslav Pekar, CSc., Brno University of Technology (BUT)
Ass.-Prof. Milan Kracalik, Ph.D., Johannes Kepler University Linz (JKU)
Ing. Jiří Smilek, Ph.D. Brno University of Technology (BUT)

Students: Ing. Marcela Lastuvkova, BUT
MA. Elke Bradt, JKU

The project AKTION No. 76p5 Characterization of hydrogels systems by advanced macro-rheological, micro-rheological and spectroscopic techniques was realized in a period from 15. 06. 2016 to 31. 03. 2017 at the Brno University of Technology in Czech Republic and at Johannes Kepler University Linz in Austria.

The mobility internship was portioned in to the five important parts: 1) Start of the project; 2) Measurement of samples and preparation new samples; 3) Visit of professor Pekař at JKU Linz; 4) Visit of associate professor Milan Kracalik at BUT 5) Finish the project and preparation of manuscript.

The start of the project was initiated by Jiri Smilek, Ph.D. His work consisted from solving of measuring equipment, which was used for the measurement of the real hydrogels samples (rheometer). During his visit he together with Austrian colleague's assoc. prof. Milan Kracalik and Ph.D. student Elke Bradt optimized the measuring system of hydrogels samples on the new equipment Zetasizer Nano ZS90 (Malvern) at JKU Linz, which is used for the measurement of microrheological properties of liquid, viscous or hydrogel samples. Jiri Smilek, Ph.D. participated on the preparation of manuscript (data sheet from previous project 73p17).

The next part of project was based on the monthly visit Ph.D. student Marcela Lastuvkova at JKU Linz. Her work was portioned at the three main aims. The first aim of the internship was the determination of mechanical properties of hydrogels based on polyacrylic acid with or without of lignohumate addition, which were prepared and measured by the previous project AKTION (reg. no. 73p17). In the present project we observed also changes of viscoelastic properties of samples from previous AKTION project in the time (almost 1 year ago). The measurements were realized on rheometer Anton Paar Physica MCR 501. Two types of tests were carried out on these samples – frequency sweep oscillation and strain sweep oscillation. Obtained results were compared with data from previous AKTION project.

The second aim of the internship was focused on the study of temperature effect on mechanical properties of pure agarose hydrogels. Agarose hydrogel represent important biopolymers with applications in medicine and pharmacy. For purposes of this project samples of hydrogels with different concentration of agarose (exactly 0.1, 0.5 and 1.0 wt. %) were prepared. These samples were used for rheological tests (at different temperatures). Then agarose hydrogels with additions of biopolymer (Carboxymethylcellulose) and polymer (Polystyrenesulfonate) with different molecular weight (exactly 70.000, 300.000 and 500.000) were prepared. Results from rheological test performed on these samples were compared.

The last aim of internship was dealing with the determination of elastic module (so called E-module) by using of AFM (Atom Force Microscopy) instrument. This measurement was very difficult I have obtained results which must be verified by subsequent analysis.

The third part of project was the visit professor Pekar at JKU Linz, where he had the presentation about our institute especially aimed on hydrogels (topic related to AKTION project).

Further, the two visits our colleges from JKU – Assoc. prof. Milan Kracalik and MA. Elke Bradt. Milan Kracalik presented the Polymer institute and he deal with the rheological methods, possibilities of measuring samples and the summary from the mobility visits. During their stay were measured prepared samples by ZetaSizer Nano SZ and by Fluorescence correlation spectroscopy (Micro Time200,PicoQuant), and determination of microrheology properties.

The final report was written by Jiri Smilek, Ph.D. and he produced all necessary duties and forms for finishing of project.

It is obvious, that the cooperation between both involved institutions is very well initiated. Ideas for common cooperation exceeding responsibilities defined in AKTION project have been devised. It is one of the most important finding, why the project AKTION between Brno University of Technology and Johannes Kepler University should continue. Therefore we believe that we will have further change for the AKTION project.

Involved persons

Person	Activity	Home university	Visit
Marcela Lastuvkova	Realization of viscoelastic measurements (mechanical testing) of hydrogels from previous project 73p17. Preparation of hydrogels with biopolymers (carboxymethylcellulose) and polymer (polystyrenesulfonate). Realization of microrheological tests (DLS). Preparation of hydrogel samples and realization of E-module measurements (AFM).	BUT	30 days
Jiri Smilek	Realization of viscoelastic measurements (mechanical testing) of hydrogels from previous project 73p17. Preparation of publication (manuscript in impacted journal) together with Austrian colleagues. Finalization of project and preparation next project call (AKTION).	BUT	2 × 9 days
Miloslav Pekar	Giving lecture, preparation of further projects and subsequent cooperation (JKU)	BUT	5 days
Milan Kracalik	Giving lecture, preparation of further projects and subsequent cooperation (BUT)	JKU	2 × 5 days
Elke Bradt	Realization of microrheological experiments (dynamic light scattering, fluorescence correlation spectroscopy). Measuring of Raman spectroscopy on hydrogels samples. Determination of results from Raman spectrophotometer. (BUT)	JKU	2 × 5 days

Two lectures were given within the project framework. The first one was given by M. Pekar at the Johannes Kepler University in Linz named **Hydrogels with integrated hydrophobic nanocontainers – structure, transport and barrier properties**. The second one by M. Kracalik at the Brno University of Technology named **Combination of rheological and spectroscopical methods for hydrogels characterization** aimed on unique combination of classical rheological techniques with spectroscopical methods especially with Raman spectroscopy.

Accomplishment of goals

1) Manuscript of scientific publication based on this cooperation

Successful cooperation between Brno University of Technology and Johannes Kepler University resulted in one manuscript named Cross correlation of swelling and rheological properties of soft materials based on superabsorbent polymers (results from previous AKTION project 73p17). This manuscript was sent to impacted peer-reviewed journal (Polymer Bulletin IF 1.371) and it is now under review process.

2) Final thesis in the field of rheological and spectroscopical characterization

Based on the cooperation of participating universities, the final thesis aimed on microrheological characterization of hydrogels was proposed. The supervisor of the master thesis is Jiri Smilek and the final thesis should be defended at academic year 2017/2018. Moreover Ass.-Prof. Milan Kracalik (IPS JKU Linz) will be opponent of two theses, which will be written at Brno University of Technology (one bachelor and one master thesis). Both of these theses are aimed on rheological or micro rheological theme.

3) Report from each individual stay

From international internship Marcela Lastuvkova has written the final report (included as attachment).

Final evaluation and acknowledgement

The members of project team would like to thank programme AKTION Czech Republic – Austria for financial support of this cooperation. Due to programme AKTION we began promising cooperation between both engaged universities.

The cooperation between FCH VUT and IPS JKU resulted in several publications (conference proceedings) and also one manuscript (results from previous AKTION project 73p17) which is now under review. We are convinced that the number of peer-reviewed publications will be higher in the next years. Therefore we are going to apply for further support by programme AKTION.

Applicant

Ass.-Prof. Ing. Milan Kracalik, Ph.D.

Linz, Austria, 7th April, 2017

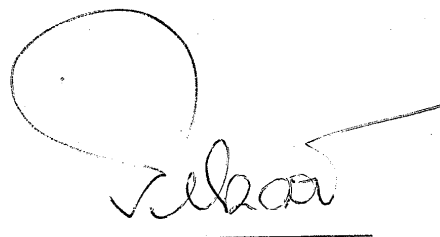


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Joint applicant

Prof. Ing. Miloslav Pekar, Csc.

Brno, Czech Republic, 11th April, 2017



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