

Research Teams

Solid-State NMR in Material Science

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Research Direction

The use of solid-state nuclear magnetic resonance (NMR) and other complementary methods in the study

- of structure and molecular dynamics of polymeric materials,
- of structure, conformations and bonding of organic molecules in nanocomposite materials.

The Importance and Benefits of Research

The detailed characterization of polymeric materials and their mixtures requires to study their morphology (crystallinity, size of crystalline and amorphous domains, structure of intermediate regions), interactions of macromolecules, compatibility of mixture components and relaxation processes occurring in a wide temperature range. This information can be obtained using ^1H and ^{13}C NMR experiments in temperature intervals which include glass transitions and melting of the studied materials. The NMR techniques make it possible to study the influence of thermal treatment, various admixtures and combination of these modifications on the properties of polymeric materials. As far as biodegradable polymeric mixtures are concerned the research also has an important ecological aspect since these materials can be used in practice as substitutes of conventional plastic materials. These materials can be used in even wider range of applications than conventional plastics.

Current Research

The study of structure and molecular dynamics of biodegradable polymeric materials in cooperation with the Polymer Institute, SAS in Bratislava.

Current Projects

Study of biodegradable polymeric materials using NMR spectroscopy.
S.G.A. project No. 1/0492/13. Principal investigator: doc. RNDr. Dušan Olčák, CSc.

Transformation of the outcomes of research projects into educational process oriented to physical engineering of materials.
Project KEGA No. 048TUKE-4/2013. Principal investigator: doc. RNDr. Dušan Olčák, CSc.

Completion of building up of a modern nuclear magnetic resonance laboratory.
Research and development project No 2003SP200280203 of a state thematic program of research and development "Complex Solution of Support and Effective Use of Science and Research Infrastructure" Co-ordinator of the project: doc. Ing. Tibor Liptaj, CSc., STU in Bratislava, Co-ordinator for TU in Košice: doc. RNDr. D. Olčák, CSc.

Centre of Excellence of the Integrated Research & Exploitation of the Advanced Materials and Technologies in the Automotive Electronics.
ITMS project No. 26220120055, Principal investigator: prof. Ing. Alena Pietriková, PhD., Technical University of Košice, department coordinator: D. Olčák, collaborators: P. Duranka, O. Fričová, V. Hronský, J. Kaššovicová, J. Kecer, M. Kladvivová, M. Kovaľaková, J. Kravčák, L. Novák, J. Ziman

Cooperation with Academic Institutions and Industry

Polymer Institute, SAS, Bratislava
Institute of Inorganic Chemistry, SAS, Bratislava
Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava
Faculty of Science, Pavol Jozef Šafárik University in Košice
Faculty of Science, Comenius University in Bratislava
Civil Engineering Faculty, Technical University of Košice
Faculty of Metallurgy, Technical University of Košice

Selected Publication

KOVAĽAKOVÁ, Mária – OLČÁK, Dušan – HRONSKÝ, Viktor - VRÁBEL, Peter - FRIČOVÁ, Oľga - CHODÁK, Ivan - ALEXYS, Pavel – SUČIK, Gabriel: Morphology and molecular mobility of plasticized polylactic acid studied using solid-state ¹³C- and ¹H-NMR spectroscopy. In: J.APPL.POLYM.SCI. 2016, DOI: 10.1002/APP.43517

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VRÁBEL, Peter - HRONSKÝ, Viktor - FRIČOVÁ, Oľga - KOVALÁKOVÁ, Mária - CHODÁK, I. - ALEXY, P.: Solid State ¹³C NMR Study of Modified Polyhydroxybutyrate. In: *Acta Physica Polonica A*. Vol. 126, no. 1 (2014), p. 419-420. - ISSN 0587-4246
<http://przyrbwn.icm.edu.pl/APP/PDF/126/a126z1p203.pdf>.

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<http://przyrbwn.icm.edu.pl/APP/PDF/126/a126z1p198.pdf>.

ĎURKOVIČ, Jaroslav - KAČÍK, František - OLČÁK, Dušan - KUČEROVÁ, Veronika - KRAJŇÁKOVÁ, Jana: Host responses and metabolic profiles of wood components in Dutch elm hybrids with a contrasting tolerance to Dutch elm disease. In: *Annals of Botany*. Vol. 114, no. 1 (2014), p. 47-59. - ISSN 0305-7364

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Photos

Solid-state NMR laboratory equipped with Varian NMR spectrometer

