NUCLEAR MAGNETIC RESONANCE DIFFUSOMETRY AND RELAXOMETRY LABORATORY

Contact details

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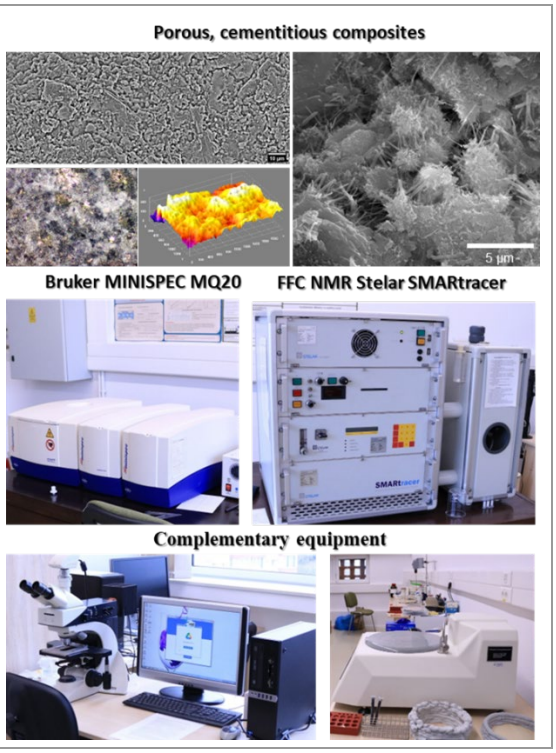

Areas of expertise

NMR diffusometry and relaxometry techniques are implemented to investigate the dynamics of liquid molecules at the interface of porous media and under confinement conditions. The confining pores of the investigated systems may have sizes ranging from nanometres to micrometres and may be entirely or partially saturated with fluids. The investigations can be done at different temperatures and resonance frequencies. The porous systems currently under study are porous glasses, carbon-based materials, colloidal crystals, polymeric nanocapsules used in controlled drug delivery, cement-based materials, bone cements, porous ceramics with magnetic impurities, biomaterials with applications in medicine, magnetic nanoparticles used as contrast agents in magnetic resonance imaging. Other materials which can be studied in our laboratory are: woods, fuel cell membranes, lubricants, fuels, catalysts, zeolites, ionic liquids, liquid crystals, rubber. Using NMR relaxometry and diffusometry techniques in the investigation of fluids confined inside porous media it is possible to extract information about pore dimensions and their connectivity. Other information that can be extracted refers to the ageing and alteration processes of different materials such as rubber, polymers, lubricants or food. In our laboratory we are also interested in developing of new NMR techniques suitable for the investigation of systems with a high content of magnetic impurities (concrete, rocks, soils, different building materials).

Team

Prof. dr. Ioan Ardelean, Lecturer dr. Codruța Badea, Asist. dr. Mihai Marius Rusu, Amalia Taut, Karoly Mostis, Alexandru Simedru

Representative projects

PN-III-P4-ID-PCE-2020-0533 (4.01.2021-31.12.2023): New cement-based nanocomposite materials for 3D printing applications; https://pce23.weebly.com/.
PN-III-P2-2.1-PED-2016-0719 (4.01. 2017-30.06.2018): Developing and testing of a new concrete, with higher flexural strength, obtained through the addition of nanoparticles and organosilane; https://ped125.weebly.com/.
PN-II-ID-PCE-2011-3-0238 (1.03. 2011-15.12.2016): Nuclear magnetic resonance studies of surface effects on dynamics of molecules confined inside porous media with magnetic impurities; https://idei305.weebly.com/.
CEEX MATNANTECH (1.03.2006-30.12.2008): NMR studies of molecular dynamics inside polymeric nanocapsules.
INSTITUTSPARTNERSCHAFT UTCN-Technical University Ilmenau, Germany (2011-2014): Molecular dynamics during the phase transition of liquids confined inside porous media (joint project financed by the Alexander von Humboldt foundation).

Significant results

The most representative publications of the past 5 years:

1. A. Cretu, C. Mattea, S. Stapf, I. Ardelean, The effect of silica nanoparticles on the pore structure of hydrating cement paste: a spatially resolved low-field NMR study, Molecular Physics 117, 1006-1014 (2019), https://doi.org/10.1080/00268976.2018.1513581
2. A. Crețu (Bede), C. Mattea, S. Stapf, I. Ardelean, The effect of silica fume and organosilane addition on the porosity of cement paste, Molecules 25 (8), 1762 (2020), https://doi.org/10.3390/molecules25081762
3. C. Cadar, A. Cretu, M. Moldovan, C. Mattea, S. Stapf, I. Ardelean, NMR T1–T2 correlation analysis of molecular absorption inside a hardened cement paste containing silanized silica fume, Molecular Physics 117, 1000-1005 (2019), https://doi.org/10.1080/00268976.2018.1513582
4. C. Cadar, I. Ardelean, Surface influence on the rotational and translational dynamics of molecules confined inside a mesoporous carbon xerogel, Magnetic Resonance in Chemistry 57 (10), 829-835 (2019) https://doi.org/10.1002/mrc.4819
5. F Gallego-Gómez, C Cadar, C Lopez, I Ardelean, Microporosity Quantification via NMR Relaxometry, The Journal of Physical Chemistry C 123 (50), 30486-30491(2019), https://doi.org/10.1021/acs.jpcc.9b10398
6. F Gallego-Gómez, C Cadar, C López, I Ardelean, Imbibition and dewetting of silica colloidal crystals: An NMR relaxometry study, Journal of colloid and interface science 561, 741-748(2020), https://doi.org/10.1016/j.jcis.2019.11.050
7. A. Nan, M. Suciu, I. Ardelean, M. Senila, R. Turcu, Characterization of the Nuclear Magnetic Resonance Relaxivity of Gadolinium Functionalized Magnetic Nanoparticles, Analytical Letters 54, 124-139 (2021), https://doi.org/10.1080/00032719.2020.1731522
8. J Stepišnik, I Ardelean, A Mohorič, Molecular self-diffusion in internal magnetic fields of porous medium investigated by NMR MGSE method, Journal of Magnetic Resonance 328, 106981 (2021), https://doi.org/10.1016/j.jmr.2021.106981
9. I. Ardelean, The Effect of an Accelerator on Cement Paste Capillary Pores: NMR Relaxometry Investigations, Molecules 26 (17), 5328 (2021), https://www.mdpi.com/1420-3049/26/17/5328
10. L.M. Nicula, O. Corbu, I. Ardelean, A.V. Sandu, M Iliescu, D. Simedru, Freeze–Thaw Effect on Road Concrete Containing Blast Furnace Slag: NMR Relaxometry Investigations, Materials 14 (12), 3288 (2021), https://doi.org/10.3390/ma14123288
11. M. Oztop Berkay Berk, C. Cavdaroglu, L. Grunin, I. Ardelean, D. Kruk, G. Mazi, Use of Magic Sandwich Echo and Fast Field Cycling NMR Relaxometry on Honey Adulteration with Corn Syrup, J. Science of Food and Agriculture, 2021, https://doi.org/10.1002/jsfa.11606 .
12. I. Lacan, M. Moldovan, C. Sarosi, I. Ardelean, Chitosan Effect on Hardening Dynamics of Calcium Phosphate Cement: Low-Field NMR Relaxometry Investigations. Polymers. 2022; 14(15):3042, https://doi.org/10.3390/polym14153042
13. M.M Rusu, D. Faux, I. Ardelean, Monitoring the Effect of Calcium Nitrate on the Induction Period of Cement Hydration via Low-Field NMR Relaxometry, Molecules, 2023, 28, 476. https://doi.org/10.3390/molecules28020476
14. M. M. Rusu, A. Vulpoi, C. Vilau, C.M. Dudescu, P. Păşcuţă, I. Ardelean, Analyzing the Effects of Calcium Nitrate over White Portland Cement: A Multi-Scale Approach. Materials, 2023, 16, 371. https://doi.org/10.3390/ma16010371
15. I. Lacan, M. Moldovan, I. Ardelean,The Influence of Chitosan on Water Absorption and Solubility of Calcium Phosphate Cement, *Coatings*, 2023, 13(9),1641. https://doi.org/10.3390/coatings13091641

The offer addressed to the economic environment

Research & development	The NMR diffusometry and relaxometry laboratory provides a variety of measurements for characterization of materials. Between these a list of possible investigations is given bellow: • Study the effects of various additives and admixtures on cement hydration; • Monitoring the alteration and ageing of rubber or polymers as well as the polymerization processes; • Determination of liquid content inside different porous materials (stone, wood, ceramics, catalysts, bricks, soil, etc.) and the pore size distribution; • Determining the degree of deterioration of lubricants; • Study the effectiveness of contrast agents used in MRI; • Determining the water content and its distribution in foods and seeds; • Determining the permeability of soils to certain pollutants; 2D optical images with resolution of up to 1μm of various non-transparent materials.
Consulting	We provide consultancy services on NMR techniques and their applications in medicine, oil industry, study of pollutants transport in soils, pore size characterization, study of cement-based materials, etc.
Training	Training of personal in the field of NMR diffusometry and relaxometry techniques and their applications

Last updated: January 2025