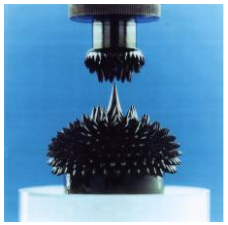


Laboratory of Magnetic Fluids Timişoara 1975-2025 A short history

Ladislau Vékás

Center for Fundamental and Advanced Technical Research

Romanian Academy-Timişoara Branch (1968-1970; 1997-)

University Politehnica of Timişoara (1970-1997)

International Workshop

Magnetic nanoparticles, magnetically controllable fluids and applications

23 October 2025 Timişoara

Magnetic fluids-First results in USA

Patent filed in **1963** by **Steven S. Papell of NASA**: *Low viscosity magnetic fluid obtained by the colloidal suspension of magnetic particles*, US Patent 3.215.572 (**1965**);
S. E. Khalafalla and G. W. Reimers, *Magnetic fluids and their manufacture*, NTIS Rep. no. PB-219 866, PAT-APPL-148 206,May 28, **1971**, 11 pp. ; US Patent Nr. 3.843.540 (**1974**).
E. L. Resler and R. E. Rosensweig, *Magnetocaloric power*, A.I.A.A. J., 2(8)1418-1422(**1964**);
Neuringer J L, Rosensweig R E, *Ferrohydrodynamics*, Physics of Fluids 7, 1927 (**1964**);
Moskowitz R., Rosensweig R.E., *Nonmechanical torque-driven flow of a ferromagnetic fluid by an electromagnetic field*, Appl.Phys.Letts, 11(10) 301-303 (**1967**).
Rosensweig, R. E., *Magnetic fluid seals*.US Patent No. 3,620,584 (**1971**)

Magnetic fluids-First results in Romania

Institute of Physics and Engineering Sciences-Romanian Academy-Iaşi Branch
Centre for Technical Physics-Iaşi

Gh. Călugăru, *Contribution a l'étude du mécanisme de l'effect Procopiu,* C.R. Acad. Paris, vol. 268, p. 828, **1969; Gh. Călugăru and R. Bădescu**, *Magnetoviscosity of the magnetic colloids from iron oxide*, in Dig. Intermag Conf., p. 384, **1975; Gh. Călugăru, R. Bădescu, and E. Luca**, *Magnetoviscosity of ferrofluids*, Rev. Roum. Phys., vol. 21, no. 3, pp. 305-308, **1976**; **Gh. Călugăru, C. Cotae, R. Bădescu, V. Bădescu, and E. Luca**, *A new aspect of the movement of ferrofluids in a rotating magnetic field*, Rev. Roum. Phys., vol. 21, no. 4, pp. 439-440,**1976; R. Bădescu and Gh. Călugăru**, *Magnetoviscozimetru automat pentru studiul ferofluidelor*, EEA. Automatica si Electronica, vol. 20, no. 3, p. 144, **1976; V. Bădescu, N. Rezlescu, R. Bădescu, and E. Luca**, *Utilization of ferrofluids for centering and damping of mobile equipments*, Electroteh. Electron. and Autom. Electroteh., vol. 26, no. 5, pp. 165-169, Jul. **1978**

From**: IEEE TRANSACTIONS ON MAGNETICS**, VOL. MAG-16, NO. 2, **MARCH 1980** 387: **808 articles and 262 patents**
Magnetic Fluids Bibliography, MARKUS ZAHN (MIT), SENIOR MEMBER, IEEE, AND KATHLEEN E. SHENTON(MIT)

LMF 1975-2025

Ştefan Procopiu
1890-1972

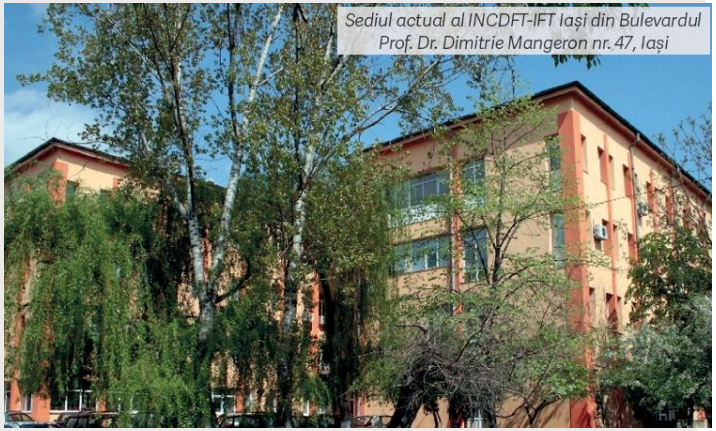
PhD at Sorbonne Paris 1924
with Gabriel Lipmann and
Aymé Cotton

- **Magneton Bohr (1918)-Procopiu (1913)**

Sur les éléments d'énergie, Annales scientifiques de l'Université de Iassy (Dec.**1912; published 2013**)

Colloidal suspensions

- *Dépolarisation de la lumière par les liquides tenant en suspension des particules cristallines,* Comptes rendus de l' Academie des Sciences, Vol.173, Paris, **1921**



National R&D Institute for Technical Physics Iaşi
(1990-)

Institute of Macromolecular Chemistry "Petru Poni"
Romanian Academy, Iaşi, 1949-

https://icmpp.ro/

Physical and Technical Research Division,
Romanian Academy-Iaşi Branch **1951-1977**
Centre for Technical Physics, Iaşi (1977-1990)
Prof. Ştefan Procopiu,
member of the Romanian Academy

Group of ferofluids research
Prof. Emil Luca
Prof. Gheorghe Călugăru
Dr. Vasile Bădescu
Dr. Constantin Cotae
Dr. Rodica Bădescu

Research on ferrofluids in Iaşi
Early 70's

LMF 1975-2025

Ferrofluids in Timişoara

Motivation and beginning

*Anton Anton, Study, design, manufacturing and testing of an MHD turbotransformer, **Diploma Thesis** Polytechnic Institute Timişoara, **1972***

*Ioan Anton et al., Researches on MHD turbotransformers, Lucrări tehnico-stiintifice, Polytechnic Institute Timişoara **1977***

Working fluid: mercury or magnetic fluid?

R. Moskowitz, R.E. Rosensweig, *Nonmechanical torque driven flow of a ferromagnetic fluid by an electromagnetic field*, Appl.Phys.Lett.,11(**1967**)

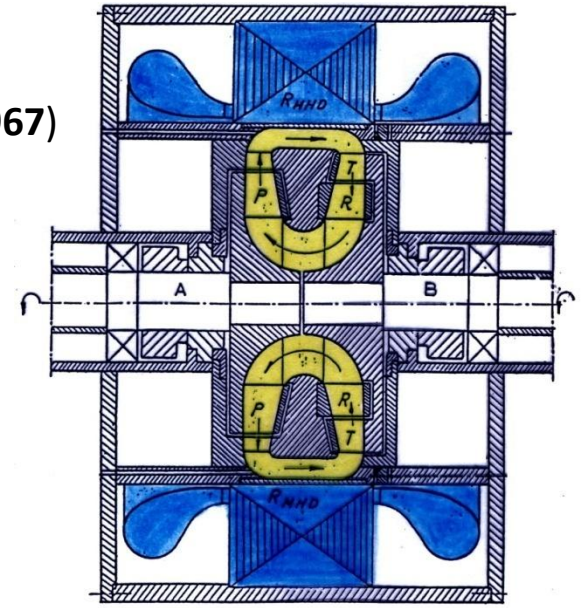
M. I. Shliomis, *Magnitnie zhidkosti (Magnetic fluids)*, Uspekhi fizicheskih nauk, 112(**1974**)

Founding the Laboratory of Magnetic Fluids from Timişoara

Department of Hydraulic Machines
Polytechnic Institute Timişoara
Acad. Ioan Anton 1975

Electromagnetic control of operating characteristics of hydraulic machines

MHD rotator+ Turbotransformer



Acad. Ioan Anton
Patent RO Nr.57574
1971

Magnetic fluids in Timişoara
A decisive step forward

1964

J. L. Neuringer, R. E. Rosensweig,
Ferrohydrodynamics
Phys. Fluids 7, 1927–1937 (1964)

1965

Steven S. Papell of NASA in 1963
filed the patent:
Low viscosity magnetic fluid
obtained by the colloidal
suspension of magnetic particles
US Patent 3.215.572 (1965)

1971

R. E. Rosensweig, 1971. *Magnetic fluid seals*
US Patent 3,620,584(1971)

1974

S. E. Khalafalla and G. W. Reimers in 1971
filed the patent
Magnetic fluids and their manufacture
US Patent 3.843.540 (1974)

1975

Prof. Ioan Anton

Member of the Romanian Academy
University Politehnica Timişoara

Founding the
Laboratory of Magnetic Fluids

The international context

Ferrohydrodynamics
MHD Turbotransformer
MF rotating seals
CS Ing. Iosif Potencz
CS Ing. Emilian Suciu†
S.l.Ing. Mircea Tămaş
CS fiz. Ladislau Vékás
Asist.res. George Giula

Acad. Ioan Anton†

Development of a multidisciplinary research team

1975-1980

Structure
Electronic Microscopy
Prof. Dr.ing.Marin Truşculescu†
Fiz. Marin Liţă

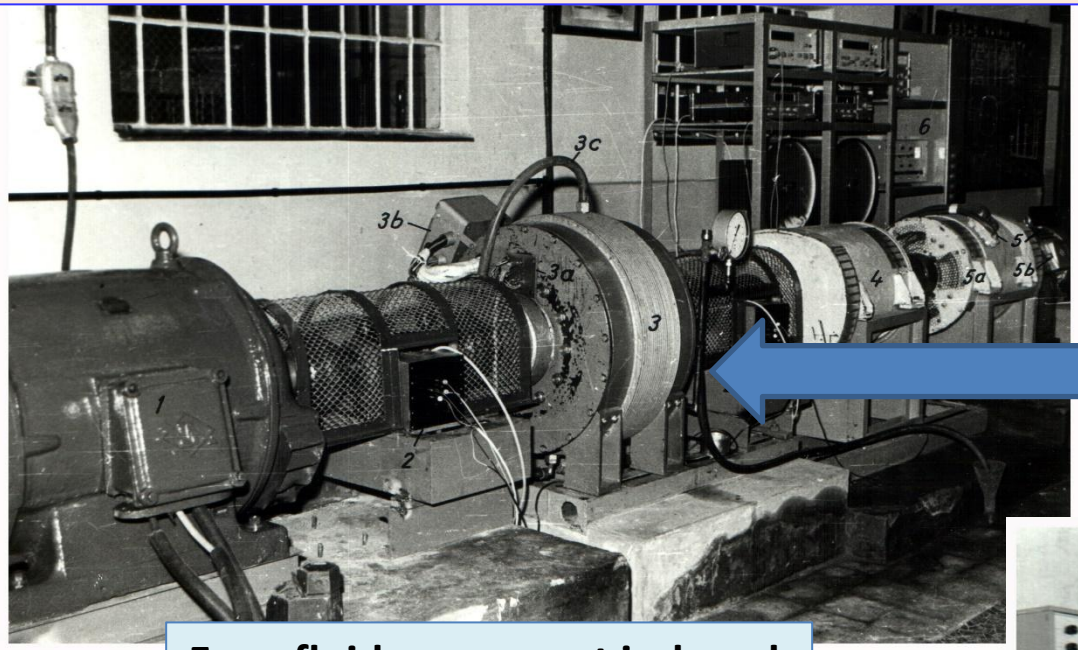
Physical properties
Magnetic forces
Prof.Dr.ing. Ioan DeSabata†
Conf.ing. Dumitru Daba†
S.l.ing. Adrian Colţeu
S.l.ing. Barbu Nicoară†

Chemical synthesis
Composition, stabilization procedures
Prof. Zeno Gropşian†
S.l.ing. Romulus Minea
Ing. chim. Ioan Temmer†
As.ing. Francisc Peter
CS chim. Doina Bica†
S.l. ing.chim. Lazăr Gabor†

Anton I.†, Vékás L., Potencz I., Suciu E.†, Tămaş E., *Turbotransformatorul MHD si alte aplicatii ale fluidelor magnetice*, Memoriile Sectiilor Stiintifice (AR), seria IV, tom III, Nr.2, 109-124(**1980**)

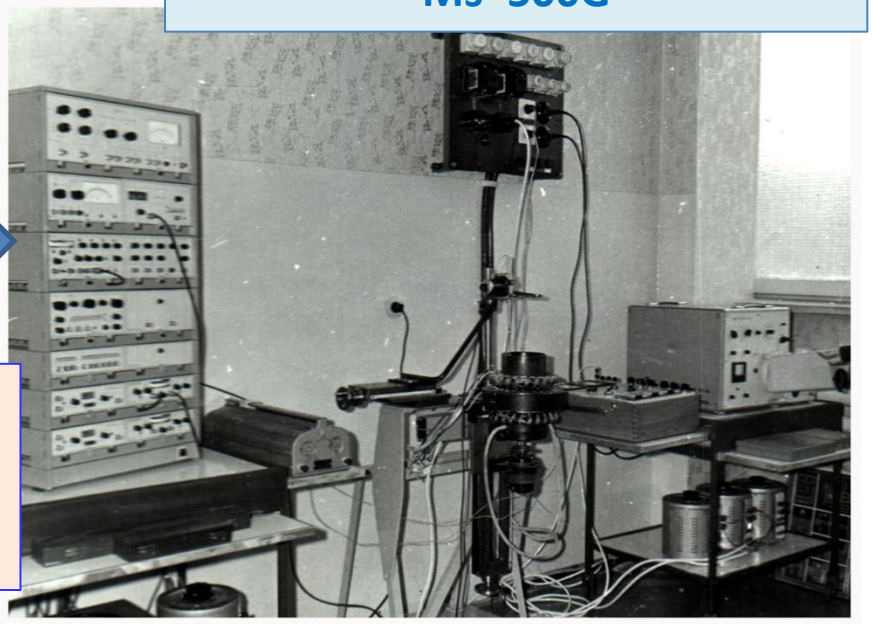
Ferrofluid synthesis

Cooperation with the group
Prof. Emil Luca† et col
Centre for Technical Physics Iaşi
1976-1979



MHD Turbotransformer
Laboratory model
Experimental testing
13.5 liters hydrocarbon ferrofluid
Ms=500G

Ferrofluid movement induced by a rotating magnetic field
Experimental set-up with hot film anemometry (DISA)



Anton I†., Vékás L., Potencz I., Suciu E.†, *Ferrofluid flow under the influence of rotating magnetic fields*, IEEE Trans. on Magnetics, MAG-16 (2)(**1980**);
2nd Int. Conf. Magnetic Fluids, 1980 (Orlando,Florida,USA)

Lucrările primului seminar cu tema "Aplicaţiile ferofluidelor", cuprinse în acest volum, doresc să contribuie la cunoaşterea mai bună de către toţi cei interesaţi, specialişti din industrie, cercetare şi învăţământ, a preocupărilor existente pe plan mondial şi la noi în ţară, în special la Institutul Politehnic "Traian Vuia" din Timişoara, în domeniul modern al ferofluidelor.

Prin străduinţele noastre de a introduce rapid aplicaţiile deja cunoscute ale ferofluidelor în industria ţării noastre, prin identificarea şi fundamentarea unor noi direcţii de cercetare, orientate spre aplicaţii concrete, dorim să aducem un cald omagiu şi să dedicăm acest volum sărbătoririi celei de a 60-a aniversări a înfiinţării Institutului Politehnic "Traian Vuia" din Timişoara, precum şi eminentului profesor Aurel Bărglăzan, membru corespondent al Academiei R.S.România, ilustru om de ştiinţă şi cadru didactic al institutului nostru, decedat în urmă cu 20 de ani, care a întemeiat, printr-o muncă neobosită şi în contact permanent cu producţia, şcoala de maşini hidraulice din Timişoara, fiind promotorul concepţiei moderne a învăţământului integrat cu cercetarea şi producţia.

Acad. Ioan Anton

11 papers; 170 pages

Synthesis of highly stable ferrofluids for engineering and biomedical applications

LMF 1975-2025

Approx. one liter of sealing magnetic fluid (mixed mineral oil based) Saturation magnetization Ms≈ 500 G

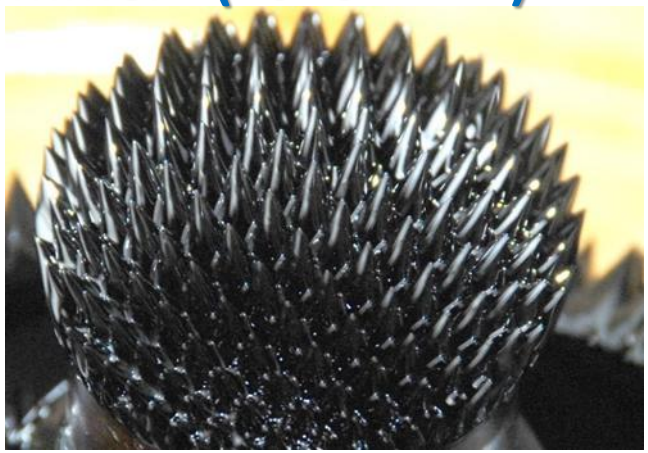
1979

High colloidal stability over

43 years

in non-uniform magnetic field

Ing. Ioan Temmer† (1929-****)



1982-??

I.Temmer†, Z. Gropşian†, R. Minea, *Studii asupra caracteristicilor fizice ale unor ferofluide*, Primul Simpozion National de Materiale Magnetice, ICPE București, vol.1, 35-45 (**1979**)

Z. Gropşian†, I. Temmer†, *Proprietatile fizico-chimice ale ferofluidelor*, Seminar tehnico-stiintific, Aplicaţiile ferofluidelor, I.P. Timişoara, pp. 5-22(**1980**)

LMF 1975-2025

Ferrofluids-chemical synthesis

Chemical coprecipitation: aqueous solution Fe^{3+}, Fe^{2+} -- **80-82^{0}C**--NH_4OH (25%)-**pH=11**—surface coating--**Fe_3O_4.OA**
Fe^{3+} / Fe^{2+} = 1.5–1.7 in atmospheric (oxidizing) conditions; ➡ approx. **50-60 g MNP/batch**

Surface coated magnetic nanoparticles

Hydrocarbon → Dispersion → **Nonpolar organic ferrofluids**

Chemisorbed surfactants: **oleic acid (OA)**, myristic acid (MA), lauric acid (LA)

DBS or PIBSA (C ≥ 8) → Secondary stabilization (physical adsorption) Dispersion ← Alcohols C_3-C_{10}/HVO/ Diesters (DOA/DOS) Vegetal oils, paraffin oil

→ **Polar organic ferrofluids**

Secondary surfactants: dodecyl benzene sulfonic acid (DBS), polymers (PIBSA, PIBSI)

NaOH → Magnetic organosol , pH 8.5 – 9.0

Water, Secondary surfactant → Dispersion → **Aqueous ferrofluids**

Technical grade FFs	FFs primary materials for biotech nano	Technical grade FFs	Bio FFs	Technical grade FFs	BioMed FFs
Low or high boiling point hydrocarbon carriers	chloroform, benzene, toluene, cyclohexane, hexane, heptane, i-octane	alcohols, ketones, diesters, high vacuum oils	vegetal oils, paraffin oil, waxes	Secondary surfactant DBS	Surfactants LA. MA, OA, CA, PAA, PLA, NaOA

Laboratory of Magnetic Fluids Timişoara

Batch-type synthesis-over 50 types of ferrofluids

Doina Bica† (1952-2008)

Doina Bica, *Rom.Rep.Phys.*(**1995**); L.Vékás, **Doina Bica**, M.V. Avdeev, *China Particuology* 5 (**2007**); E. Tombácz, **Doina Bica** et al., *J Phys Condensed Matter* (**2008**); L.Vékás, M.V. Avdeev, **Doina Bica** in: D. Shi (Ed) *NanoScience in Biomedicine* (Springer, **2009**)

Doina Bica† *et col* Romanian Patents (10): 90078 (**1985**); 93107 (1987); 97224 (1989); 97559 (1989); 107547 B1(1989); 107548 B1(1989); 105048 (1992) ; 105049 (1992); 115533 B1(2000);122725 (2009)

Pilot-scale manufacturing of ferrofluids for magnetogravimetric separation

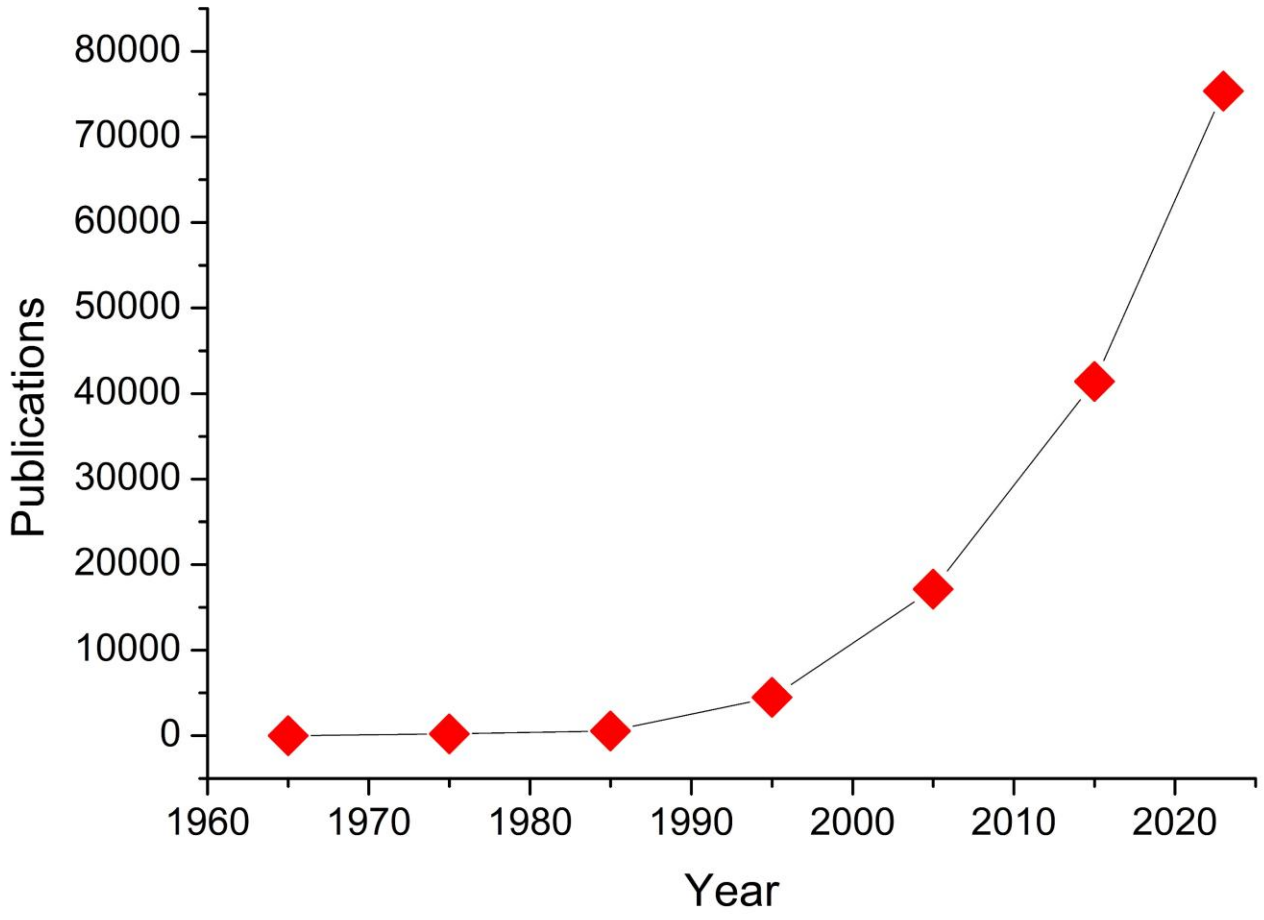
Department of Anorganic Chemistry
Polytehchnic Institute of Timişoara

A decisive step for ferrofluid technologies in Romania

Prof. Romulus Minea, Assoc.Prof. Lazăr Gabor†

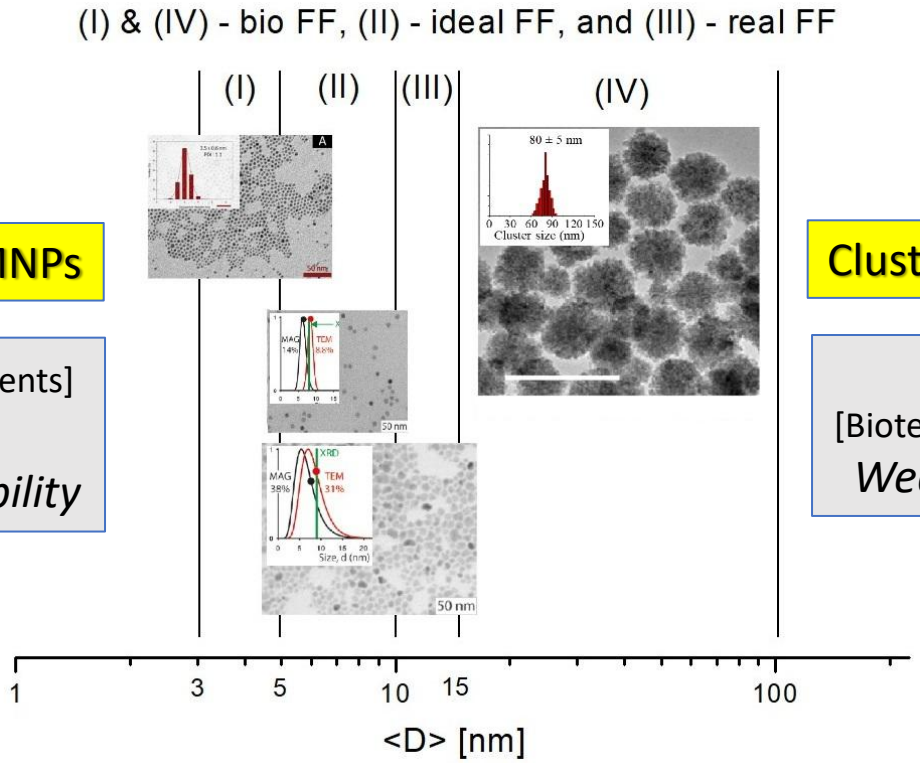
Early 80's

WoS - Publications: ferrofluids; magnetic fluids; magnetic nanofluids
April 2023



The number of publications highly increased in the last two decades especially due to applications in biotechnology and nanomedicine

Engineering and Bio-Ferrofluids



Single MNPs

Clustered (multicore) MNPs

Bio-FFs [Contrast agents]
Engineering FFs
High colloidal stability

Mainly Bio-FFs
[Biotechnology&Nanomedicine]
Weak colloidal stability

Particle size ranges

(I) bio-ferrofluids (**3-5 nm**) (II) ideal ferrofluids (**5-10 nm**),
(III) engineering (real) ferrofluids (**5-15 nm**), (IV) bio-ferrofluids (**15-100 nm**)

V. Socoliuc, M. V. Avdeev, V. Kuncser, Rodica Turcu, Etelka Tombácz, L. Vékás,
Ferrofluids and bio-ferrofluids: looking back and stepping forward,
Nanoscale 14(2022)(101 pages)

Advanced characterization of magnetic nanoparticles and ferrofluids

A major requirement

Ferrofluids and Bio-ferrofluids

Measurement & evaluation of properties

Particle size distributions:

TEM, HRTEM, XRD

Composition, stabilization procedures, colloidal stability, structural processes in magnetic field

SANS, SANSPOL, SAXS, XPS

Dilution stability, phase transition, stability in intense magnetic field

magneto-optical investigations, DLS, SLS

Flow properties in magnetic field:

Magnetorheological investigations

Rheometer MR

Magnetic properties vs. MNP volume fraction: **magnetometry *VSM*, *Mössbauer spectroscopy***

Radiation and thermal resistance

Chemiluminiscence, Differential scanning calorimetry

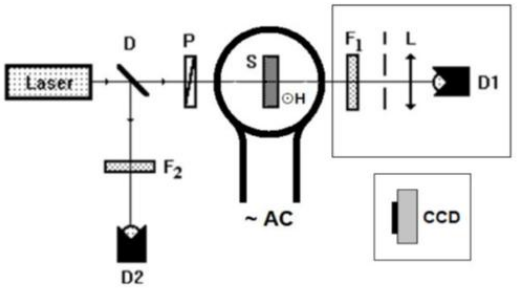
Advanced characterization of magnetically controllable fluids

Univ POLITEHNICA Timişoara-CCISFC & Romanian Academy-Timisoara Branch-CCTFA

Zetasizer DLS – Nano ZS Malvern (UK)

New experimental equipments 1996-

Vibrating Sample Magnetometer VSM – 880 DMS (USA)



a)

b)

Small-angle light scattering Home made-Lab MF

Magnetization curves
Magnetic/ hydrodynamic size
Dimensional distributions
Agglomerates/structures
Zeta potential
Flow curves
Magnetorheological effect

Rheometer MCR 300 Anton Paar (Austria) with MR cell

Advanced structural characterization of magnetic fluids

Small-Angle Neutron and X-ray Scattering investigations started in the early '90s
SANS and **SAXS**

Maria Bălăşoiu **1991**
M.V. Avdeev
V.L. Aksenov
V.M. Garamus
Regine Willumeit
Gy.Török
L. Rosta
K.D. Knudsen
V.I. Petrenko
L. Almásy
O.V. Tomchuk
A.V. Nagornyi

SANS-1 GKSS Geesthacht

Frank Lab Neutron Physics-JINR Dubna

Deutsches Elektronen-Synchrotron DESY-Hamburg

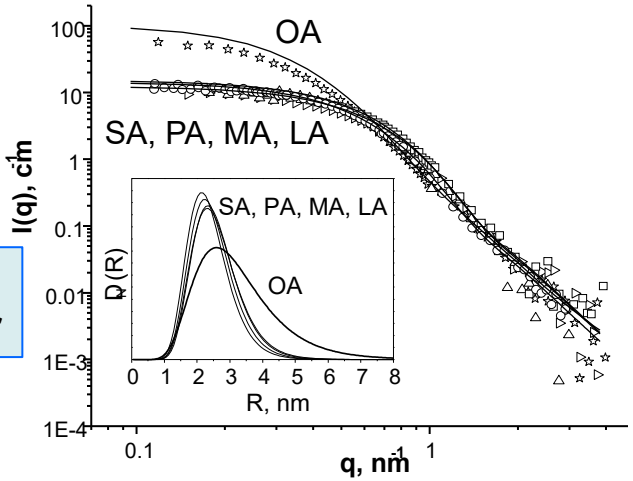
SANS-IFE Kjeller

SANS SzFKI Budapest

Development of multiannual international partnerships
Over 60 common publications

SANS and SAXS- advanced structural characterization methods

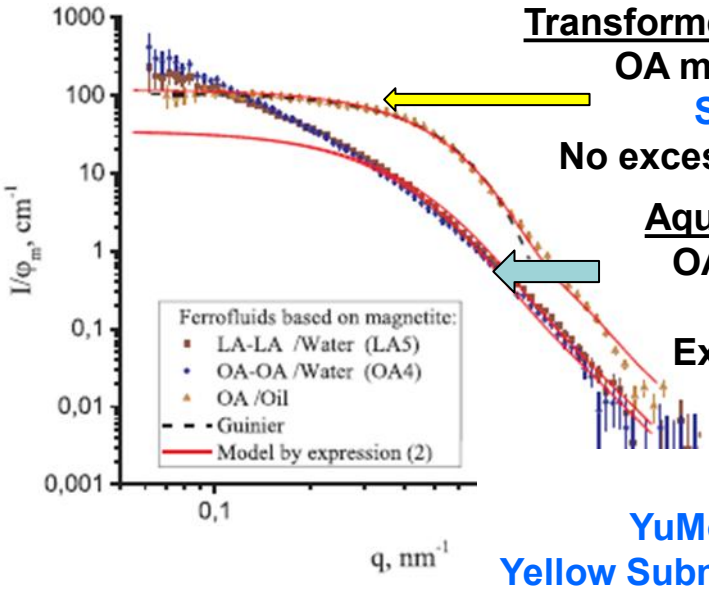
FF (DHN)
Nonpolar



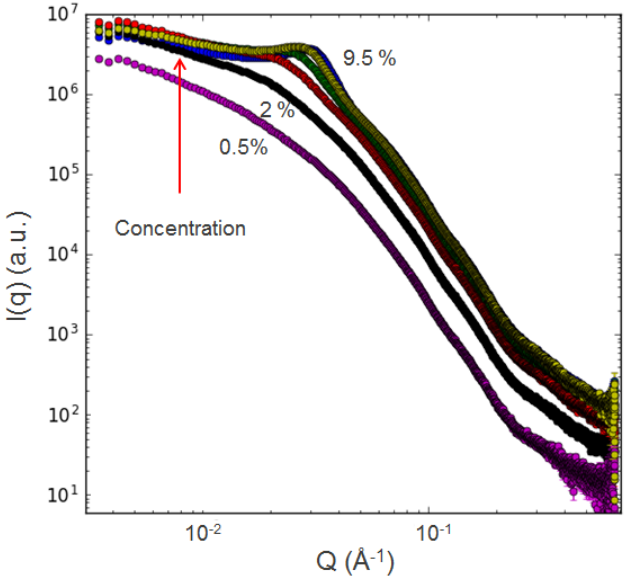
SANS
GKSS Geesthacht
Yellow Submarine BNC Budapest

Transformer oil based FF
OA monolayer
Steric
No excess surfactant

Aqueous FF samples
OA+OA & LA+LA
Electrosteric
Excess surfactant

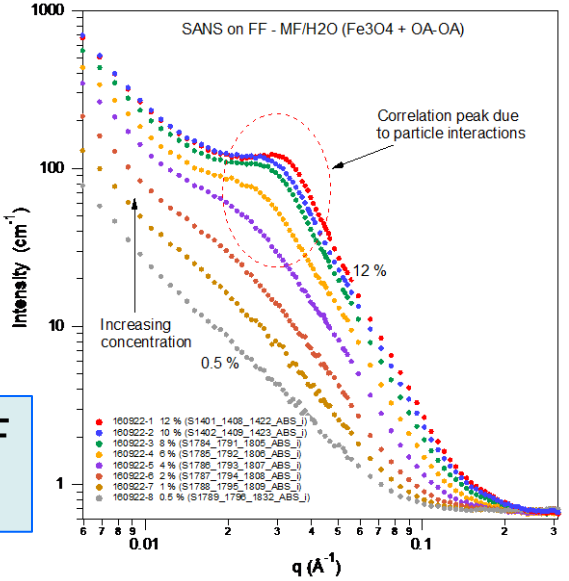


SANS
YuMo JINR Dubna
Yellow Submarine BNCBudapest



SAXS-DESY Hamburg

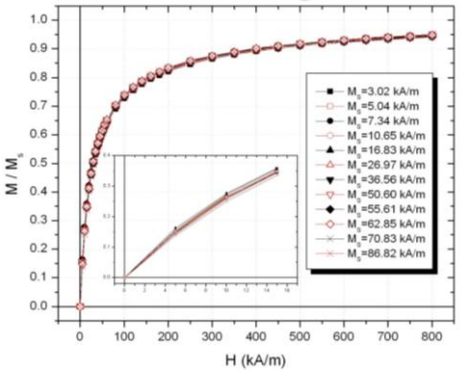
Aqueous FF
(OA+OA)



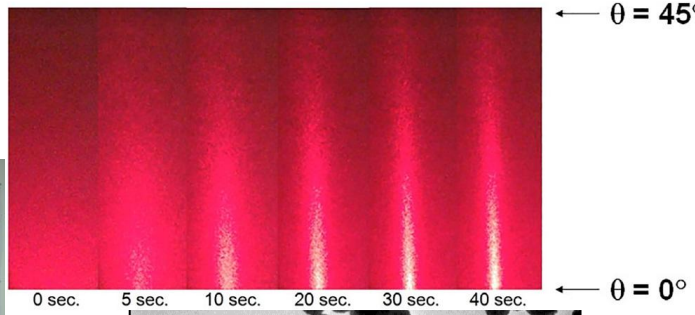
SANS-IFE Kjeller

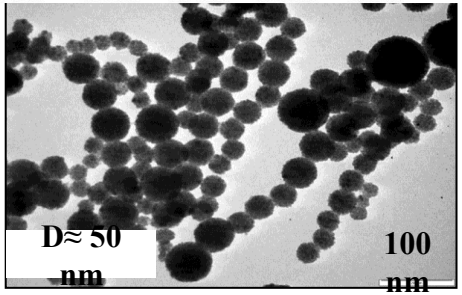
Magnetic properties, nanoparticle size distributions

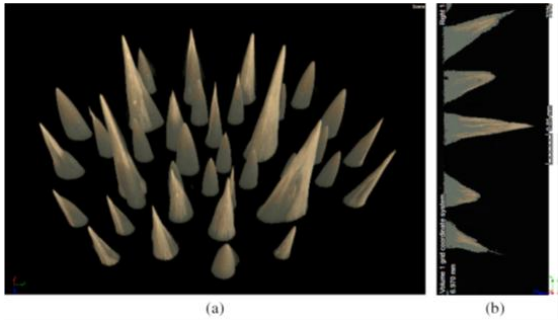
Ferrofluids, magnetic nanocomposites, nano-micro composite fluids
Magnetic, electronic microscopy and light scattering investigations

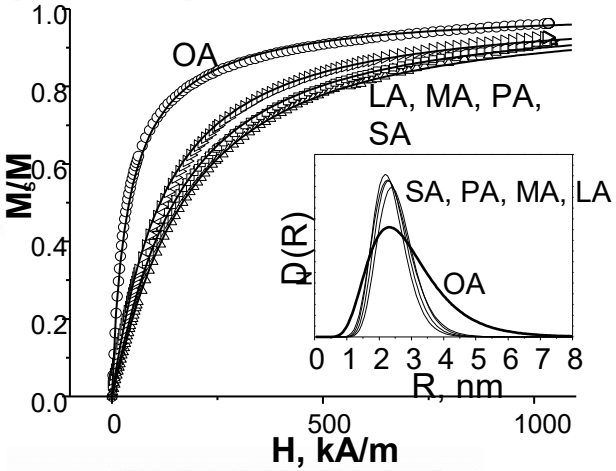


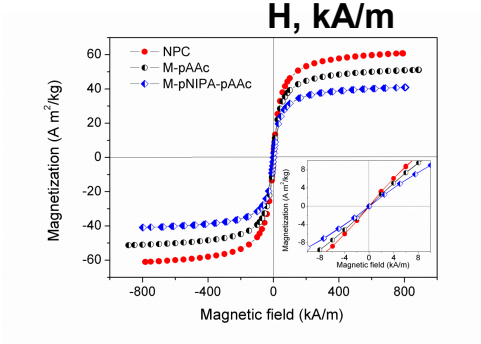
Dr. Vlad-Mircea Socoliuc
and collab.
Lab MF Timişoara

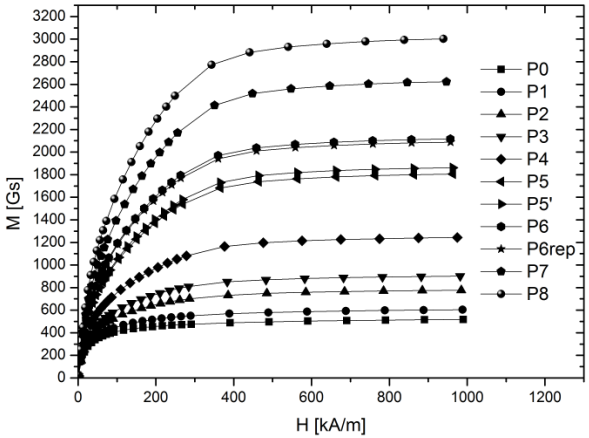


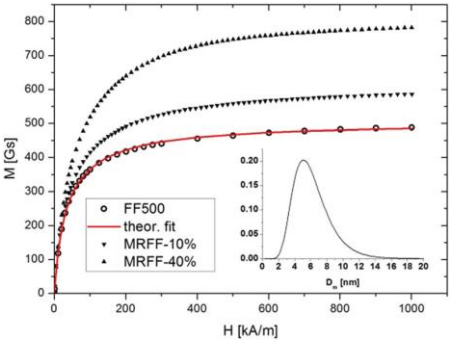








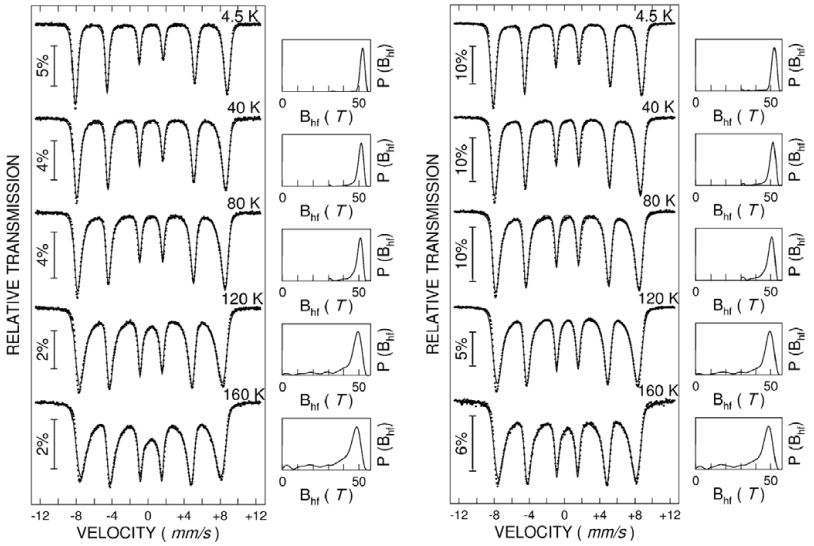




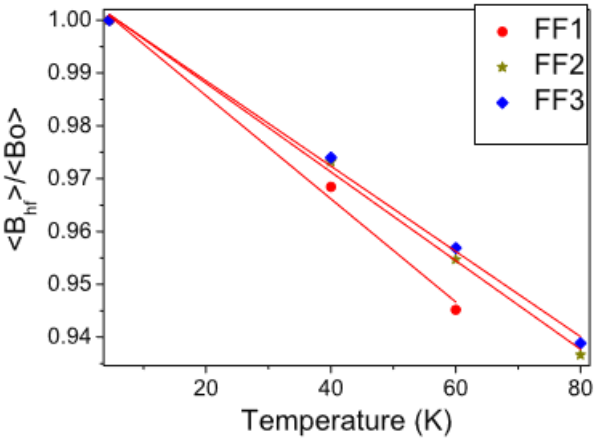
Nanomagnetism, Mössbauer spectroscopy

Colloidal stability, efficiency of screening particle interactions

Magnetoresponsive nanocomposites



- Increase of anisotropy energy
- Increase of the blocking temperature
- Increase of dipolar particle interactions



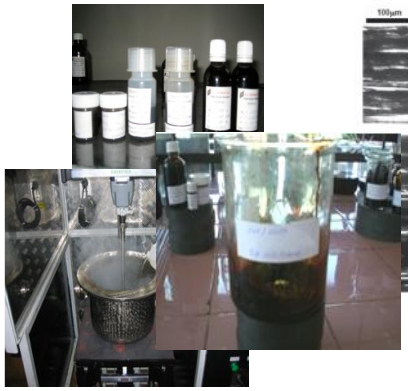
High magnetization and high colloidal stability engineering ferrofluids
Increasing MNP concentration-Effects of decreasing interparticle distance

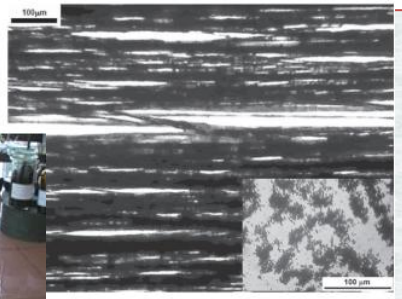
Group of Dr. Victor Kuncser
National R&D Institute for Physics of Materials
INCDFM Bucureşti-Măgurele

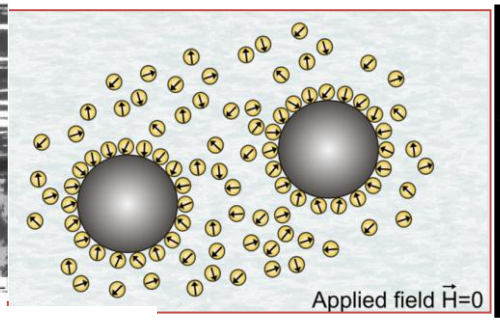
Follow the talk "**Changing magnetic dimensionality by assembling magnetic nanoelements. New functionalities and applications**"

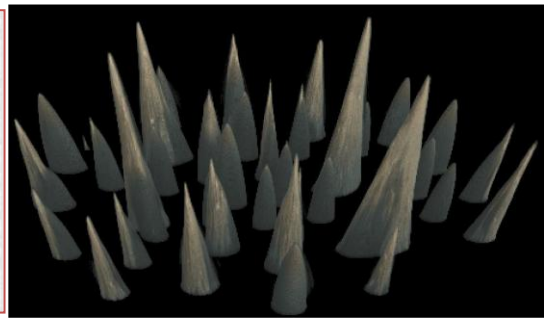
Flow properties-Magnetorheology

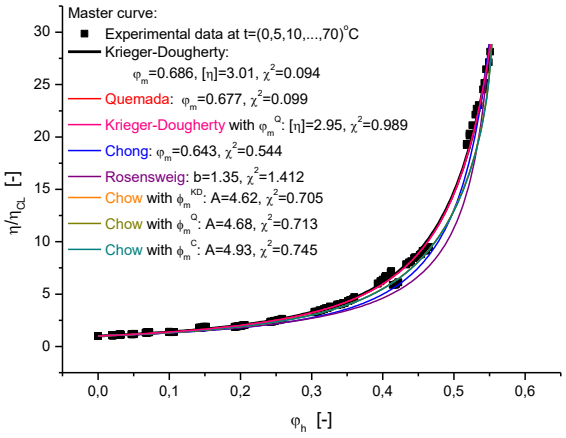
Ferrofluids, MR fluids, nano-micro composite fluids

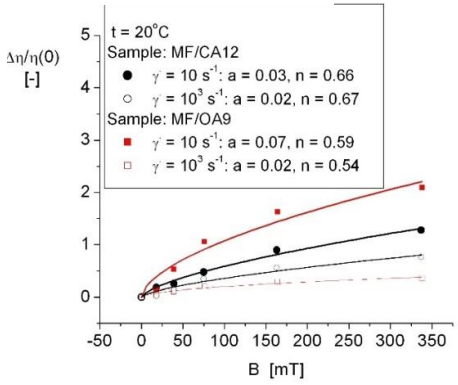


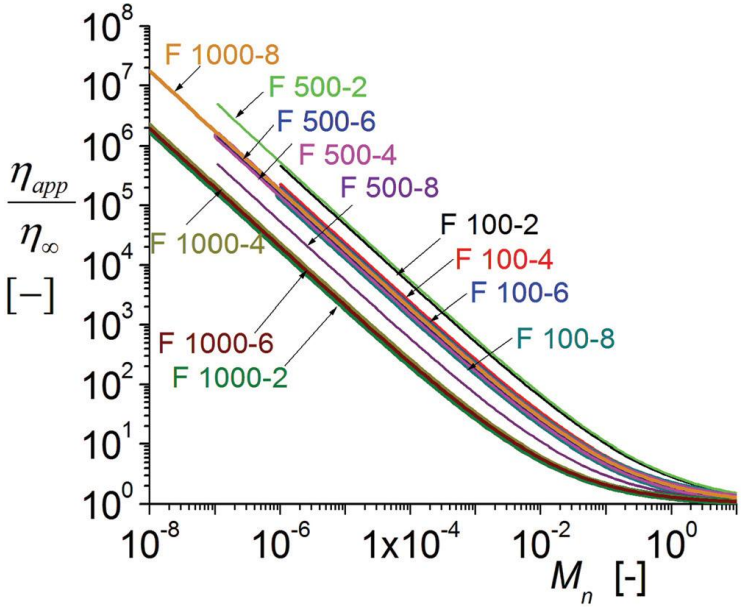












Prof. Daniela Susan-Resiga
and collab.
Lab MF Timişoara

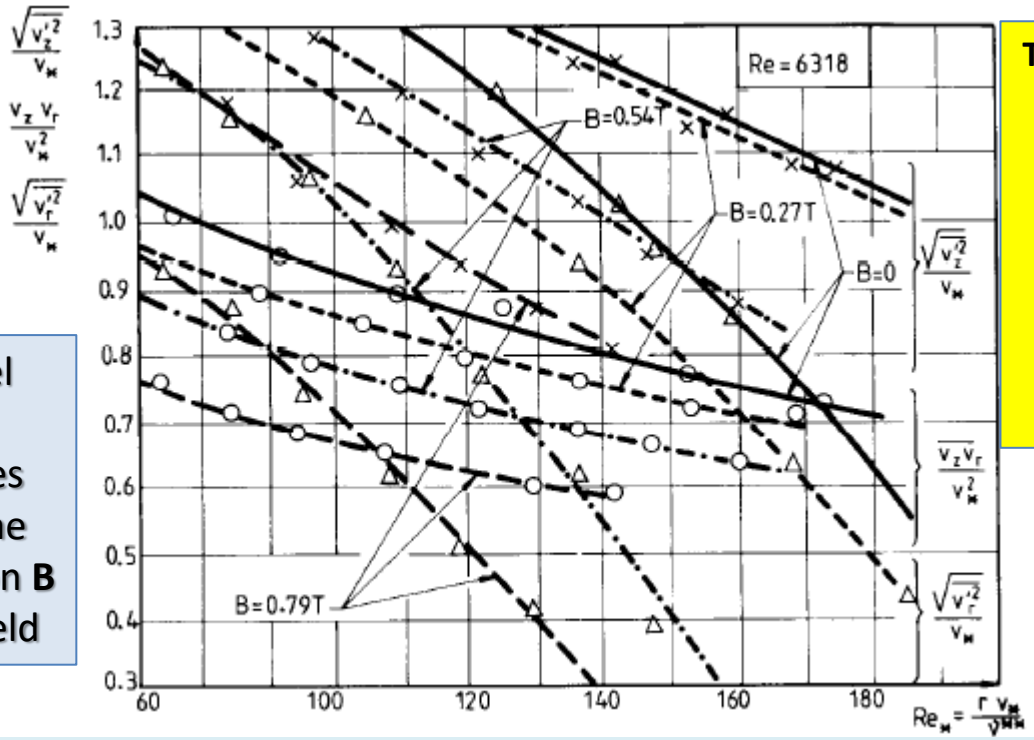
Follow the talk of Sebastian Muntean
"**Flow control in hydraulic machinery using nano-micro composite magneto-rheological fluids**"

Measurement of turbulence suppression due to a transverse magnetic field applied on a ferrofluid motion

J. Magn.Magn. Mater. , **1990**, 85, 137-140

Professor Anton I. Anton-DrHC of the University Politehnica Timişoara

Technical University of Civil Engineering, Bucharest



The advanced hotfilm measuring technique and experimental methodology used successfully overcome difficulties in achieving turbulent regimes in ferrofluids (due to high FF viscosity) and in characterising the flow (due to FF opacity)

Turbulence level and Reynolds stresses decrease with the magnetic induction **B** of the applied field

Magnetic field controlled turbulence in quantum ferrofluids in the absence of viscosity and quantization of vorticity

Quantum Ferrofluid Turbulence

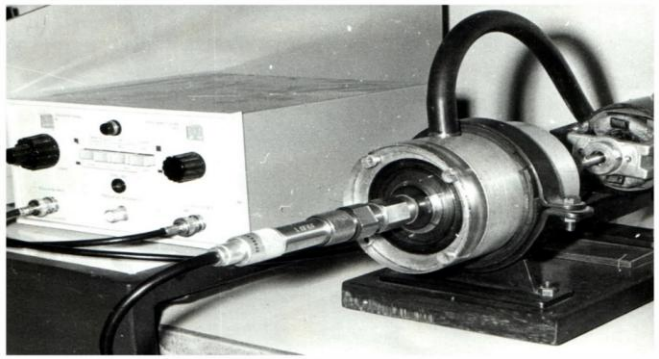
T. Bland, G.W. Stagg, L. Galantucci, A.W. Baggaley, and N. G. Parker

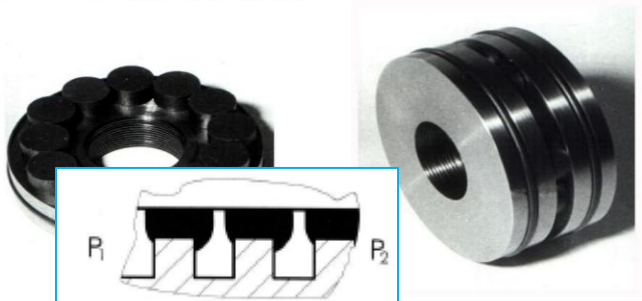
PHYSICAL REVIEW LETTERS, **2018**, 121, 174501

Joint Quantum Centre Durham, Newcastle University, Newcastle, UK

Early started applications

The first leakage-free magnetofluidic rotating seals





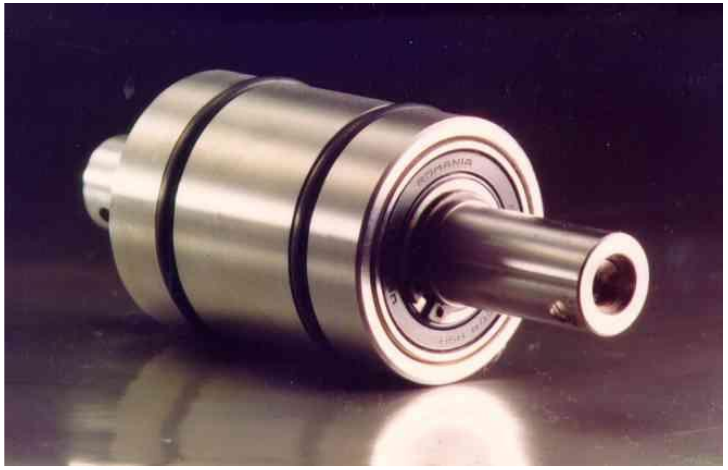
A completely new sealing technology in Romania- starting in 1979

CS ing. Iosif Potencz, CS ing. Emilian Suciu†

Asist. cercet. George Giula

I. Potencz et col Patent RO 87422 (1984)

Anton I.† and coworkers, *Experimental researches in ferrohydrodynamics*, **VIth Conf.Fluid Machinery, Budapest, vol.1, 29-38(1979);** *Magnetic fluid seals: some design problems and applications*, **J.Magn.Magn.Mater., 65, 379-381 (1987)**



MF rotating feedthrough for high power electric switches with SF6

High power electric transformers

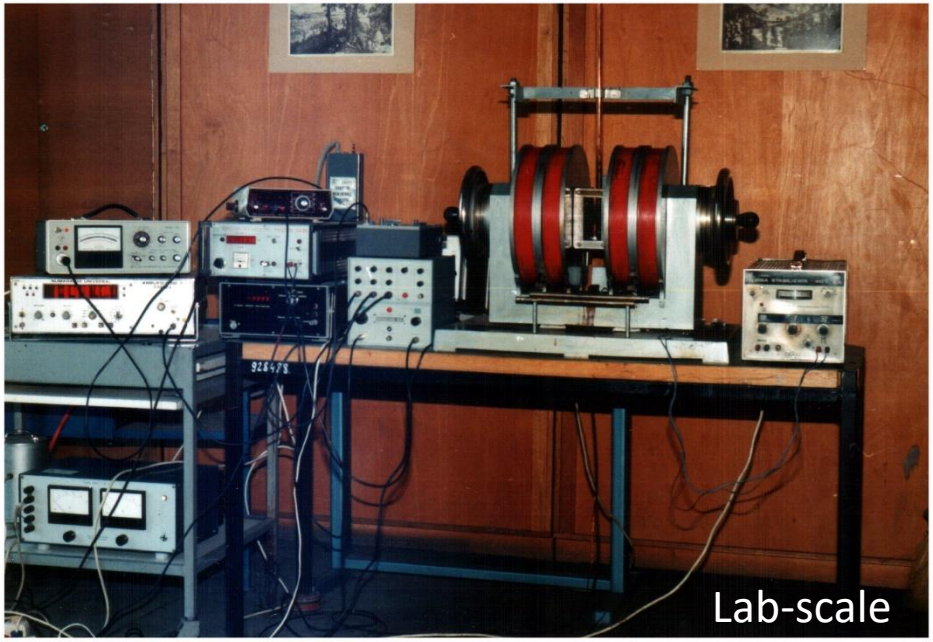
MF rotating feedthrough for high vacuum Crystal growth equipment

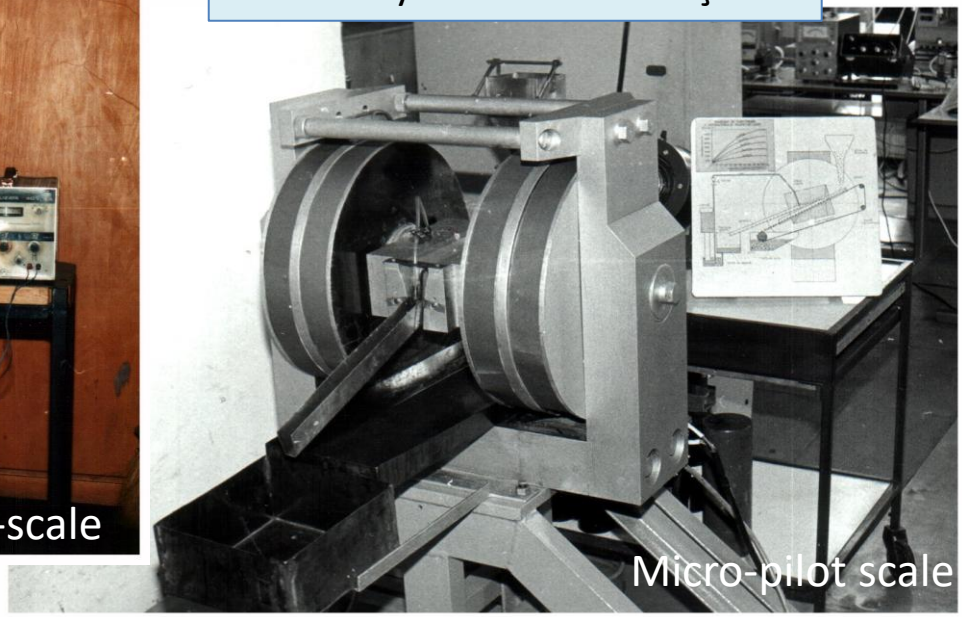
Fac. Physics West Univ Tms; ICMET Craiova; ICPE București; IAEM Tms; ROSEAL Co

Magnetogravimetric separator with ferrofluid for non-ferrous minerals and electrotechnical waste

Cooperation with the **Institute of Research for Nonferrous Minerals-Baia Mare (1980-1992)**
Project leader (1980-1984) Dr.Eng. Lucian Borduz (later at Ferrofluidics Co. USA)

Graduate with excellent results of the Fac. Industrial Chemistry University Politehnica Timişoara





First order magnetofluidic levitation
Continuosly variable apparent density between large limits (1-20 g/cm3)

Waste separation-using FFs
A recent development in Amsterdam
See: Ben Ernè, book ch (RSC) (to be published)

Anton I., Ilie P. and collab *Magnetodensimetric separator* Patent RO 101687 (1992)
Anton I., Ilie P. and collab. *Separation of metals from electrotechnical waste* , Patent RO 103720 A (1992)

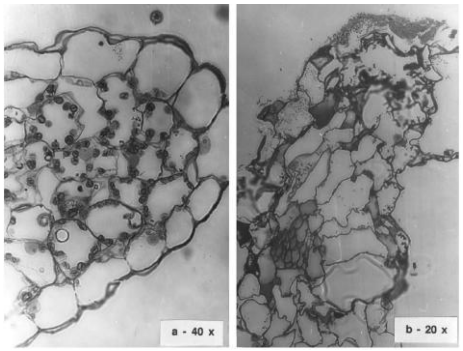
Biomedical applications of magnetic fluids

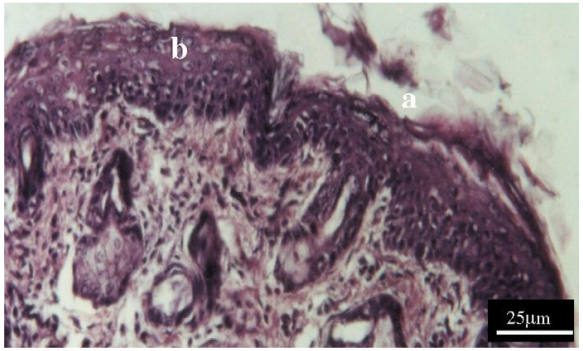
MNP influence on plant cell growth-simulated hypogravity conditions

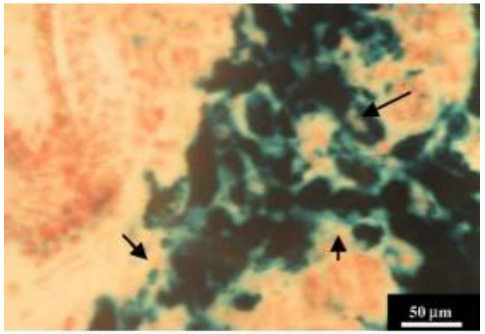
Magnetic nanocomposites for radiation protection, effects on tumor cells

Cooperation with Banat University of Agricultural Sciences

Research groups of Prof. Gallia Butnaru and Prof. Mariana Şincai

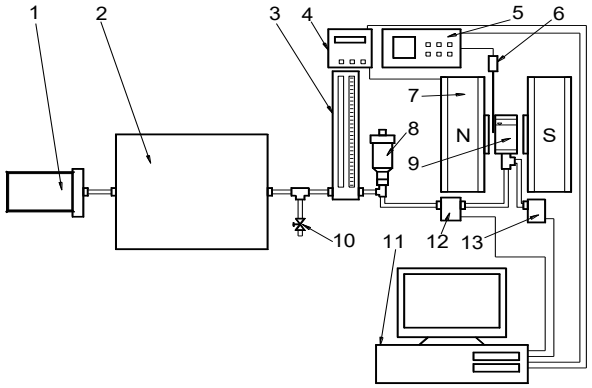


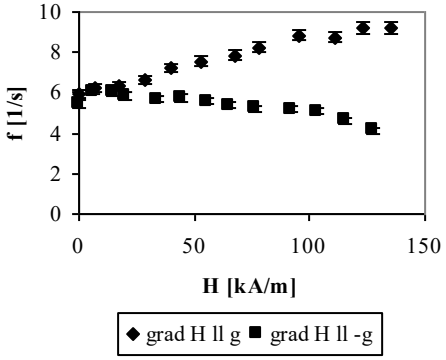


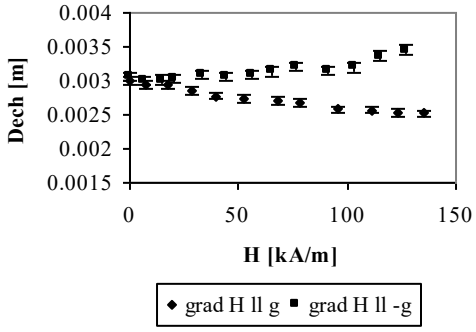


Magnetic fluids in heat transfer processes

Bubble dynamics controlled by magnetic field



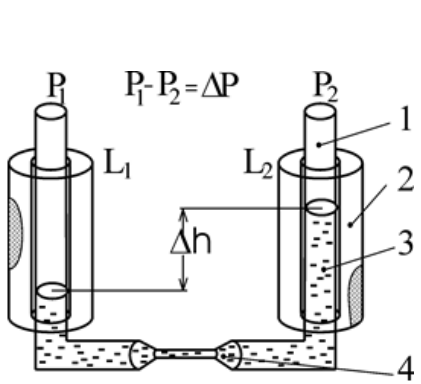


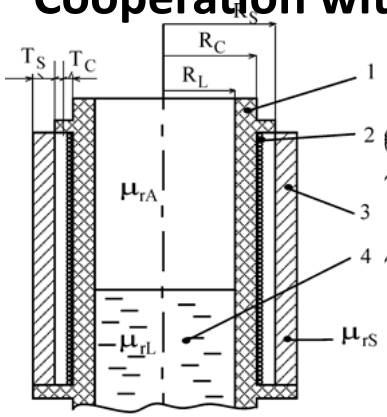


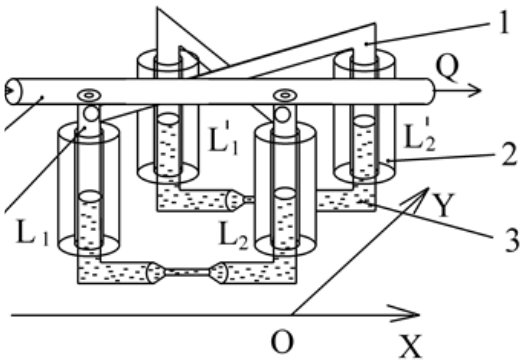
Prof. Floriana Stoian and collab. Univ. Politehnica Timişoara

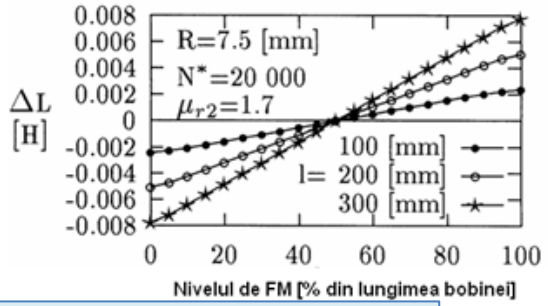
Inductive transducers with magnetic fluids

Cooperation with AEM Timișoara 1986-1992

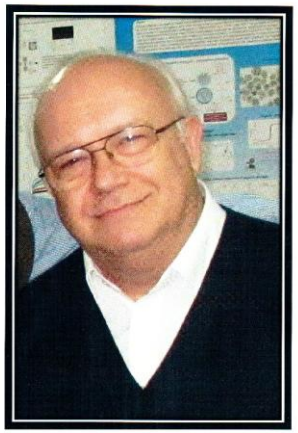








Pressure difference;
Gas flow; Inclination angle



Dr.eng. Nicolae C. Popa (1955-2021)

Over 20 publications&patents

Rev. Roum. Sci. Techn. Mec. Appl. (1985); Sensors and Actuators A, 32(1992); 59(1-3)(1997); (1997); IEEE Transactions on Magnetics, 30(1994); J.Magn.Magn.Mater., 201 (1999) ; SPIE Proceedings Volume 4946(2003); Int.J.Appl. Electromagn. Mech.(2004; 2008); Phys.Stat.Sol.(2004); RomRepPhys 58(2006); Sensors Lett. (2007); Patents RO 98430 (1989); RO 98431(1989)

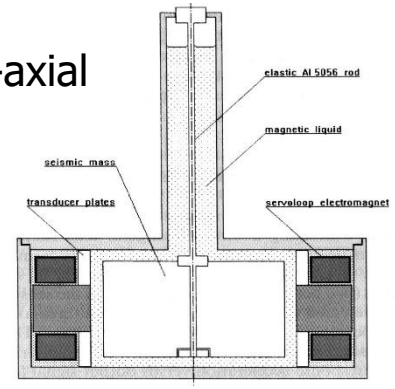
LMF 1975-2025

Inertial sensors with magnetic fluids

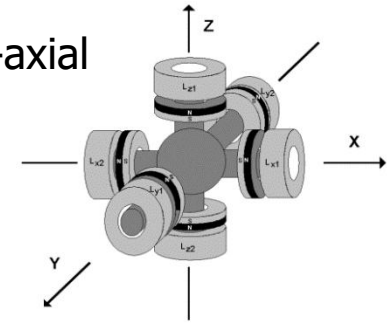
National Institute for Research and Development in Electrical Engineering (ICPE) Bucuresti
Institute for Gravitation and Space Sciences (IGSS) Bucuresti

Accelerometers with FF

Bi-axial



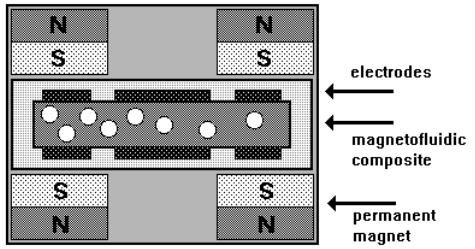
Tri-axial

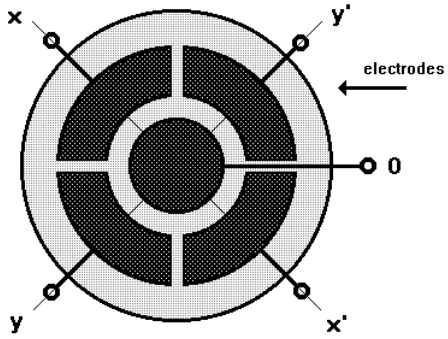


First and second order magnetofluidic levitation effects

Research group of Dr. Marius-Ioan Piso

Accelerometer with MF composite





High sensitivity **10^{-6} - 10^{-9} m/s²**

Large domain of accelerations **10^{-3} - 10 m/s²**

Patent RO 86751 (1985); Patent RO 99036 (1992); *Magnetofluidic inertial sensors*, **RomRepPhys, 47(1995);** *Applications of magnetic fuids for inertial sensors*, **JMagnMagnMater, 201 (1999);** *Magnetic fluids composites and tools for microgravity experiments*, **JMagnMagnMater, 201 (1999).**

Professor Ioan DeSabata† (1928-2006)

Outstanding teaching activity 44 years
"Fundamentals of Electrotechnical Engineering"
Vice-Rector of the
University Politehnica Timişoara (1966-1976)
Member of the Technical Sciences Academy of Romania (1998-)

Research fields: Hall effect and sensors, Ferrofluids

Scientific adviser of PhD students in the field of *Ferrofluids and applications*
Adrian Colţeu, Mircea Rădulescu, Barbu Nicoară†,
Constantin Blaj, Marian Greconici, Nicolae C. Popa†

FERROFLUIDS: Magnetic properties and forces, ferrohydrodynamics, magnetic fluid seals and bearings, magnetogravimetric separators, inductive sensors
Over 30 publications

Bul. St. Techn. IPT, 29(43) 1-10 (1984) ; Rev.Roum.Sci.Tech.-Mec.Appl., 30(2-3) 237 (1985); J. Magn. Magn. Mater., 65, 379-381 (1987); Rev.Roum. Sci. Techn.-Mec.Appl., 34, 13-19 (1989); J. Magn. Magn. Mater., 85 (1-3) 219-226 (1990); Sensors and Actuators A, 32, 678 – 681 (1992); Romanian Reports in Physics, 47(3-5) 387-396 (1995);J. Magn. Magn. Mater., 201, 385-390 (1999) Rev.Roum.Sci.Techn.-Electrotechn.et Energ., 46(1) 79-88 (2001).

Engineering and biomedical applications

Scientific partnerships

For details follow the talk of Vlad-Mircea Socoliuc

Applied Research-Lab Magnetic fluids Timişoara

Ferrofluids. Magnetorheology

Long-term cooperation

Dept. Applied Physics-Ludwig Maximilians University Munich

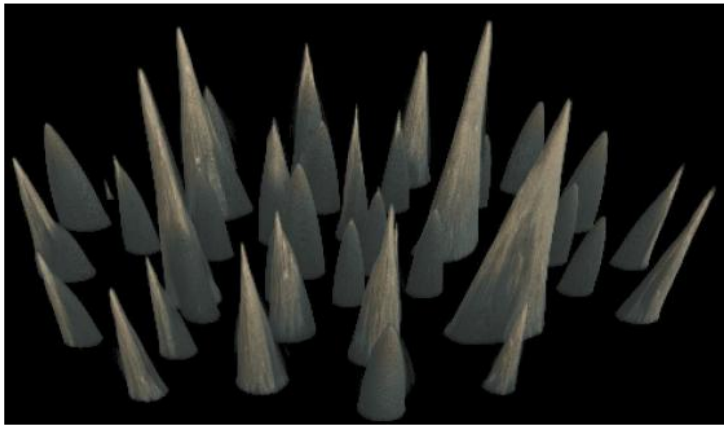
Prof. Klaus Stierstadt-Dr. Honoris Causa-University Politehnica Timişoara 30.06.1998

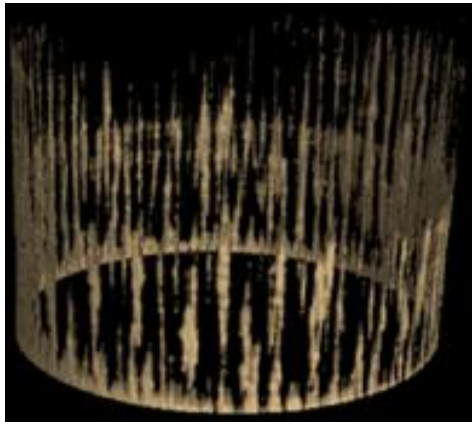
Prof. Stefan Odenbach-Institute of Fluid Mechanics

Faculty of Mechanical Science and Engineering, Technical University Dresden

Starting with 1993 DAAD and EU grants

Ferrofluid-Rosensweig surface instabilities





Tünde Borbáth (ROSEAL Co)-PhD period at TU Dresden

Ferrofluid based MR fluid-Stable spikes in non-uniform magnetic field similar to Rosensweig surface instabilities

A unique feature specific to FF based MR fluids

T Borbáth, I Borbáth, S Günther, O Marinică, L Vékás, S.Odenbach, **Three-dimensional microstructural investigation of high magnetization nano–micro composite fluids using x-raymicrocomputed tomography**, Smart Materials &Structures,23(**2014**); T Borbáth, S Günther, D Yu Borin, Th Gundermann and S Odenbach, **XμCT analysis of magnetic field-induced phase transitions in magnetorheological elastomers**, Smart Materials& Structures, 21(**2012**);
M. Schott. L. Vékás, Doina Bica, I. Potencz, V. Sofonea, **Rheological and magnetorheological behaviour of various magnetic fluids**, Magnetohydrodynamics, 33(1) (**1997**)

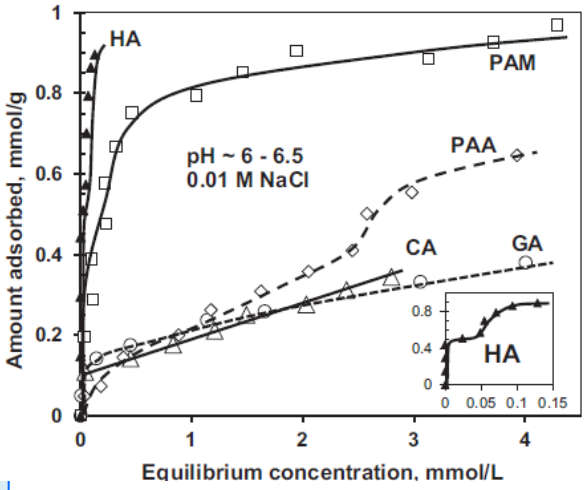
LMF 1975-2025

Stabilization of magnetite NPs in biorelevant aqueous media

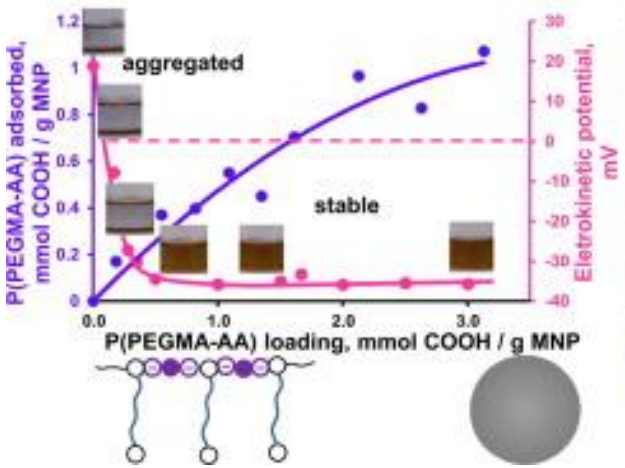
Aqueous ferrofluids for biomedical applications

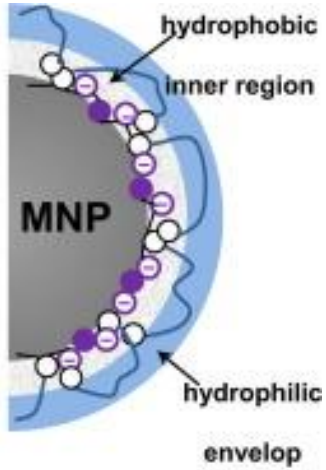
HA-humic acid
PAM-poly(acrylic -co-maleic acid)
PAA-polyacrylic acid
CA-citric acid
GA-gallic acid

Aqueous colloids
Univ. Szeged
INCDTIM Cluj-Napoca
Lab. MF Timisoara



Adsorption isotherms of polyacids on magnetite





Copolymer-free carboxylate (acrylic acid, AA) and PEG segments arranged in a comb-like structure- **P(PEGMA-AA)**

Magnetic iron oxide nanoparticles: Recent trends in design and synthesis of magnetoresponsive nanosystems
E. Tombácz, R. Turcu, V. Socoliuc, L Vékás, Biochemical and Biophysical Research Communications, 2015

P(PEGMA-AA)-Efficient electrosteric stabilization of magnetite NPs and nanoclusters for pH>4:

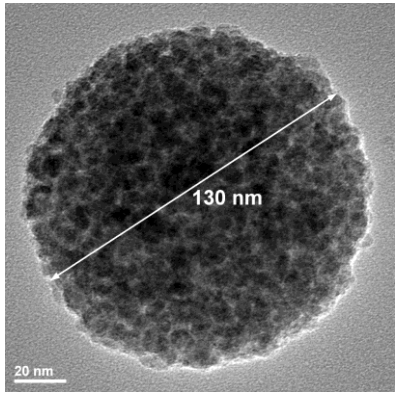
- electrostatically via the carboxylate moieties and sterically via the PEG moieties
- surface coating provide high protein repellency via the structured PEG layer
- anchor bioactive proteins via peptide bond formation with the free carboxylate groups

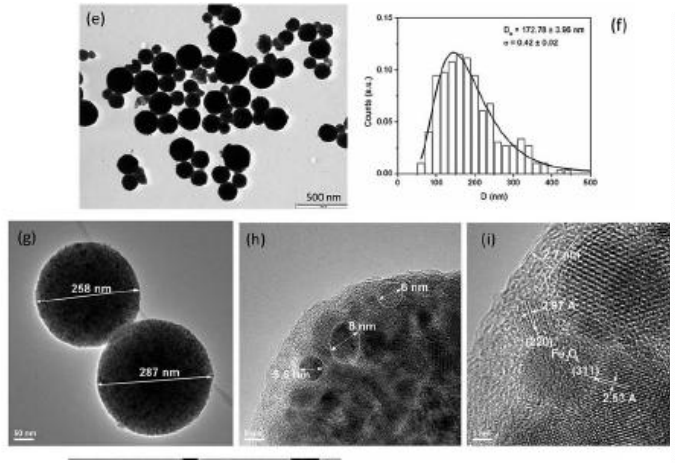
Group of Prof. Etelka Tombácz and Assoc.Prof. Erzsébet Illés, University of Szeged

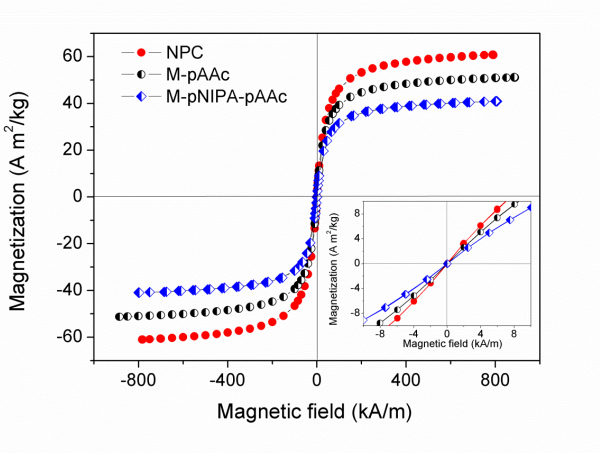
Follow the talk "**Colloidal stability of nanomagnets in biorelevant media, challenges and experiences in the past decades**"

Functionalized magnetic nanoparticle composites and applications

Magnetic separation of high value biomaterials







Miniemulsion procedure-Assembling hydrophobic oleic acid-coated Fe3O4 nanoparticles from toluene-based FF into water-dispersible nanoparticle clusters

FP7-MagPro2Life
2009-2013

Group of Dr. Rodica Turcu
National Institute for R&D of Isotopic and Molecular Technologies Cluj-Napoca

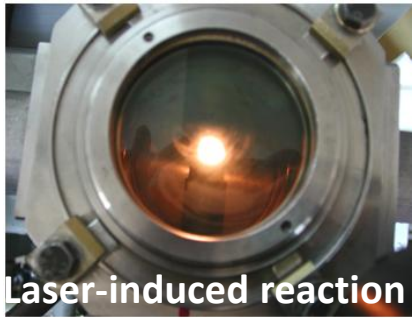
Fischer I. et al.,
J. Chromatography A1305(2013)

Follow the talk of
Izabela Crăciunescu, Rodica Turcu
Two decades
of Magnetic Nanomaterials:
Innovation through partnership

Magnetic support (Manufacturer)	Description of particle materials for protein purification	Mean size (nm)	Flow rate (L/h)	Separation efficiency (%)
MagPrep Silica 25 (Merck KGaA)	Magnetite crystals coated with a thin layer of silica	25	5	>95
MagPrep SO_3 100 (Merck KgaA)	Magnetite crystals coated with a thin layer of silica	100	5	>99
Poly(NIPA-co-AAc) (INCDTIM Cluj-Napoca, Romania)	Magnetite embedded within a poly(N-isopropylacrylamide-co-acrylic acid) matrix	200	9	**>99**
M-PVA-DEAP (PerkinElmer Chemagen Technologie GmbH)	Spherical beaded polyvinyl alcohol – magnetite composite particle functionalized with diethylaminopropyl groups	2000	9	>99

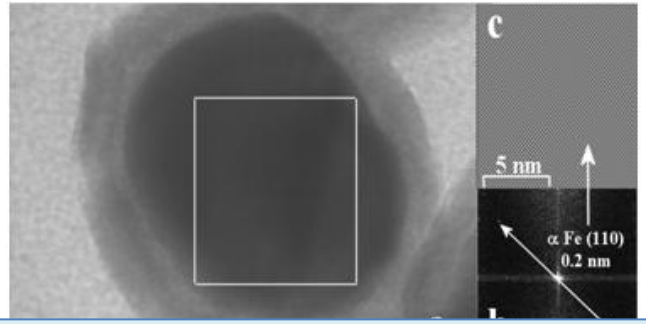
Iron/iron oxide/carbon nanocomposite particles by laser pyrolysis

Group of Dr. Ion Morjan,
Dr. Florian Dumitrache
National Institute for Laser,
Plasma & Radiation Physics
INFLPR Bucharest-Măgurele



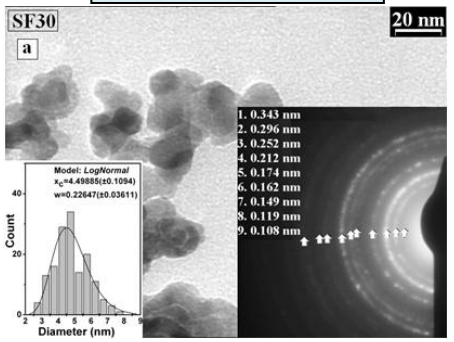
Thermal decomposition
Gas phase laser pyrolysis

x_c~4.5 nm

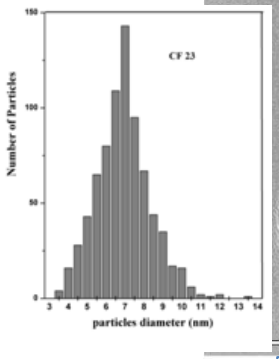


Iron-Iron-oxide core-shell nanoparticles (14 nm core, 4.5 nm shell)

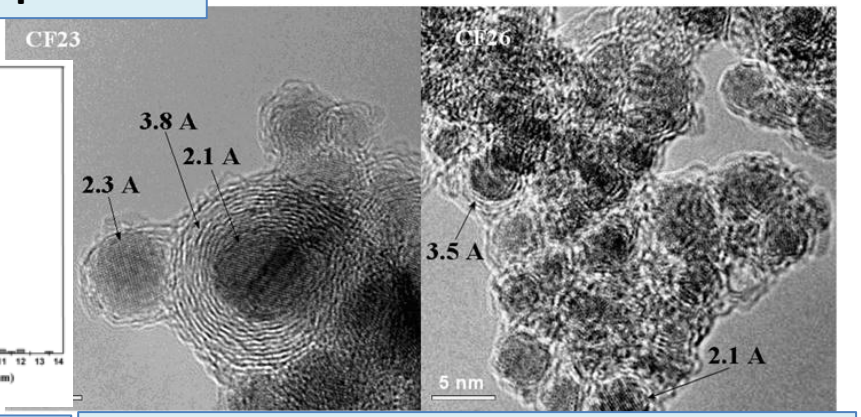
Collected γ-Fe2O3 dry nanopowder



Follow the talk
Florian Dumitrache, Claudiu Fleacă
Magnetic Nanoparticles synthesized by laser pyrolysis: morpho-structural properties and applications



3.5-10.5 nm



Iron-Carbon core-shell nanoparticles

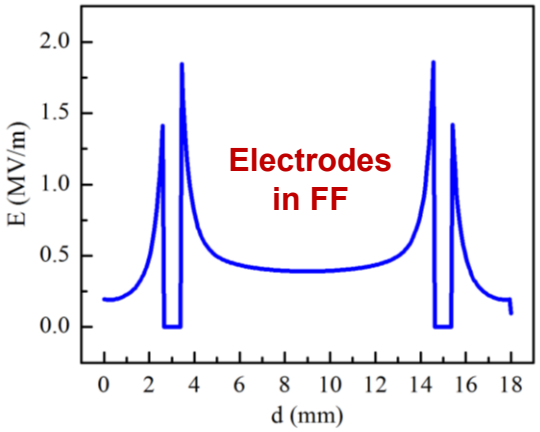
Ferrofluids-electrical insulating and cooling fluids

Power transformer

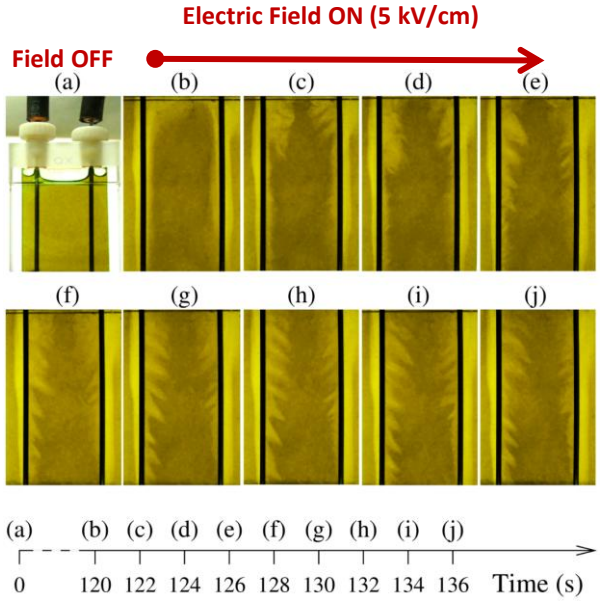
Electrical insulation and cooling
Safety and reliability
Reduced size and mass
Economic considerations

Most of collapses originated in the insulation failure

Transformer oil based ferrofluid- a possible insulating/cooling fluid for electric transformers



Group of
Dr. Peter Kopčanský
Dr. Milan Timko
IEP Kosice



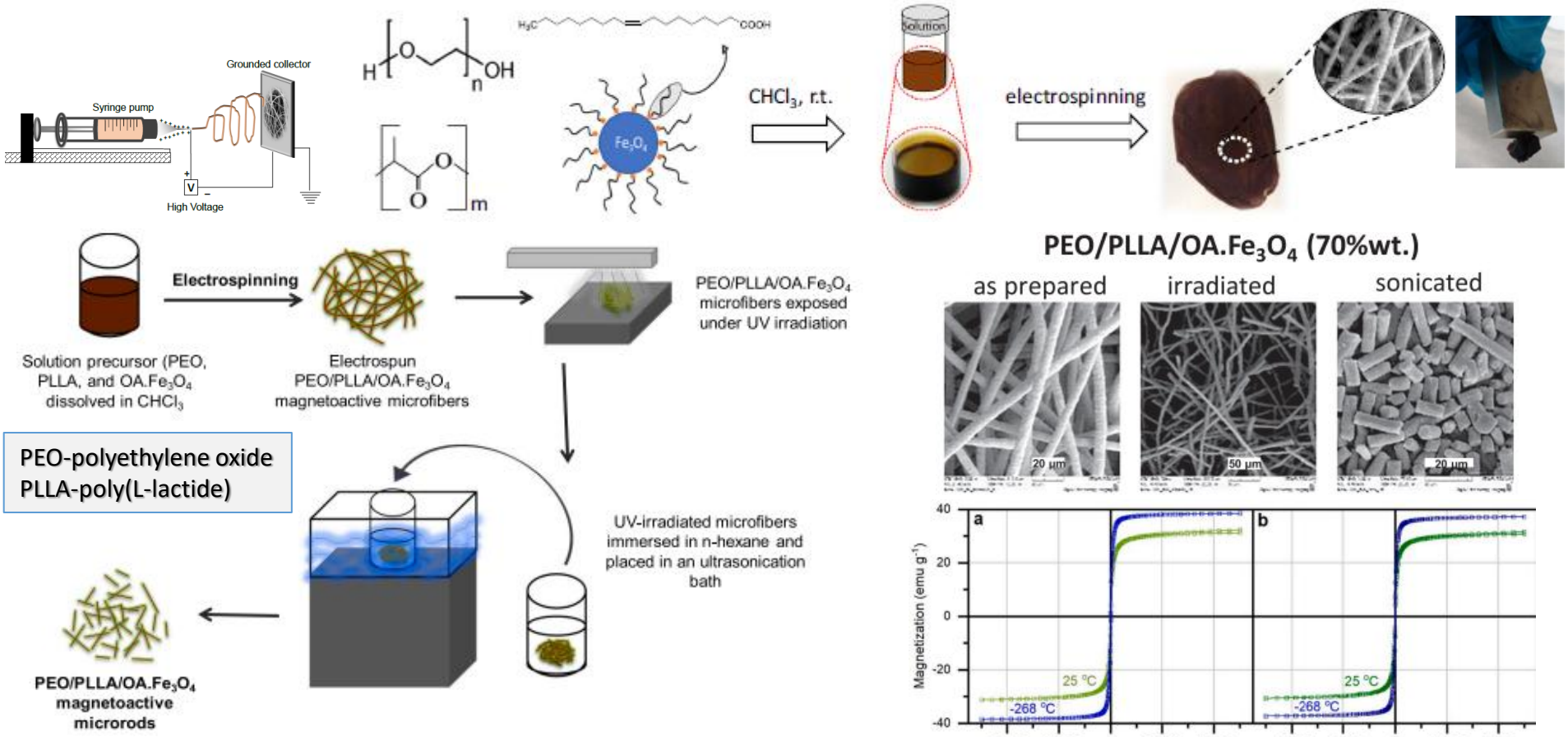
Electrohydrodynamic pattern formation and evolution in a ferrofluid

- Electric field induced MNP aggregation
- Critical field-triggering aggregation
- Percolative MNP structures
- Increased electrical breakdown field (?)
- Improved heat transfer properties

Follow the talk
Magnetic fluids and their composites

Magnetoresponsive biodegradable fibrous membranes and microrods

Volatile organic (chloroform, tetrahydrofuran) ferrofluid mediated synthesis

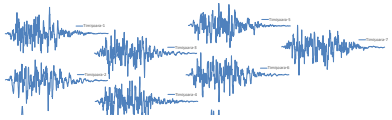


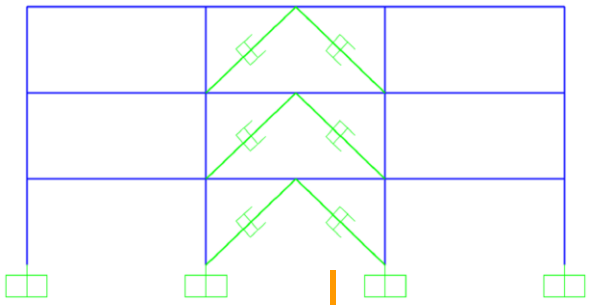
Group of Prof. Theodora Krasia-Christoforou
Dept.Manufacturing Engineering, University of Cyprus

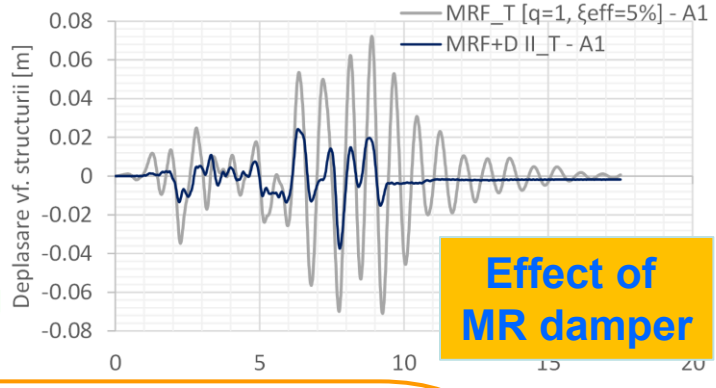
Follow the talk "**Romania–Cyprus Synergy in Magnetic Polymer Nanocomposites: A 20-Year Collaborative Journey**"

LMF 1975-2025

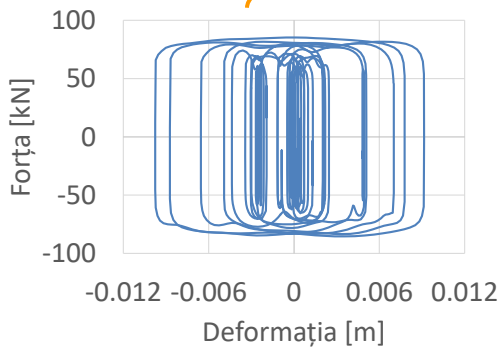
Semi-active MR dampers for seismic protection

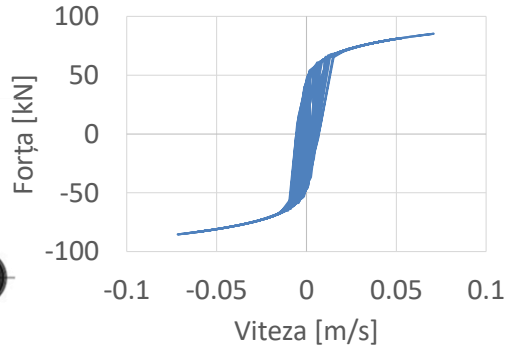


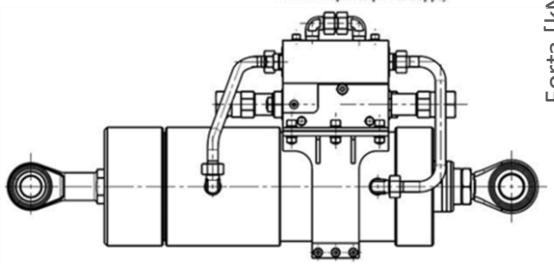




Effect of MR damper



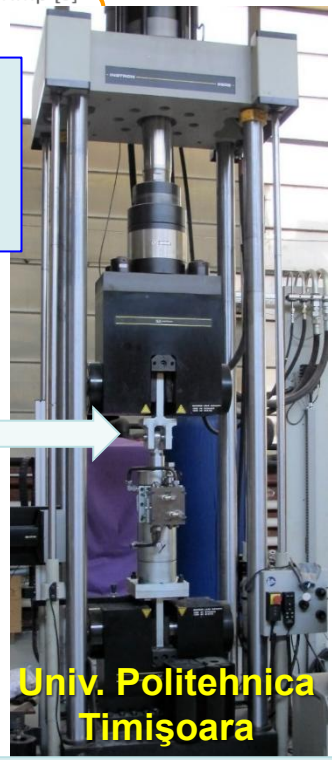




MR damper using Ferrofluid based nano-micro MR fluid

Set-up for the experimental investigation of a **Hybrid BRB- MR seismic protection system**
10 tf capacity

BRB
Buckling Restrained Brace

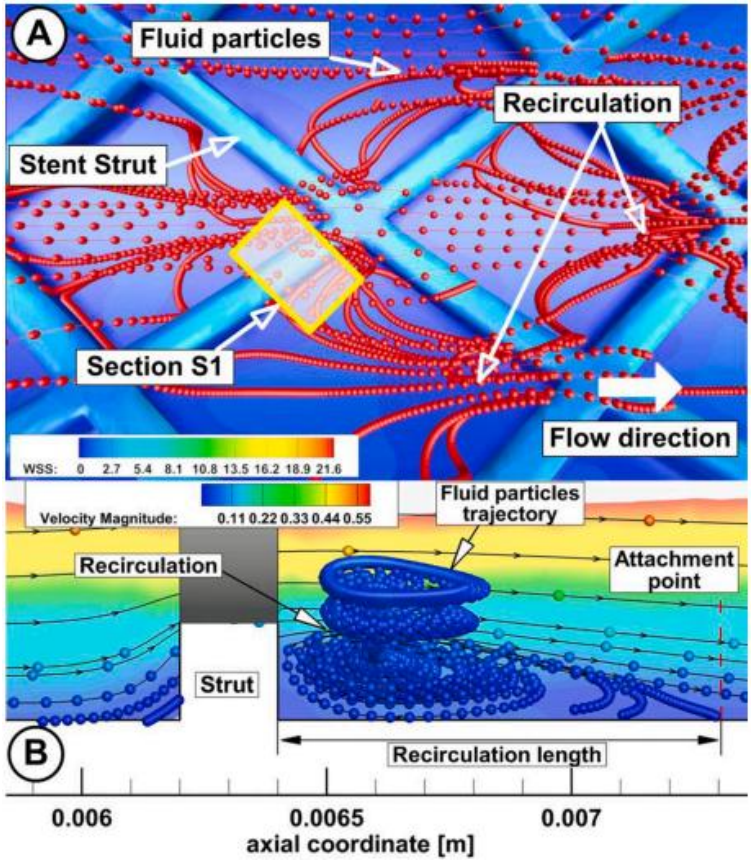


Group of Prof. Dan Dubină, member of the Romanian Academy
University Politehnica Timișoara, Faculty of Civil Engineering

Project **Semnal MRD**
PN-II-PT-PCCA
2014-2017

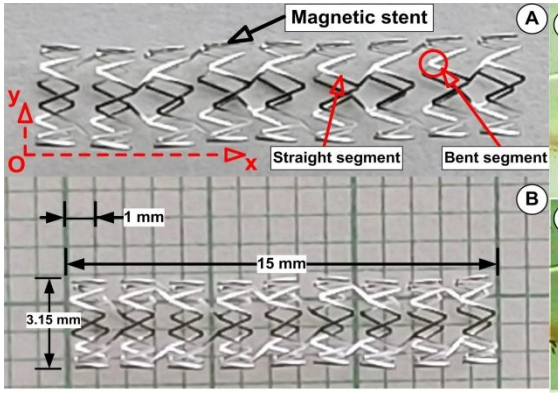
Ferromagnetic stent targeting by functionalized magnetoresponsive nanocomposite particles

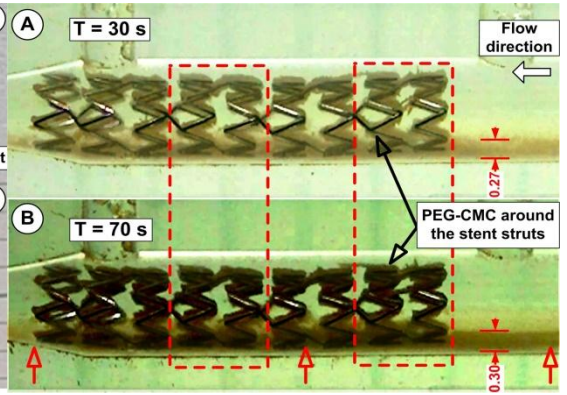
Numerical simulation of the flow

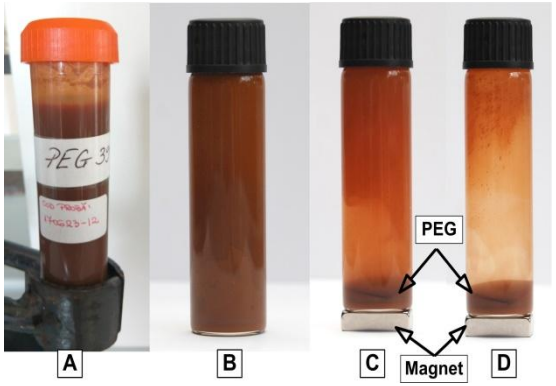


Experimental testing--Bio-ferrofluid

PEG functionalized
Fe3O4 NP clusters in aqueous suspension







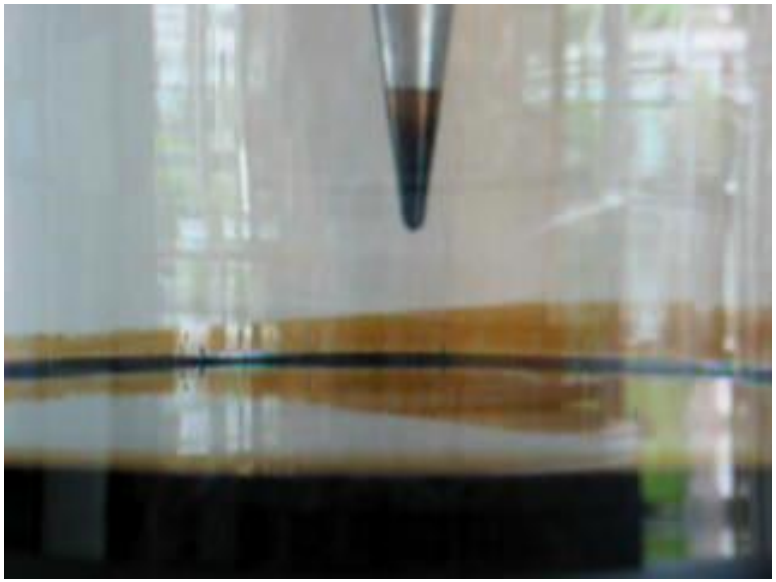
CFATR-Timişoara
INCDTIM Cluj-Napoca
Mayo Clinic, Rochester
University of Szeged

Project PED
MNPs2STENT
2022-2024

Dr. Sandor Bernad and collab.
Lab Hydrodynamics and Cavitation
CFATR Timişoara

Magnetic colloids and ferrofluids

Long-term cooperation - Lab van't Hoff Physical&Colloid Chemistry
Prof. Albert P. Philipse – University of Utrecht



Mineral oil based Ferrofluid
Doina Bica†-Lab MF Timişoara
Exponate-100 years anniversary of the van't Hoff Laboratory 2004

University of Utrecht

PhD theses

Gerard van Ewijk 2001
Karen Butter 2003
Mark Klokkenburg 2007
Maria Claesson 2007
Bob Luigjes 2012

Dr. Mircea Raşa

Post-doc periods-Lab van'tHoff
2000-2004

Albert P. Philipse, Colloid Science
Oxford Univ. Press, 2026

Follow the talk
Thermodynamic structure formation in colloidal dispersions of single – domain magnetite nano - particles

Steps toward industrial scale

ROSEAL Co. Odorheiu Secuiesc

Magneto-fluidic rotating seals

Started in 1982 (IMPF)

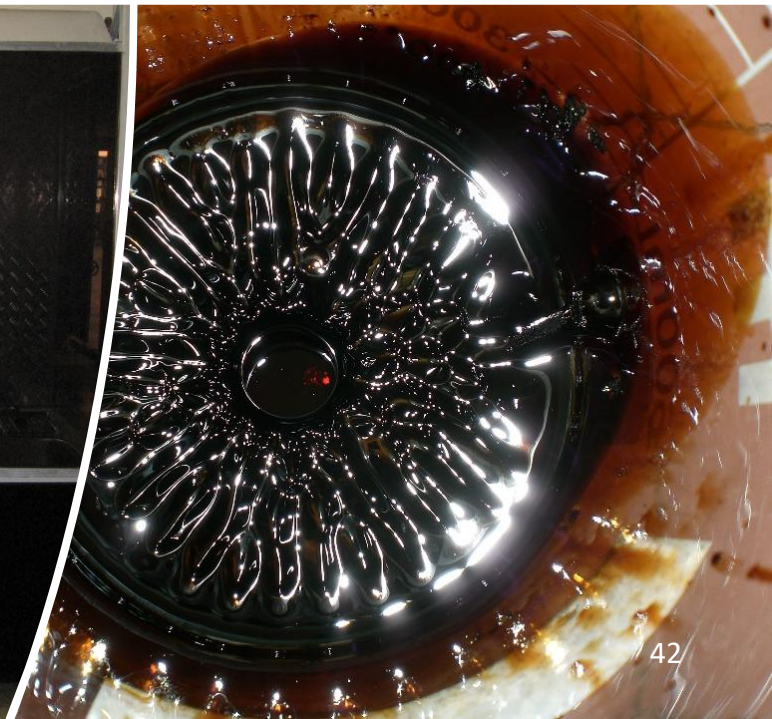
Micro-pilot scale synthesis of ferrofluids

Group of General manager Ing. István Borbáth

Technology transfer

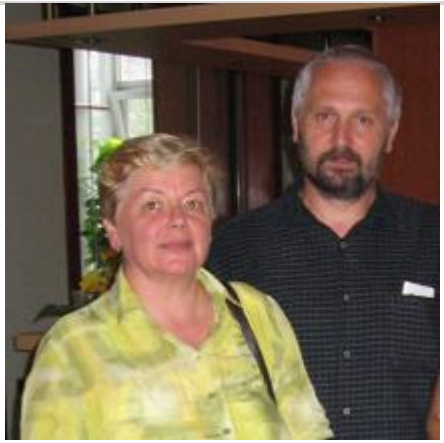
Lab Magnetic Fluids to ROSEAL Co.

2006-



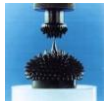
2007

Technology transfer Lab Magnetic Fluids-ROSEAL Co.



LMF 1975-2025

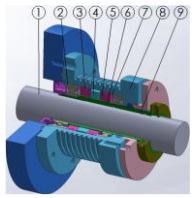
Leakage-free rotating seals with magnetic fluid

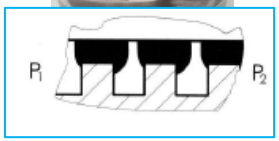


Lab Magnetic Fluids Timişoara

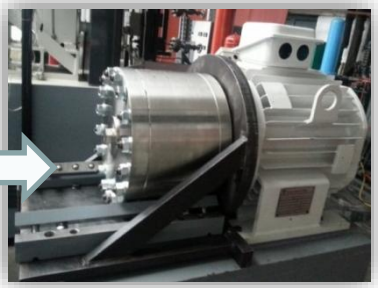
Technology Transfer

ROSEAL Co



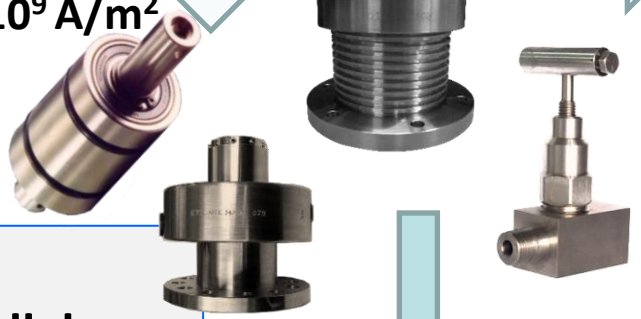


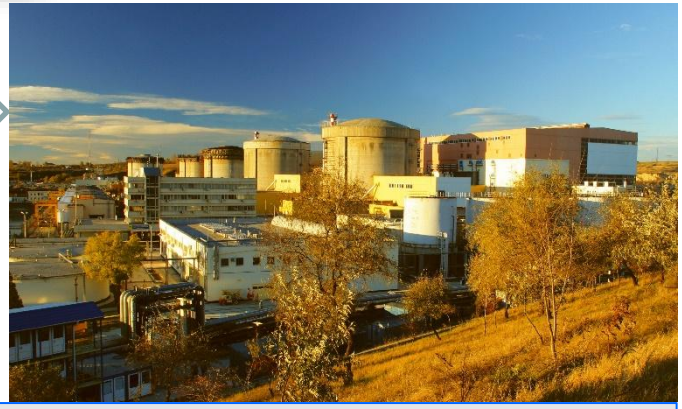
Magnetic fluid seals
Qualification for Environment, Radiation and Thermal resistance
MF Long-term colloidal stability in high gradient magnetic field



$B \approx 1.1\ T;\ |gradH| \approx 10^8 - 10^9\ A/m^2$

Fans, blowers, compressors
High power electric switches
Vacuum technology





Cernavodă Nuclear Power Plant-Units 1 and 2 (CANDU) Equipped with MF seals (2012-)

Follow the talk
Tünde Borbáth and collab.
High quality ferrofluids and leakage - free rotating seals. Technology transfer, developments and perspectives

Highly efficient reduction of tritium escape much below the admissible level, resistance to radiation and long-term (over 12 years) maintanence-free operation

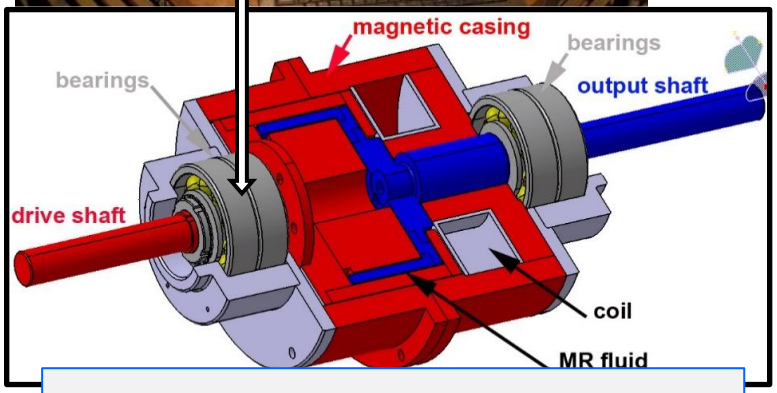
MHD flow control in hydraulic turbomachines

Recent developments

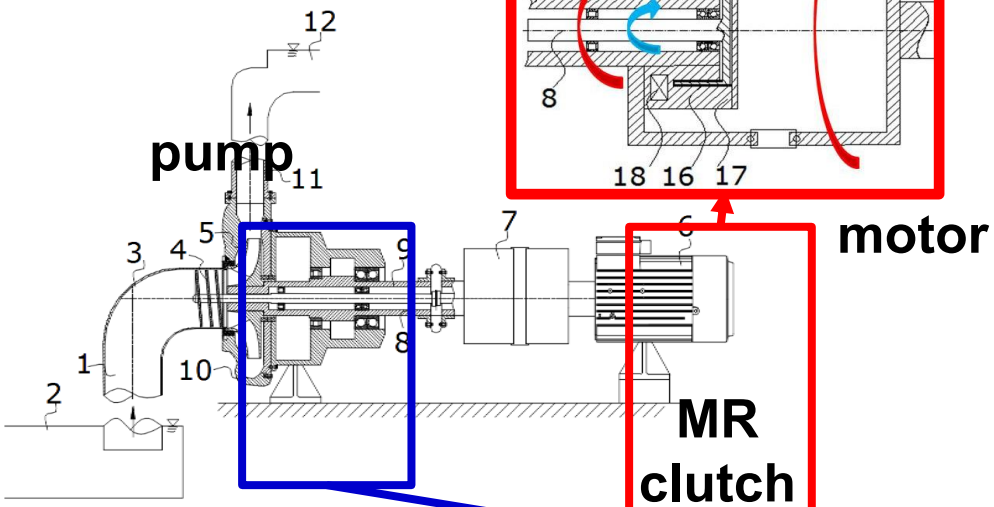
Magnetorheological flow controller devices for hydraulic machines

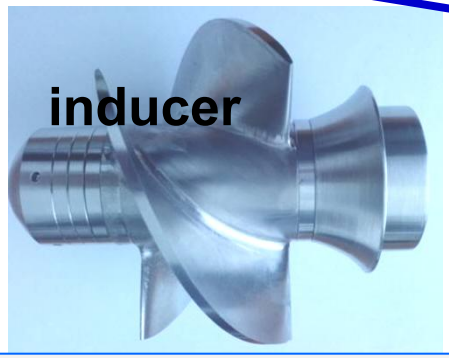
MR clutch → slowing down the inducer speed → controlling the flow at the impeller inlet → improves pump cavitational behaviour-avoiding erosion

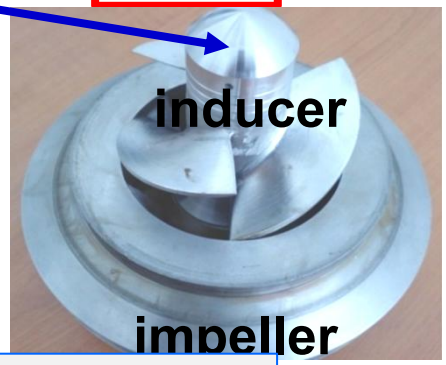
A new development of the initial solution-Prof. Ioan Anton



Pump system with MR clutch







Research group of Dr.Eng. Sebastian Muntean

Follow the talk **Flow control in hydraulic machinery using nano - micro composite magneto - rheological fluids**

Laboratory of Magnetic Fluids

Devoted to Research and Development

1975-2025

Working together

Partners in Romania and abroad

Recent results and perspectives

Head of the Department
of Hydraulic Machines
1962-1973 and 1982-1989
Rector of the University
Politehnica Timișoara, 1971-1981

The most prominent Romanian scientist in the field of hydraulic machines

PhD supervisor: 40 theses

Member of the Romanian Academy 1963
Vicepresident 1974-1990
President *ad interim* 1981-1984
Director, Center for Fundamental and Advanced Technical Research Timişoara 1970-1971; 1997-2009

Founder of the Lab Magnetic Fluids 1975

Anton I. et al *Application orientated researches on magnetic fluids* (review)
J. Magn. Magn. Mater.,85(1990)
22 publications-Ferrofluids and applications

Professor Ioan Anton†, member of the Romanian Academy (1924-2011)

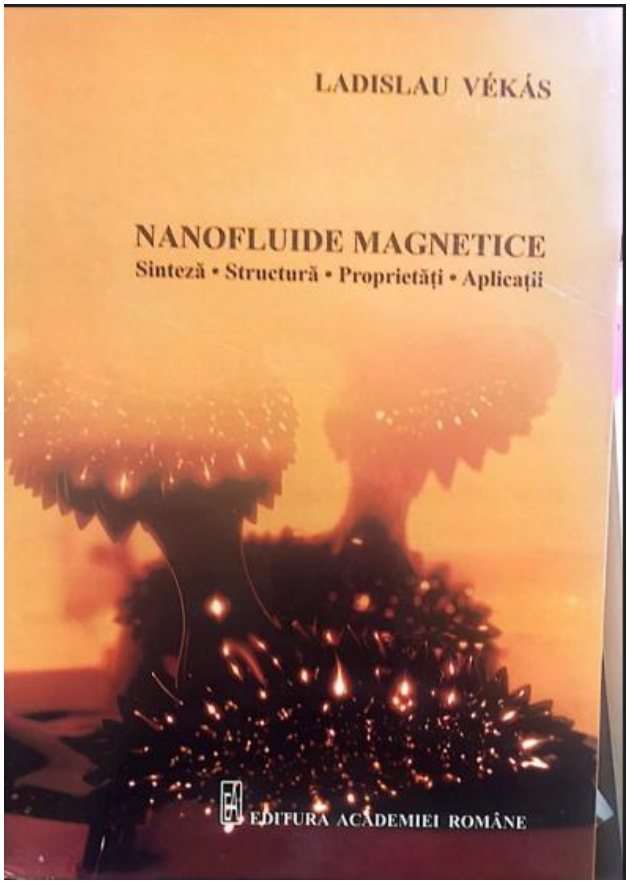
International Workshop on Magnetically controllable fluids, Timișoara 1994

Opening address

International Conference on Magnetic Fluids ICMF8 Timișoara 1998

Professor Ioan Anton-Laboratory of Magnetic Fluids

"Magnetic fluids and applications" for students and young researchers



Course and laboratory experiments Starting 1977/1978 until 1992

Department of Hydraulic Machinery
University Politehnica Timişoara
A great number of diploma works

Long-term cooperation with PhD students of Professor Ioan Hrianca and Professor Daniel Vizman
Faculty of Physics, West University Timişoara
PhD theses: Mircea Raşa (Cannon Co. Eindhoven), Vlad Socoliuc (Lab MF Timişoara), Oana Marinică (Continental Co. Timişoara)

Potencz I., N.C. Popa†, L. Vékás, E. Suciu†, **Adrian Melinte (AEM Timişoara),** Transducer for the measurement of small pressure differences, Patent RO 98431(1989)

Muntean S., Susan-Resiga R., Bosioc A., Constantin S., Maxim D., Tănasă C., Vékás L., Borbáth I., **Anton Liviu (DeptHydrMach.)**, Equipment for reducing cavitational effects and level at turbo pump inlets, Patent RO131578-B1(2019).

LMF 1975-2025

Ferrofluids and bio-ferrofluids: looking back and stepping forward

V. Socoliuc , M. V. Avdeev, **V. Kuncser, Rodica Turcu, Etelka Tombácz** and L. Vékás (Review Article) **Nanoscale, 2022**, 14, 4786-4886; https://doi.org/10.1039/D1NR05841J

Engineered magnetoactive collagen hydrogels with tunable and predictable mechanical response

S Karagiorgis, A Tsamis, C Voutouri, **Rodica Turcu**, S A Porav, **V Socoliuc**, L Vekas, Maria Louca, T Stylianopoulos, V Vavourakis, **Theodora Krasia-Christoforou**, **Materials Science and Engineering C**, **2020**, 114, 111089; https://doi.org/10.1016/j.msec.2020.111089

High performance magnetorheological fluids: very high magnetization FeCo–Fe3O4 nanoclusters in a ferrofluid carrier

Izabell Crăciunescu, Elena Chiţanu, Mirela M. Codescu, N. Iacob, A. Kuncser, **V. Kuncser, V. Socoliuc, Daniela Susan-Resiga, Florica Bălănean**, G. Ispas, **Tünde Borbáth, I. Borbáth, Rodica Turcu** and L. Vékás **Soft Matter, 2022**, 18(3)626-639; DOI https://doi.org/10.1039/D1SM01468D

High magnetization composite magnetic fluid: structure, magnetorheology and new sealing mechanism in rotating seals

Daniela Susan-Resiga, Vlad-Mircea Socoliuc, István Borbáth, Tünde Borbáth, Septimiu Casian Tripon, **Florica Bălănean** and Ladislau Vékás **Soft Matter, 2024**,20(31)6176-6192; https://doi.org/10.1039/D3SM01693E

Many thanks for participation and working together!

Chapter 2: **Albert P. Philipse**, ***Thermodynamic structure formation in colloidal dispersions of single-domain magnetic nanoparticles***

Chapter 3: **Etelka Tombácz** (corresp author) and **Erzsébet Illés**, ***Iron Oxide Nanoparticle Systems in Biorelevant Media – The Key Role of nanoparticle Coating***

Chapter 4: Petri C. Papaphilippou and **Theodora Krasia-Christoforou** (corresp author), ***Synthesis, characterization and evaluation of magnetic nanomaterials in the recovery of heavy metal/radioactive soil and wastewater contaminants***

Chapter 5: N. Iacob, C. Comănescu, A. Kuncser, A. Iuga, G. Schinteie, P. Palade, C. Locovei and **V. Kuncser** (corresp author), ***Magnetism at the Nanoscale – Implications for Engineering and Biomedical Applications***

Chapter 6: K. D. Knudsen (corresp author) and L. Vékás, ***Structuring processes in magnetic nanoparticle systems. Investigations by small-angle techniques***

Chapter 9: Veronika Lackova, Natalia Tomasovicova, **M. Timko**, Katarina Konyova, D. Miakota, M. Molcan, P. Bury, M. Vevericik, O. V. Kovalchuk, L. A. Bulavin and P. **Kopcansky** (corresp author), ***Ferronematics : Composition, Structure, and Properties***

Chapter 17: **Daniela Susan-Resiga, R.A. Szakal, A.I. Bosioc,** L. Vékás**, S. Muntean** (corresp author), ***Nano-Micro Composite Magneto-rheological Fluids – From Magneto-rheology to Flow Control***

7 chapters from a total of **17** in

Magnetoresponsive soft nanosystems. Fundamentals and applications (to appear in 2026)

Royal Society of Chemistry Nanoscience & Nanotechnology Series

(Eds. Sophie Laurent and Ladislau Vékás)

Many thanks for participation and working together!

Thank you for attention!