

Magnetic Materials and Nanomaterials

MagMatNano

research group

Professor **Ionel Chicinaș**

Contact details

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Areas of expertise

- **Nanocrystalline and nanocomposite magnetic powders production by mechanical alloying/milling;**
- Production of bonded magnets;
- Sintered magnetic materials (soft and hard);
- Obtaining of **nanocrystalline compacts** (composite and sintered – **Spark Plasma Sintering**);
- **New directions:**
 - nanocrystalline materials obtained by **severe plastic deformation**;
 - **metallic/ceramic nanocomposites** for high mechanical properties;
 - **amorphous powders** obtained by mechanosynthesis;
- Materials characterisation;
- Structural analysis (X-ray diffraction, SEM + EDX), thermal analysis (DTA, TG+DSC)

Team and key skills

Ionel Chicinas, Professor, PhD supervisor, Head o group

Florin Popa, ass. prof, PhD., in materials engineering (UTCN) and materials physics (UJF, Grenoble)

Bogdan Viorel Neamțu ass. prof., PhD., in materials engineering (UTCN) and materials physics (UJF, Grenoble)

Traian Florin Marinca, PhD., in materials engineering

Calin Prica, PhD., in materials engineering

Adriana Sorcoi, PhD., in materials engineering

2 PhD students

2 Master students

3 students for licence diploma

Representative research equipments

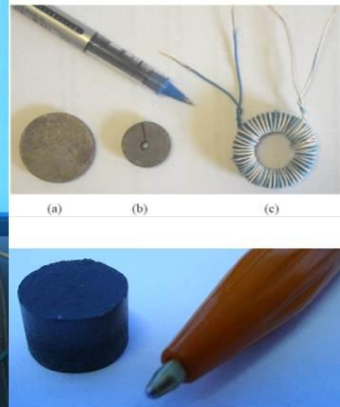
- 2 high energy planetary ball mills, one Pulverisette 4 – Fritsch, having the GTM system of temperature and pressure control
- Powders characterisation equipments (Laser Particle Size Analyzer – Analisette 22 - Fritsch– domeniu 10 nm-2 mm),
- Remagraph-Remacomp-Combination C705 hysteresisgraph for AC (up to 10 kHz) and DC determination for soft magnetic materials,
- Permagraph L hysteresisgraph for hard magnetic materials,
- X-ray diffractometer Dron 3 equipped with data acquisition board,



Representative research equipments

- Scanning electron microscope JSM 5600-LV (Jeol), equipped with EDX spectrometer (Oxford Instr.),
- DTA, TG+DSC (Setaram),
- Hydraulically presses
- Sintering furnaces, dilatometer, plastic injection installation, measuring and control equipments.

 Home-made spark plasma sintering equipment – designed and realised by the research group.



National and International Collaborations

The group has scientific collaboration and facilities for experiments and magnetic/structural measurements at:

- **Babes-Bolyai University Cluj-Napoca – Prof. Viorel Pop group** (Brucker D8 diffractometer, magnetic susceptibility balance, electrical resistivity measurements, etc.),
- **S.C. Sinterom S.A.** (sintering furnaces),
- **Joseph Fourier University, Grenoble and Néel Institute, CNRS, Grenoble – Prof. Olivier Isnard** (TEM, magnetic measurements up to 3 K and in fields up to 11 T, DSC, etc.)
- **Inst. Nationale Polytechnique, Grenoble and Néel Institute, CNRS, Grenoble – Prof. Olivier Geoffroy** (dynamic magnetic measurements at high frequency, etc.)
- **Rouen University – Prof. Jean-Marie Le Breton** (Mössbauer spectrometry).
- **Inst. of Physics, P.J. Šafarik University, Kosice – Prof. Peter Kollar and Jan Füzér** (amorphous and soft magnetic composite materials).
- The group has as well collaborations with **INCDFTM Bucharest, ICPE-CA Bucharest, INCDTIM Cluj-Napoca, IFT Iasi**, and other international scientific contacts with researchers from **Spain (Madrid), Italy (Torino, Trento), Greece (Athena)**



The most representative publications of the last 5 years

In last 5 years (2008-2013) the group published 56 papers (**30 in ISI quoted journals**) and has **more than 125 citations** (119 in ISI WoS).

Selected papers:

- T.F. Marinca, I. Chicinaş, O. Isnard, V. Popescu, *Journal of the American Ceramic Society*, **96** [2] 469–475 (2013)
- J.M. Le Breton, O. Isnard, J. Juraszek, V. Pop, I. Chicinaş, *Intermetallics*, **35**, 128-134 (2013)
- T.F. Marinca, I. Chicinaş, O. Isnard, *Ceramics International*, **38**, 1951–1957 (2012)
- B. V. Neamţu, O. Geoffroy, I. Chicinaş, O. Isnard, *Materials Science and Engineering B*, **177** (2012) 661-665
- B.V. Neamtu, I. Chicinaş, O. Isnard, F. Popa, V. Pop, *Intermetallics*, **19**, 19-25 (2011),
- T.F. Marinca, I. Chicinaş, O. Isnard, V. Pop, F. Popa, *J. Alloys and Compounds*, **509** (2011) 7931
- B.V. Neamţu, O. Isnard, I. Chicinaş, C. Vagner, N. Jumate, P. Plaindoux, *Materials Chemistry and Physics*, **125**, 364–369 (2011)
- F. Popa, O. Isnard, I. Chicinaş, V. Pop, *Journal of Magnetism and Magnetic Materials*, **322**, 1548–1551 (2010)

In last 5 years (2008-2012) the group members presented **35 oral and poster papers** in International, European or World conferences/congresses

I. Chicinaş, B. V. Neamţu, O. Isnard, C. Vagner, V. Pop, *Préparation et caractérisation de poudres nanocristallines magnétiques douces du Ni-Fe-X-Y par broyage mécanique humide* -

Keynote, *Materiaux 2010 Congrès, Nantes France, 18-23 Oct. 2010*

I. Chicinaş, *Soft Magnetic Nanocrystalline/Nanostructured Materials Produced by Mechanical Alloying Routes – Invited lecture – European Summer School on Magnetism, Sept. 9th-18th-2007, Cluj-Napoca*

The most representative patents, products of the last 5 years

Design and realization of an home-made spark plasma sintering equipment – **patent pending**.

P = 30-100 kPa, I = 2000 A



The group obtained and studied:

1. Nanocrystalline magnetic powders of Ni_3Fe , Supermalloy (NiFeMo , NiFeCuMo) and developed 2 mechanical alloying method (mechanical alloying combined with annealing, MA with germ of product insertion) – **2 PhD thesis in co-tutele defended, 22 published papers (11 in ISI journals)**.
2. Nanocomposite magnetic powders of spring-magnet type ($\text{SmCo}_5/\alpha\text{-Fe}$, $\text{SmCo}_2\text{Cu}_3/\alpha\text{-Fe}$, $\text{Nd}_2\text{Fe}_{14}\text{B}/\alpha\text{-Fe}$, $(\text{Pr,Dy})_2\text{Fe}_{14}\text{B}/\alpha\text{-Fe}$) obtained by mechanical milling – **12 published papers, 9 in ISI journals**.
3. Soft magnetic composite materials from nanocrystalline powders obtained by mechanical alloying – **PhD thesis in co-tutele, 9 published papers, 3 in ISI Journals**.
4. Soft nanocrystalline/nanosized ferrites obtained by reactive milling – **15 papers, 6 in ISI journals, PhD thesis**.
5. Nanocomposite powder of soft ferrite/alloy type ($\text{ZnFe}_2\text{O}_4/\text{Fe}$, $\text{ZnFe}_2\text{O}_4/\text{Ni}$, $\text{NiFe}_2\text{O}_4/\text{Fe}$ etc) and nanocomposite compacts. **2 ISI proceedings paper and PhD thesis in final stage**.

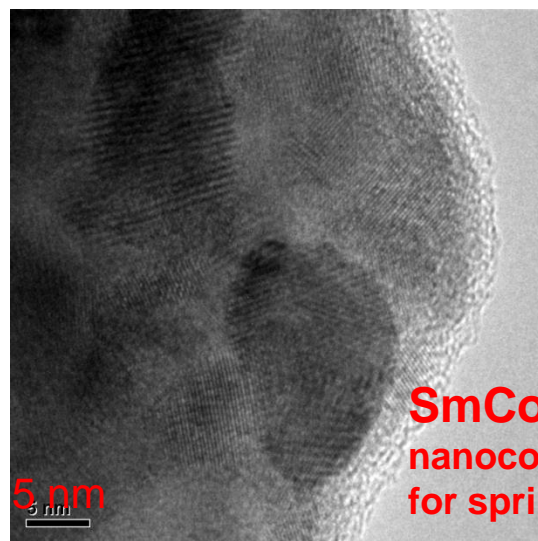


Magnetic materials produced by MagMatNano Research Group

Nanocrystalline/nanocomposite powder and compacts based on soft magnetic ferrite



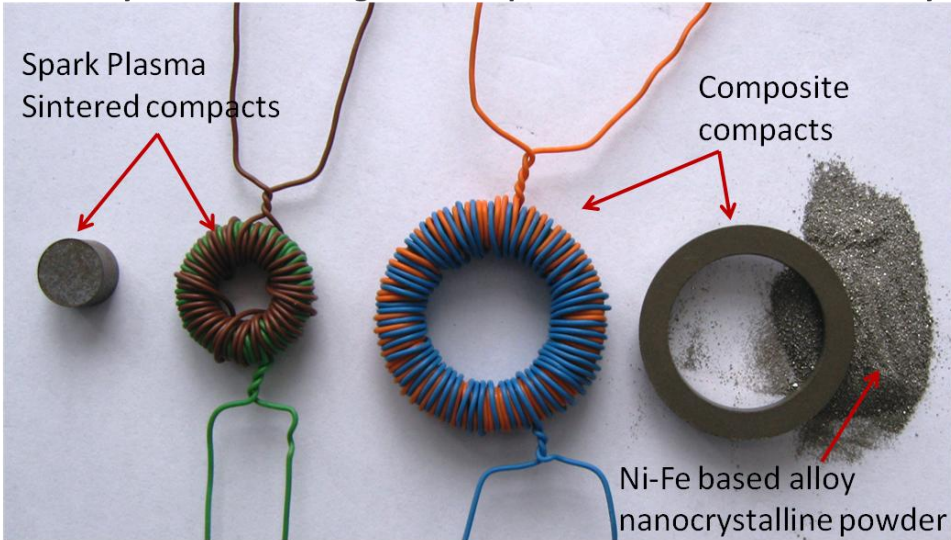
$NiFe_2O_4/Ni$ SPS nanocomposite compact
 $NiFe_2O_4/Fe$ nanocomposite powder
 $ZnFe_2O_4$ nanocrystalline/nanosized powder
 $CuFe_2O_4$ nanocrystalline powder



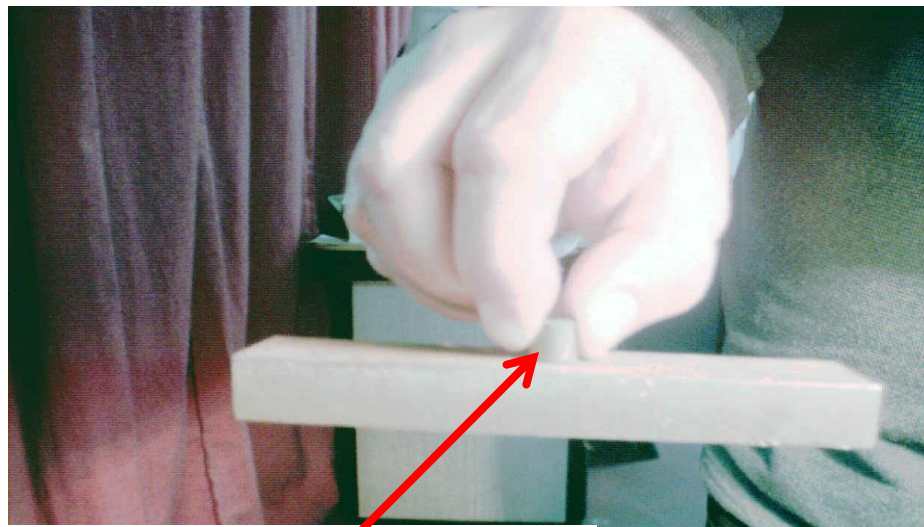
SmCo₅/Fe nanocomposite powder for spring magnets

5 nm

Nanocrystalline soft magnetic compact based on nickel-iron alloy



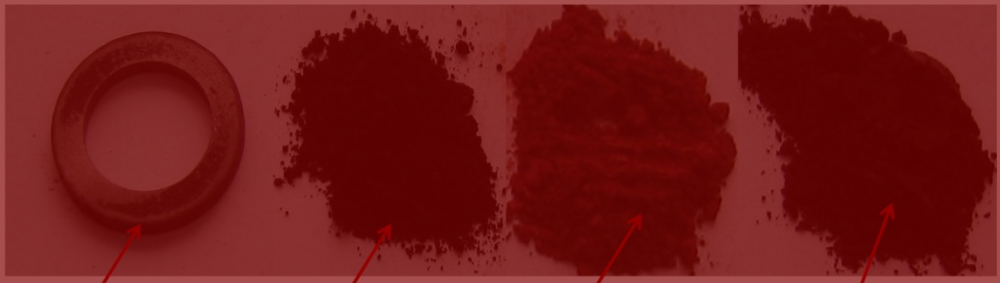
Spark Plasma Sintered compacts
 Composite compacts
 Ni-Fe based alloy nanocrystalline powder



Nd₂Fe₁₄B bonded magnet

Magnetic materials produced by MagMatNano Research Group

Nanocrystalline/nanocomposite powder and compacts based on soft magnetic ferrite



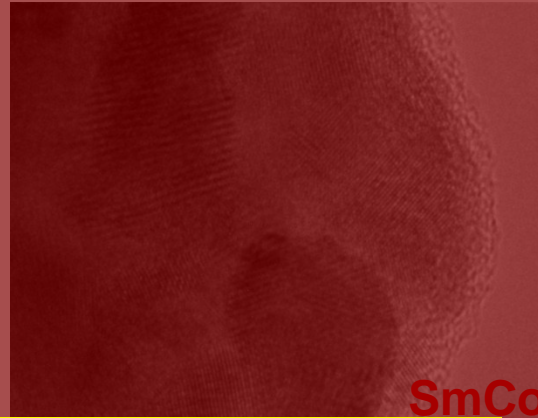
$NiFe_2O_4/Ni$

$NiFe_2O_4/Fe$

$ZnFe_2O_4$

$CuFe_2O_4$

SPS nanocomposite nanocomposite compact

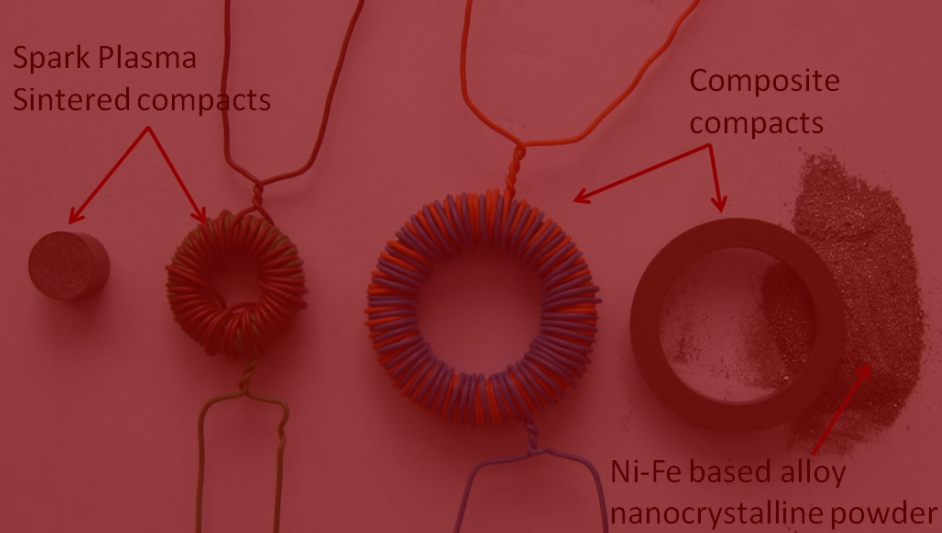


$SmCo_5/Fe$

nanocomposite powder for ring magnets

Thank you for your attention!

Nanocrystalline soft magnetic compact based on nickel-iron alloy



Spark Plasma Sintered compacts

Composite compacts

Ni-Fe based alloy nanocrystalline powder



$Nd_2Fe_{14}B$ bonded magnet