


MAGNETIC MATERIALS AND NANOMATERIALS RESEARCH GROUP

Contact details

Name	Magnetic materials and nanomaterials
Acronym	MatMagNano
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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 – SPS), consulting in magnetic materials field, materials characterization, structural, morphological and thermal analysis (X-ray diffraction, SEM + EDX, DTA, DSC+TG).

Team

Prof. Dr. Ionel Chicinaş, Dr. Calin Virgiliu Prica, Dr. Adriana Lidia Sorcoi, Dr. Florin Popa, Dr. Bogdan Viorel Neamţu, Dr. Traian Florin Marinca; Phd. students: Cristina Stanciu, Cristina Voicu, Eng. Horea Florin Chicinaş; Master students: Katalin Ildiko Simon, Darius Ovidiu Jucan, Ana Cotai

Representative projects

“**Powders and soft magnetic materials nanocomposites of ferrite/transition metal (MeFe₂O₄/(Fe, Ni, Fe-Ni-X) type exchange coupled, obtained by mechanical alloying**”, ID, (2008)
 “**Fe-Ni soft magnetic nanocrystalline powders obtained by mechanical alloying. Obtaining, properties, realization of the nanocrystalline compacts for applications**”, PNII, (2007)
 “**Exchange coupled nanocomposite magnetic materials**”, PNII, (2008)
 “**Soft magnetic nanocrystalline/nanostructured powders and compacts obtained by mechanosynthesis and spark plasma sintering**”, PNII-ID-PCE, (2012)
 “**Amorphous soft magnetic Fe-based and Co-based powders and cores prepared by mechanical alloying and spark plasma sintering**”, PNII-RU-TE, (2012)
 “**Spark plasma sintered soft magnetic composite/nanocomposite compacts of iron alloy/iron mixed ferrite type**”, PNII-RU-TE, (2012)
 “**Researches on synthesis of spark plasma sintered nanocomposite compacts of Permalloy/Fe-Si type using mechanically alloyed powders**”, Bilateral cooperation project: France-Romania, (2013-2014)

Significant results

The most representative publications of the past 5 years:

1. I. Chicinas, T.F. Marinca, F. Popa, B.V. Neamţu, “Rhometal interface in pseudo-core shell powders like Permalloy/Rhometal type”, in *Appl. Surf. Sci.*, vol. 358, 2015, pp. 627-633.
2. S. Gutoiu, O. Isnard, I. Chicinas, F. Popa, A. Takacs, V. Pop, “The influence of milling and annealing conditions on the structural and magnetic behavior of Nd₂Fe₁₄B/ α -Fe hard/soft magnetic nanocomposites”, in *J. Alloys Compd.*, vol. 646, 2015, pp. 859-865.
3. B.V. Neamţu, T.F. Marinca, I. Chicinaş, O. Isnard, F. Popa, “Structural and magnetic characteristics of Co-based amorphous powders prepared by wet mechanical alloying”, in *Adv. Powder Technol.*, vol. 26(1), 2015, pp. 323-328.

4. I. Chicinaş, T.F. Marinca, B.V. Neamţu, P. Pascuta, V.Pop, "Thermal stability of the manganese-nickel mixed ferrite and iron phases in the $Mn_{0.5}Ni_{0.5}Fe_2O_4/Fe$ composite/nanocomposite powder", in *J. Therm. Anal. Calorim.*, vol. 118, 2014, pp. 1269–1275.
5. B.V. Neamţu, T.F. Marinca, I. Chicinaş, O. Isnard, F. Popa, P. Pascuta, "Preparation and soft magnetic properties of spark plasma sintered compacts based on Fe-Si-B glassy powder", in *J. Alloys Compd.*, vol. 600, 2014, pp. 1-7.
6. T.F. Marinca, B.V. Neamţu, I. Chicinaş, O. Isnard, "Structural and magnetic characteristics of composite compacts of Fe/Fe_3O_4 type obtained by sintering", in *IEEE Trans. Mag.*, vol. 50(4), 2014, 2800604.
7. B.V. Neamţu, I. Chicinaş, O. Isnard, I. Ciascai, F. Popa, T.F. Marinca, "Consolidation and DC magnetic properties of nanocrystalline Supermalloy/iron composite cores prepared by SPS", *J. Magn. Magn. Mater.*, vol.353, 2014, pp.6-10
8. T.F. Marinca, B.V. Neamţu, F. Popa, V.F. Tarţa, P. Pascuta, A.F. Takacs, I. Chicinaş, "Synthesis and characterization of the $NiFe_2O_4/Ni_3Fe$ nanocomposite powder and compacts obtained by mechanical milling and spark plasma sintering", in *Appl. Surf. Sci.*, vol. 285, 2013, pp. 2-9.
9. V.F. Tarţa, T.F. Marinca, I. Chicinaş, F. Popa, B.V. Neamţu, P. Pascuta, A.F. Takacs, "Stability of phases in ball milled zinc ferrite/iron composite produced by spark plasma sintering", in *Mater. Manuf. Process.*, vol.28, 2013, 933-938.
10. R. Larde, J.M. Le Breton, A. Maitre, D. Ledue, O. Isnard, V. Pop, I. Chicinaş, "Atomic Scale Investigation of $SmCo_5/\alpha-Fe$ Nanocomposites: Influence of Fe/Co Interdiffusion on the Magnetic Properties", in *J.Phys.Chem C.*, vol.117, 2013, pp.7801.
11. F. Popa, O. Isnard, I. Chicinaş, V. Pop, "Thermal Evolution of the Ni_3Fe Compound Obtained by Mechanical Alloying as Probed by Differential Scanning Calorimetry", in *J. of Alloys and Compounds*, vol. 554, 2013, pp. 39-44.
12. T.F. Marinca, I. Chicinaş, O. Isnard, "Structural and magnetic properties of the copper ferrite obtained by reactive milling and heat treatment", in *Ceram. Int.*, vol. 39, 2013, pp. 4179-4186.
13. J.M. Le Breton, O. Isnard, J. Juraszek, V. Pop, I. Chicinaş, "A Mössbauer investigation of Ni_3Fe alloys obtained by high energy ball milling and subsequent annealing", in *Intermetallics*, vol. 35, 2013, pp. 128-134.
14. T.F. Marinca, I. Chicinaş, O. Isnard, V. Popescu, "Nanocrystalline/nanosized $Ni_{1-\gamma}Fe_{2+\gamma}O_4$ ferrite obtained by contamination with Fe during milling of $NiO-Fe_2O_3$ mixture. Structural and magnetic characterization", in *J. American Ceramic Society*, vol. 96, 2013, pp. 469-475.
15. B.V. Neamţu, O. Geoffroy, I. Chicinaş, O. Isnard, "AC magnetic properties of the soft magnetic composites based on Supermalloy nanocrystalline powder prepared by mechanical alloying", in *Mater.Sci.Eng. B*, vol.177, 2012, 661-5.
16. T.F. Marinca, I. Chicinaş, O. Isnard, V. Pop, F. Popa, "Synthesis, structural and magnetic characterisation of nanocrystalline nickel ferrite– $NiFe_2O_4$ obtained by reactive milling", in *J. Alloys Compd.*, vol.509, 2011, 7931-7936.
17. B.V. Neamţu, O. Isnard, I. Chicinaş, C. Vagner, N. Jumate, P. Plaidoux, "Influence of benzene on the Ni_3Fe nanocrystalline compound formation by wet mechanical alloying: an investigation combining DSC, X-ray diffraction, mass and IR spectrometries", in *Mater. Chem. Phys*, vol. 125, 2011, pp. 364-369
18. B.V. Neamtu, I. Chicinaş, O. Isnard, F. Popa, V. Pop, "Influence of wet milling conditions on the structural and magnetic properties of Ni_3Fe nanocrystalline intermetallic compound", in *Intermetallics*, vol. 19, 2011, pp. 19-25.

Significant solutions:

Synthesis routes for obtaining nanocrystalline/nanosized, composite/nanocomposite and amorphous magnetic materials
Nanocrystalline/nanosized, composite, nanocomposite and amorphous powder compaction.

Products and technologies (Designed and developed of home-made spark plasma sintering equipment):

1. The group obtained 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. Nanocomposite magnetic powders of spring-magnet type ($SmCo_5/\alpha-Fe$, $SmCo_2Cu_3/\alpha-Fe$, $Nd_2Fe_{14}B/\alpha-Fe$, $(Pr,Dy)_2Fe_{14}B/\alpha-Fe$) obtained by mechanical milling
3. Soft magnetic nanocomposite materials, from nanocrystalline powders obtained by mechanical alloying
4. Soft nanocrystalline ferrites obtained by mechanical alloying
5. Nanocomposite powder of soft ferrite/alloy type ($ZnFe_2O_4/Fe$ or Ni , $NiFe_2O_4/Fe$ etc) and nanocomposite compacts

Patents/patents pending:

1. P. Cărlan, I. Chicinaş, *Procedeu de obţinere a pulberii de compuşi intermetalici $IrAl$ şi $IrAl_3$ şi ţintă de iradiere pentru gamagrafie industrială obţinută din aceasta*, Patent RO 123425 B1,
2. I. Chicinaş, T.F. Marinca, F. Popa, B.V. Neamţu, *Pulbere nanostructurată de tipul Permalloy(Supermalloy)/Rhometal si procedeu de obţinere*, OSIM/19.09.2014/ RO130354-A0, patent pending,
3. I. Chicinaş, T.F. Marinca, F. Popa, B.V. Neamţu, *Pulberi compozite de tipul fe sau aliaj feromagnetic/ferită magnetic moale cu structură de tipul pseudo „core-shell” şi procedeu de obţinere*, OSIM - Nr. A10083/18.12.2015, patent pending.

The offer addressed to the economic environment

Research & development	Preparation of nanocomposite/nanocrystalline/nanosized magnetic powders and composite/nanocomposite compacts. Structural, morphological and magnetic characterisation of powders and compacts. Study of exchange coupling in nanocomposites. Researches on the development of magnetic materials for medium and high frequencies. Production of the bonded magnets, production of the nanocrystalline and nanostructured powders by mechanical alloying/milling and reactive milling, production of magnetic cores (sintered and composite), specific measurements, structural analysis, SEM and EDX analysis.
Consulting	Soft and hard magnetic materials, magnetic hysteresis measurement in DC & AC (up to 10 kHz) for permanent magnets & magnetic cores, mechanosynthesis, reactive milling, X-ray diffraction, SEM+EDX
Training	Lectures in: magnetic materials, mechanosynthesis, XRD, SEM, EDX, DSC-TG. Coordination for PhD projects related to elaboration of magnetic powders produced by mechanical alloying, bonded magnets, sintered soft&hard, composites&nanocomposite magnetic materials.