

# RESEAU FRANCAIS DE MECANOSYNTHESE

## Lettre N°38

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Mai 1998

**114 (+3) Groupes de Recherches (dont 49 (+2) à l'étranger)**

**157 (+5) Correspondants**

**Bureau : E. Gaffet (Président), G. Le Caër (Secrétaire Général), A.R. Yavari (Trésorier)**

### 5 Nouvelles Adhésions

**D. Cracco** - CNRS - LCMTR - Thiais - France

**A. Demortier** - LASIR CNRS - Lille - France

**C. Lenain** - LRCS - CNRS Amiens - France

**Lu Li** - Dpt Mech. Prod Eng. - Nat. Univ. Singapore - Singapour

**S.J. Savage** - Defence Research Establishment - Stockholm - Suède

## JRFM98

**Le Mans - 12 & 13 Mai 1998**

**Thème 1998 : Propriétés Physiques et Chimiques des Matériaux Nanostructurés**

### Fiche d'inscription

**3èmes Journées du Réseau Français de Mécanosynthèse**

**Le Mans les 12 & 13 mai 1998**

Nirina Randrianantoandro (Journées RFM98), Laboratoire de Physique de l'Etat Condensé (UPRES A 6087 CNRS), UFR Sciences, Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans Cedex 09

Tél : 02.43.83.35.11, Fax: 02.43.83.35.18,

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Adresse : .....

Téléphone: ..... / Fax : .....E-Mail :

Souhaite présenter une communication lors des JRFM98 sous forme de  
dune communication orale                      dun poster

Titre .....

(joindre un résumé dune page maximum, avec le titre et l'adresse complète  
( tél, e-mail), caractère : Times 12 et marges 25 mm)

**Frais d'inscription**(+ 2 déjeuners et un dîner)

Etudiant(e) en thèse : gratuit                      autre : 300 FF

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**Mode de paiement :**

Bon de commande                      Chèque

Libellé à l'ordre du Réseau Français de Mécanosynthèse.

Laboratoire de Physique de l'Etat Condensé (UPRES A 6087 CNRS), UFR Sciences, Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans Cedex 09 - Fax : 02.43.83.35.18

### Liste des Conférenciers Invités (liste provisoire)

- [1] **Mesures granulométriques**  
J. Dodds  
Ecole des Mines d'Albi
- [2] **Microstructures et susceptibilité en hyperfréquences de matériaux magnétique**  
M. Bertin  
ONERA Chatillon
- [3] **Utilisation des techniques de diffusion des neutrons et des rayons X pour étudier les propriétés structurales d'alliages obtenus par mécanosynthèse**  
N. Cowlam  
Université de Sheffield
- [4] **Amélioration des propriétés mécaniques par nanodispersion d' $\text{Al}_2\text{O}_3$  dans l'intermétallique FeAl**  
F. Thévenot, K. Wolski, J. Le Coze  
Ecole des Mines de St Etienne

### Propositions de Communications Orales (liste provisoire)

- [1] **"Comportement à long - terme des alliages nanocristallins  $\text{Ti}_2\text{RuFe}$  and  $\text{Ti}_2\text{RuFeO}_2$  vis à vis de la réaction de dégagement d'hydrogène dans les conditions d'utilisation de l'industrie des chlorates"**  
L. Roué, E. Irissou, S. Bouaricha, M. Blouin, D. Guay - INRS Varennes (Québec) - Canada  
S. Boily, J. Huot, R. Schulz - Institut Recherche d'HydroQuébec- Québec - Canada
- [2] **"Propriétés physique et chimiques de composites nanostructurés Al -- AlN"**  
P. Goeuriot, C. Troadec, J. Vicens, J.L. Chermant, P. Verdier, Y. Laurent  
ENSME St Etienne, LERMAT Caen, URA 1486 Rennes
- [3] **"Réactivité des poudres mécaniquement activées : application à la synthèse du type SHS dans les systèmes Fe - Si et Mo - Si"**  
C. Gras, F. Charlot, E. Gaffet, F. Bernard, J.C. Niepce  
L2RS /CNRS Dijon & CNRS / IPSE Belfort
- [4] **Etudes des relations structure / propriétés d'absorption de l'hydrogène dans le cas d'alliages broyés mécaniquement**  
D. Cracco, A. Percheron - Guegan - CNRS Thiais
- [5] **"Mécanosynthèse du système Fe - F"**  
H. Guerault  
Université du Maine - Le Mans
- [6] **Propriétés électrochimiques de composés hydrurables de type AB<sub>5</sub> et A<sub>2</sub>B préparés par mécano-chimie.**  
C. Lenain, L. Aymard, F. Salver-Disma, J-B. Leriche et J-M. Tarascon - LRCS - CNRS / Univ Amiens  
Y. Chabre. Université Joseph Fourier, Grenoble, FRANCE

### Propositions de Communications par Affiches (liste provisoire)

- [1] **"Etude par spectrométrie Mössbauer et microscopie électronique à transmission d'alliages Fe - Cr élaborés par mécanosynthèse"**  
C. Lemoine, A. Fnidiki, D. Lemarchand, J. Teillet  
GMP CNRS - Université de Rouen
- [2] **"Relations Microstructure / Texture / Propriétés de Fe Al obtenu par mécanosynthèse et extrusion"**  
S. Lenhard, F. Wagner, T. Grosdidier, S. Revol, R. Baccin  
CNRS 2090 - Metz et CEA/CEREM Grenoble
- [3] **"Evolution de la taille des cristallites et du taux de microdéformations au cours du broyage : cas du fer nanométrique"**  
M. Zouggar, P. Chartier, J. Mimault, M. Grosbras  
S2PMI - Université de Poitiers
- [4] **"Synthèse et caractérisation de l'évolution d'alliages Al Ni Zr hors équilibre"**  
J.-P. Braganti, O. Held, F.-A. Kuhnast, J.-C. Gachon  
UMR CNRS 7555 - Université H. Poincaré - Nancy
- [5] **"Expansion thermique anormale du Ni nanocristallin obtenu par broyage"**  
M. Tachikart, Ph. Lesage, C. Meunier, S. Vives, E. Gaffet  
LIP/IPSe - CNRS/IPSe Belfort - LMIT Montélimar
- [6] **"Influence du mode de broyage pour l'élaboration d'intermétallique FeAl par MASHS"**  
F. Charlot, E. Gaffet, F. Bernard, J.C. Niepce  
L2RS - CNRS Université de Bourgogne - Dijon & CNRS/IPSe Belfort
- [7] **"Etude de Recuits d'alliages Fe - Cr partiellement mélangés"**  
T. Ziller, P. Delcroix, G. Le Cœur  
LSG2M - CNRS/Ecole des Mines - Nancy
- [8] **"Caractérisation physico - chimique de dioxydes de titane broyés"**  
T. Girot, S. Begin - Colin, A. Mocellin, G. Le Cœur, M.O. Simonnot, J.F. Remy, M. Sardin

LSG2M - CNRS/ Ecole des Mines - Nancy & LSGC/CNRS - Nancy

[9] "**Mécanosynthèse de molybdates de lanthanés**

Ph. Lacorre, R. Retou, N. Randrianantoandro  
Universite du Maine - Le Mans

[10] "**Effet de la microstructure sur les propriétés magnétiques d'alliages à base de Cobalt obtenus par Mécanosynthèse**"

N.E. Fenineche, O.El Kedim, E. Gaffet  
LIP/IPSé et CNRS Belfort

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**ANNONCE DE CONGRES ET / OU ECOLES  
CONGRESS AND SCHOOL ANNOUNCEMENTS**

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**All the details may be obtained by E-Mail to E. Gaffet**

**JRFM 98**

Le Mans - France - 12 - 13 Mai 1998

Comité d'organisation : J.-M. Grenèche, Y. Labaye, N. Randrianantoandro, G. Silly, E. Gaffet

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**PM2Tec 98**

**Int. Conf on Powder Metallurgy and Particulate Materials**

Las Vegas - USA - 31 Mai 4 Juin 1998

E-Mail : info@mpif.org - WebSite : www.mpif.org

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**3rd Pacific RIM International Conference on  
Advanced Materials and Processing**

Honolulu - Hawaï - 12 - 16 Juin 1998

Contact : M. Imam - Naval Research Lab. Washington - E-Mail Imam@anvil.nrl.navy.mil  
et R. DeNale NSWC - E-Mail : DeNale@Oasys.dt.Navy.mil

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**NANO'98**

Stockholm - Suède - 14 - 19 Juin 1998

Secrétariat Cof. : nano98@kth.se

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**Advanced Nanomaterials from Vapor (ANFV'98)**

Uppsala - Suède (Satellite Meeting to NANO'98) - 17 Juin 1998

Contact : L. Kiss - Uppsala University /E-Mail : Laszlo.Kiss@Material.uu.se

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**CIMTEC'98 - World Ceramics Congress and Forum on New Materials**

Florence - 14 - 19 Juin 1998

Web Site : <http://www.dinamica.it/cimtec98/>

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**3rd International Symposium on Metallic Multilayers (MML'98)**

Vancouver - 14 - 19 Juin 1998

Contact : E-Mail : Conference\_Service@SFU.CA

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**E\_MRS 1998 - Spring Meeting**

Strasbourg - France - 16 - 19 Juin 1998

E-Mail : emrs@phase.c-strasbourg.fr

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**"High Temperature Nanostructured Materials" Session**

**High Temperature Materials, Processing and Diagnostics Gordon Conference**

New Hampshire - 19 - 24 Juin 1998

Contact : J. Gole - Georgia Institute of Technology E-Mail : PH294jg@prism.gatech.edu  
et N. Jacobson E-Mail Nathan.S.Jacobson@lerc.Nasa.gov

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**41ème Colloque de Métallurgie de l'INSTN**

"Ségrégation Interfaciale dans les Solides

Saclay - France - 23 - 25 Juin 1997

Contact : J. Pignetti - Secrétariat 41 ème Colloque INSTN

CEA Saclay - INSTN - 91191 - Gif sur Yvette Cedex - Fax : +33 - (0) 1 - 69 08 97 77

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**4th Russian Conference on the  
Physics and Chemistry of Ultra Dispersed Systems"**

Obninsk - Russie - 29 Juin 3 Juillet

Contact : P.N. Martynov E-Mail : Sta@ippe.rssi.ru

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**Journées Francophones des Jeunes Physico-Chimistes**

7-9 juillet 1998 - Montpellier

La 4e édition de ces journées multidisciplinaires propose aux étudiants et jeunes chercheurs un lieu de rencontre et d'échange autour de la Physico-Chimie. Trois grands thèmes seront abordés: - Biologie, Santé, Environnement;

- Matière, Matériaux;  
- Réactivité, Surfaces, Interfaces.

Chaque thème sera introduit par une personnalité scientifique, développé par une série de communications orales et complété par une séance de communications par affiche.

Responsables: Josette Olivier-Fourcade, Jean-Claude Jumas, Pierre-Emmanuel Lippens

Renseignements: Pierre-Emmanuel Lippens

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Montpellier Cedex 05

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Internet : <http://ubik.crism.cnrs-mop.fr/jfjpc98/jfjpc-98.html>

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**High Temperature Nanostructured Materials**

Gordon Conference - New Hampshire - USA - 19 - 24 Juillet 1998

Contact : Nanthan.S.Jacobson@lerc.nasa.gov

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**EuroMAT'98**

Lisbonne - Portugal - 22 - 24 Juillet 1998

E-Mail : lfspm@lemac.ist.utl.pt

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**Intelligent Processing of Nanostructured Ceramics**

Materials Science Summer Institute - New Brunswick - 20 - 29 Août 1998

Contact : L.C. Klein Rutgers University - E-Mail ; Licklein@RCI.Rutgers.Edu

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**6èmes Journées de la Matière Condensée "JMC6" et  
17th General Conference of the Condensed Matter Division of the European Physical Society  
"CMD17"**

Grenoble - France - 25 - 29 Août 1998

Org : Société Française de Physique et European Physical Society

Website : <http://www.polycnrs-gre.fr/eps.html>

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**Fatigue Damage of Structural Materials II**

Engineering Foundation Conference

Cape Cod - Massachusetts - USA 31 Août - 4 Septembre 1998

Org. A.K. Vasudevan, J.C. Cammett, T. Nicholas, K. Jata

E-Mail : engfnd@aol.com

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**ESTAC 7 et EUROSOLID - 5**

Baltonfüred - 30 Août - 4 Septembre 1998

Contact : Prof. G. Liptay - Hungarian Chemical Society - Fö u. 68, Budapest - H - 1027 Hongrie

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**5th International Conference on Nanometer scale Science and Technology (NANO 5)**

Birmingham - UK - 31 Aout - 4 Septembre 1998

Site : <http://www.iop.org/IOP/Confs/IVC>

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**Ninth International Symposium on Small Particles and Inorganic Clusters (SPIC 9)**

Lausanne - Suisse - 1 - 5 Septembre 1998

Website : <http://ipent.epfl.ch/isspic9>

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**Magnetism of Nanostructured Phases - MNP Conference**

**EMMA Satellite Meeting**

San Sebastian (Espagne) - 4 / 6 Septembre 1998

E-Mail : wupdocal@sp.ehu.es

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**9th European Symposium on Comminution and Classification**

Albi (France) - 8 - 10 Septembre 1998

sous l'égide de l'European Federation of Chemical Engineering

Contacts : J. Dodds - Chairman of the Organizing Committee

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**First Joint ESF - NSF Symposium on Aerosols for Nanostructured Materials and Device**

Edinburgh - Ecosse - 12 Septembre 1998

Contact : h. Fissan@uni-duisburg.de ou dyhpui@tc.umn.edu

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**First International Conference on Inorganic Materials**

Synthesis, Characterisation, Properties and Applications of Inorganic Materials

Versailles - 16 / 19 Septembre 1998 - France

Website : <http://www.elsevier.nl/locate/materials98>

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**ISAPM98**

**3rd International Symposium on Advanced Powder Materials (ISAPM98)**

23 - 26 September 1998 - KAIST - Tajejong - Corée du Sud

Correspondence : Prof. Suk-Joong L. Kang or Ms. Sung Sook Park - Center for Interface Science and Engineering of Materials (CISEM) - Korea Advanced Institute of Science and Technology (KAIST) - Yusong-gu, Kusong-dong, Taejon,

305-701 Korea - Tel : 82-(0)42-869-4113, 8919 / Fax : 82-(0)42-869-8920  
E-mail : sjkang@sorak.kaist.ac.kr / e\_cisem@cais.kaist.ac.kr

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**Solid State Chemistry : Novel Syntheses and New Materials**

Bordeaux - France - 24/26 Septembre 1998

Website : <http://chemistry.rsc.org/rsc/confs.htm>  
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**The Reh binder Memorial International Conference  
on Colloid Chemistry and Physical Chemical Mechanics**

Moscou (Russie) - 4 - 8 Octobre 1998

Contact : Prof. N.B. Uriev - Institute of Physical Chemistry - Leninsky Prospect 31 -  
11795 Moscow - Russie

E-Mail : Reh binder98rehb.chem.msu.su ou <http://www.chem.msu.su>  
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**Powder Metallurgy 98**

Granada - Espagne - 18 - 22 Octobre 1998

Site Web : <http://www.epma.com/congress/>  
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**JA 98**

Paris - 27 - 29 Octobre 1998

Symposium 1 : Phénomènes déterministes et aléatoires en science des matériaux

Symposium 2 : Matériaux poreux et mousses : élaboration, structures et propriétés

Symposium 3 : Les hydrures métalliques

Symposium 4 : Propriétés Thermophysiques et thermomécaniques des matériaux de la mesure à la simulation de  
procédés industriels

Symposium 5 : Analyse d'images et reconnaissance de formes en matériaux

Symposium 6 : Lois de comportement et calcul de structures

Org. SF2M - Contact : SFMM@wanadoo.fr  
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**Symposium on Advanced Technologies for Particle Production**

AICHE Annual Meeting

15 - 20 November - Miami Beach - FL - USA

Technical Sessions and ChairPersons

1/ Particle Synthesis in Dispersions and Supercritical Fluids-R. Davis/MT Harris/D. Tomasko

2/ Sol - Gel Synthesis of Particles - A McCormick/PN Kumta/T. Okubo

3/ Chemical Kinetics during Particle Formation - J. Floess, K. Higashitani, S. E. Pratsinis

4/ In-Situ Diagnostics during Particle Formation-Ph. W. Morrison,R.M. Carangelo, D.T. Spicer

5/ Agglomerate Particle Dynamics - G. Fotou, SK Friedlander, Takahashi

6/ Computational Fluid Dynamics during Particle Formation and Growth - L. Collins, K. Kontomaris

7/ Aerosol Reactors - A.W. Weimer, M. Kamal Akhtar

8/ Particle Charging - T. Matsoukas

9/ Film synthesis by Particle Technologies - G. Grader, S. Bhandarkar

10/ Nanoparticles - M. Senna, TJ Mountziaris, H. Glicksmn

11/ Particulate deposits : Transport mechanisms, microstructure and properties : D. Rosner

12/ Posters on Advanced Technologies for Particles Production : G. Beaucage, H. Riemenschneider

Web Site : [www.iche.org](http://www.iche.org)  
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**ISMANAM98**

International Symposium on Metastable, Mechanically Alloyed and Nanocrystalline Materials

Wollongong (Sydney) - Australie - 7 - 12 Décembre 1998

**International Advisory Committee :**

V.V. Boldyrev, R.W. Cahn, S. Enzo,H. Fecht, E. Gaffet, A. Garcia - Escorial, A.L. Greer, E.Y. Gutmanas,

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R. Schwarz, R.W. Siegel, M. Umemoto

**ISMANAM Steering Committee:**

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R. Bormann, G. Cocco, A. Hernandez, C.C Koch, M. Magini, R. Schulz, A.R. Yavari

Contact : A. Calka E-Mail : Andrzej\_Calka@uow.edu.au et

WebSite : <http://www.uow.edu.au/conferences/ismanam98>  
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**Satellite Symposium on Mechanochemistry / ISMANAM98**

(Mechanochemical Synthesis and Mechanochemistry)

Wollongong - Australie 7 /12 Decembre 1998

**International Advisory Committee :**

E. Ivanov (Chairman), A. Calka, V. Bodyrev, P. Butyagin,

E. Gaffet, E. Gutman, M. Senna, C. Suryanaryana, R. Schwarz

WebSite : <http://www.uow.edu.au/conferences/ismanam98>  
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**Nanostructured Hybrid Materials**

Symposium TMS Annual Meeting - San Diego CA - USA - 28 Février 4 Mars 1999

Contact : gmchow@anvil.nrl.navy.mil

**NOUVEAU  
NEW**

**12th International Conference on Wear of Materials**  
Atlanta - Georgie / USA - 25 - 29 Avril 1999  
contact : Amy Richardson E-Mail A.Richardson@elsevier.co.uk  
or web site : <http://www.elsevier.nl/locate/wom99>

**Nanostructured Materials Symposium at the 5th IUMRS International Conference on Advanced Materials (ICAM'99)**

Beijing - Chine - 31 Mai - 5 Juin 1999  
Contact : Kelu@imr.ac.cn

**10th International Conference on Rapidly Quenched and Metastable Materials (RQ10)**

Bangalore - Inde - 23 - 27 Août 1999  
Website : <http://www.metalrg.iisc.ernet.in/rqten/>

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**Annonces de Soutenance de Thèses**  
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**Effects of the mechanical milling on carbons : negative electrode materials of Li - ion batteries"**

**F. Salver Disma** - Université de Picardie Jules Verne **4 Février 98**

**Jury :** Aymard L., Beguin F., Coulon M., Furdin G., Lassegues JC, Percheron Guegan A., Rouzard JN, Tarascon JM.

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**"Elaboration et Caractérisations de Cermets Alumine - Métal à partir de poudres obtenues par Mécanosynthèse"**

**J.-L. Guichard** - INPL - Nancy - **23 Janvier 1998**

**Jury :** A. Simon, C. Carry, F. Thévenot, G. Le Caër, A. Mocellin

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**"Spinelles nanométriques à valence mixte et à fort taux de lacunes cationiques : Transfert électroniques dans un ferrite de molybdène Fe<sub>2.47</sub>Mo<sub>0.53</sub>O<sub>4</sub>, de la synthèse aux propriétés magnétiques dans le système fer - vanadium Fe<sub>3-x</sub>V<sub>x</sub>O<sub>4</sub> (0<x<2).**

**V. Nivoix** - Université de Bourgogne - **17 Décembre 1997**

**Jury :** M. Lenglet, H. Pascard, G. Bertrand, E. Gaffet, M. Guyot, M. Lallemand, A. Rousset, B. Gillot

=====  
**"The Preparation of Nitrides and Carbides by Mechanical Treatment - Phases and Structures"**

G.M. Wang - School of Physics, University College, The University of New South Wales - Australian Defence Force Academy - Canberra, ACT 2600 - Australia - **10/12/97**

**Supervisor - S.J. Campbell - Co - Supervisors : W.A. Kaczmarek and A. Calka**

This thesis is primarily concerned with investigation into the synthesis of iron carbides, iron nitrides, tungsten carbides and tungsten iron carbides prepared by ball milling technique. The iron nitrides, mainly the  $\epsilon$ -Fe<sub>3</sub>N<sub>x</sub> type phase with  $x$  1.1 - 1.2, were prepared by milling Fe powder with pyrazine (C<sub>4</sub>H<sub>4</sub>N<sub>2</sub>) and pyrazole (C<sub>3</sub>H<sub>4</sub>N<sub>2</sub>). The insight to the structural and phase(s) evolutions which occurred during milling and subsequent thermal treatments was obtained by using the methods of x - ray diffraction, Mössbauer spectroscopy, scanning electron microscopy, thermal analysis and chemical analysis. The main aims of this research are to reveal the effects of milling conditions such as milling time and ball to powder ratio on the milling products, and so to investigate the mechanism of ball milling as an approach for the preparation of materials.

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**"Suivi par Diffraction X en Temps Réel de la Formation par Combustion des intermétalliques des systèmes Al - Ni, Al - Ti, Al - Ni - Ti"**

**J. F. Javel** - Université de Nancy I - **3 Octobre 1997**

**Jury :** J.F. Berar, F. Bernard, M. Bessiere, M. Dirand, J.C. Gachon, P. Galez, J.C. Jorda

=====  
**"Contribution à l'Etude de la Transformation - Tribologique Superficielle en Fretting"**

**E. Sauger** - Ecole Centrale de Lyon - Génie des Matériaux **26 Septembre 1997**

**Jury :** L. Mora - Ponsonnet, P. Blanchard, K. Dang Van, C. Esnouf, E. Gaffet, E. Rosset, A.B. Vannes, L. Vincent

=====  
**"Mechanically induced order-disorder transitions in AlFe"**

Thesis by **M. Meyer**, December 1996

presented at Universidad Nacional de La Plata, Argentina - directed by L. Mendoza-Zélis

## Bibliographie Récente

N.B. : En cas de difficultés à vous procurer une copie des articles suivants, n'hésitez pas à contacter E. Gaffet (CNRS / IPSé - Belfort)

### Livres ou "Special Issues"

Proceeding du Congrès "Mechanically Alloyed, Metastable and Nanocrystalline Materials"- Barcelone (1997)  
Editor : M.D. Baro, S. Surinach - Materials Science Forum 269 - 272 (1998)

### PERIODIQUES

(Rubrique assurée en partie grâce au concours de M<sup>me</sup> TAUZIN - FIN BiPSé)

#### [45] DISPERSION STRENGTHENING OF COPPER ALLOYS

Sauer C. Weissgarber T. Dehm G. Mayer J. Pusche W. Kieback B. - Zeitschrift fur Metallkunde. 89(2):119-125, 1998  
Copper alloys with high electrical and thermal conductivities in combination with high strength at elevated temperature have been developed by including very fine thermodynamically stable TiC dispersoids into a Cu or an age-hardenable CuTi4 matrix. TiC dispersion strengthened copper alloys were prepared by mechanical alloying in a planetary ball mill using a blend of atomized prealloyed CuTi(X) powder and graphite powder. The mechanism of the formation of TiC dispersoids during milling and heating at various temperatures was investigated using X-ray diffraction and by TEM investigations. The processing technique was found to result in TiC dispersoids of different sizes (diameter 10 to 50 nm) preferentially localized on the grain boundaries. The matrix of the alloys is microcrystalline (grain size 100 to 500 nm). The observed creep behaviour of the alloys is described in dependence on size and volume fraction of the dispersoids and the composition of the matrix. It is demonstrated that these alloys - despite their microcrystalline microstructure - show a high creep strength, provided numerous small dispersoids are located on the grain boundaries, thus effectively preventing grain boundary sliding.

#### [44] MECHANICALLY ENHANCED REACTIVITY OF SILICON FOR THE FORMATION OF SILICON NITRIDE COMPOSITES

Shaw LL. Yang ZG. Ren RM. - Journal of the American Ceramic Society. 81(3):760-764, 1998

The chemical reactivity of silicon can be enhanced by mechanical activation. Ball milling elemental silicon powders with a small amount of carbon addition at ambient temperature has resulted in an enhanced nitridation of silicon at high temperatures. In comparison with powder mixtures without milling, the nitridation process at 1250 degrees C has been accelerated by a factor of 9 and 23 by milling powder mixtures in N<sub>2</sub> and NH<sub>3</sub>, respectively, before nitridation. The enhanced nitridation process for powders milled in N<sub>2</sub> is primarily attributed to the mechanical activation, whereas for powders milled in NH<sub>3</sub>, the trapped nitrogen within the powder mixtures during milling also contributes to the enhanced nitridation process, in addition to the effect of the mechanical activation.

#### [43] DENSIFICATION AND DILATION OF SINTERED W-CU ALLOYS

Upadhyaya A. German RM. - International Journal of Powder Metallurgy. 34(2):43-55, 1998

This study examines the effect of milling on the densification and dimensional change of a range of W-Cu alloys. Comilling of tungsten and copper powders enhance densification as compared to mixing. During heating, the compacts prepared from mixed powders swelled between 450 and 600 degrees C. Swelling is detrimental to compact shape retention and restricts densification. Most probably, swelling resulted from reduction of oxygen impurities in the copper. Calculations show that formation of reduction products within the powder generates a stress of about 98MPa. This leads to swelling of the copper particles and an overall swelling of the compacts. Compact swelling can be avoided by promoting conditions which prevent stress generation within the compacts, such as using low oxygen copper powder, pressing the compact at low compaction pressure, and using an inert sintering atmosphere. Comilling the constituents effectively avoids compact swelling. The study suggests alternative powders or processing routes to minimize swelling.

#### [42] B2-PHASE FORMATION AND HYDRIDING PROPERTIES OF (Mg<sub>1-x</sub>Al<sub>x</sub>)Ni (x=0-SIMILAR-TO-0.5)

Orimo S. Ikeda K. Fujii H. - Journal of Alloys & Compounds. 266(1-2):L 1-L 3, 1998

Crystalline forming abilities of the alloys (Mg<sub>1-x</sub>Al<sub>x</sub>)Ni were systematically examined by mechanical alloying of Mg-rich compositions ranging from x=0 to x approximate to 0.5. A crystalline phase with small crystallites of B2(CsCl)-type structure was firstly found to be formed in the alloys with x=0.3, 0.4 and 0.5, even in the as-alloyed state. This crystalline phase was thermally stable, and was able to interstitially dissolve hydrogen atoms without any structural transformation. These results indicate that the alloys can be regarded as a new series of hydrogen storage materials in the Mg-Ni system

#### [41] DIFFERENT OXIDATION REACTIONS OF ILMENITE INDUCED BY HIGH ENERGY BALL MILLING

Chen Y. - Journal of Alloys & Compounds. 266(1-2):150-154, 1998

Oxidation reactions of ilmenite (FeTiO<sub>3</sub>) have been investigated during thermal annealing and ball milling processes using X-ray diffraction and thermal analyses. Thermal oxidation reactions consist of a low-temperature (<1000 degrees C) reaction with the formation of intermediate phases (Fe<sub>2</sub>Ti<sub>3</sub>O<sub>9</sub> and Fe<sub>2</sub>O<sub>3</sub>) and high-temperature (>1000 degrees C) reactions with the formation of final thermally stable phases (Fe<sub>2</sub>TiO<sub>5</sub> and TiO<sub>2</sub>). Only the low-temperature reaction occurred during ball milling at room temperature and the high-temperature reactions were not observed, even after a prolonged milling. It is also found that the thermally stable Fe<sub>2</sub>TiO<sub>5</sub> phase transforms to the metastable Fe<sub>2</sub>Ti<sub>3</sub>O<sub>9</sub> phase during milling in oxygen. The different behaviours of the oxidation of ilmenite between thermal annealing and mechanical milling are due to different structural stabilities of oxides and different reaction mechanisms.

**[40] AN INVESTIGATION OF MECHANICALLY ALLOYED FE-AL**

Eelman DA. Dahn JR. Mackay GR. Dunlap RA. - Journal of Alloys & Compounds. 266(1-2):234-240, 1998  
An X-ray diffraction and Fe-57 Mossbauer effect spectra study of mechanically alloyed Fe<sub>100-x</sub>Al<sub>x</sub> is presented. Alloys with 0 less than or equal to x less than or equal to 60 were prepared from elemental powders in a high energy ball mill. Alloys of the composition Fe<sub>50</sub>Al<sub>50</sub> were also studied in detail as a function of milling time in order to better understand the phase formation in these alloys. X-ray measurements showed all fully milled samples to be of the bcc structure. Up to x=40, Mossbauer effect spectra showed the alloys to be ferromagnetic with a decreasing mean hyperfine field as a function of x. For x>40 no magnetic splitting was observed indicating that the alloys are paramagnetic at room temperature. Hyperfine field distributions of the ferromagnetic alloys can be interpreted in terms of Fe neighbor environments as a function of Al content. As a function of milling time, the composition of the Fe<sub>50</sub>Al<sub>50</sub> alloy may be described in terms of changing proportions of three different phases; a ferromagnetic bcc phase (FeAl<sub>y</sub>), a paramagnetic fee phase (AlFey) and a paramagnetic bcc phase (FeAl). The relative proportions, compositions and microstructures of these phases may be understood from the combined X-ray diffraction and Mossbauer effect measurements.

**[39] SYNTHESIS OF ALUMINA-NITRIDE NANOCOMPOSITES BY SUCCESSIVE REDUCTION-NITRIDATION IN MECHANOCHEMICALLY ACTIVATED REACTIONS**

Puclin T. Kaczmarek WA. - Journal of Alloys & Compounds. 266(1-2):283-292, 1998  
According to our recent study, zircon (ZrSiO<sub>4</sub>) mineral can be reduced to a zirconium silicide-alumina mixture by mechanochemically induced replacement reaction with aluminium. Further milling in nitrogen atmosphere produced zirconium nitride-alumina-silicide ceramic composite. This two step procedure can be extended for application to a variety of oxide starting materials. In this paper we present nitridation results for oxides of the group IV metals (Ti, Zr, and Hf). These elements were successfully nitrided to form compounds with the approximate composition MN<sub>0.9</sub> (M=metal). Intermediate phases including ternary alloys and sub-oxides were detected during the milling process. Resulting nitride-oxide ceramic compositions are compared to those predicted by thermodynamic considerations.

**[38] INCREASE OF SPECIFIC SURFACE AREA OF METAL HYDRIDES BY LIXIVIATION**

Huot J. Bouaricha S. Boily S. Dodelet JP. Guay D. Schulz R. - J. Alloys & Compounds. 266(1-2):307-310, 1998  
In this paper, we present a new and powerful method to increase the specific surface area of nanocrystalline ball milled materials. The method consists of using a lixiviation technique to increase the surface area. The element to be lixivated is ball milled with the hydrogen-absorbing alloy. After complete mixing, the lixiviated element is leached in an appropriate solution. The end product is a porous metal hydride with high specific surface area. The system magnesium-lithium is presented as an example. The results show that before lixiviation, the alloys absorb hydrogen slowly and the hydrogen capacity is reduced due to the presence of lithium. After lixiviation, the specific surface area shows a ten-fold increase and the hydrogen sorption kinetics are faster.

**[37] SYNTHESIS OF SM<sub>2</sub>FE<sub>17</sub>-CARBONITRIDES BY MECHANICAL GRINDING SM<sub>2</sub>FE<sub>17</sub> WITH PYRAZINE**

Jakubowicz J. Jurczyk M. - Journal of Alloys & Compounds. 266(1-2):318-320, 1998  
Sm<sub>2</sub>Fe<sub>17</sub>-carbonitrides were synthesized by mechanical grinding of Sm<sub>2</sub>Fe<sub>17</sub> powders with pyrazine (C<sub>4</sub>H<sub>4</sub>N<sub>2</sub>), without a crystallization treatment. The structural and magnetic properties were measured. It was found that magnetic powders with the composition of Sm<sub>2</sub>Fe<sub>17</sub>(C<sub>2</sub>N)<sub>(z)</sub> (z similar to 3.0) exhibited an intrinsic coercivity of 0.55 MA m(-1) (7 kOe) and remanent magnetic polarization of 0.83 T, at room temperature, and they were anisotropic. This study demonstrates that formation of Sm<sub>2</sub>Fe<sub>17</sub>-carbonitrides by mechanochemical reaction between Sm<sub>2</sub>Fe<sub>17</sub> and pyrazine has significant potential for the synthesis of powders in an economic, one-step method.

**[36] FORMATION OF AMORPHOUS FE<sub>1-x</sub>B<sub>x</sub> ALLOYS DURING SOLID STATE ALLOYING WITH HEXANE**

Ruuskanen P. Heczko O. - Journal of Non-Crystalline Solids. 224(1):36-42, 1998  
Fe<sub>1-x</sub>B<sub>x</sub> alloys were synthesized in an argon atmosphere using a high performed in argon with hexane as a process control agent (PCA). With powders and crystalline FeB and Fe<sub>2</sub>B phases with nanometer size existed. The amorphous phase content increased with the increase of the boron content. When hexane was used as a process control agent the carbon content of the ball-milled powder was found to increase as a function of the ball-milling time, A maximum carbon content of 37 at.% was measured after 500 h of milling, The increase in the carbon content being caused by the dissolution of the hexane. The dissolved carbon was found to increase the formation of the amorphous phase in the structures. Within a composition range of 0.1 less than or equal to x less than or equal to 0.2 a single phase amorphous structure exists, Within a composition range of 0.2 < x less than or equal to 0.5 the structure consists of a mixture of an amorphous phase and crystalline FeB and Fe<sub>2</sub>B phases. The average Curie temperature of the alloys milled in argon was 780 degrees C, and that of alloys milled with hexane only a little less than 750 degrees C. The onset of the exothermic reaction temperatures during annealing of the powders was about the same, 450 degrees C, for both alloy types. Mossbauer measurements revealed that the carbon does not form carbides but remains in a solid solution within the amorphous matrix.

**[35] FE CLUSTERING IN FCC CU-Fe ALLOYS PREPARED BY MECHANICAL ALLOYING**

Dunlap RA. Eelman DA. Mackay GR. - Journal of Materials Science Letters. 17(6):437-439, 1998.

**[34] SOFTENING AND HARDENING EFFECT IN FE-BASED NANOCRYSTALLINE FE(X) (X = AG, AL CR, CU, MN, NI) ALLOYS PREPARED BY HIGH ENERGY BALL MILLING**

Zhu M. Ahn JH. Che XZ. Li BL. Li ZX. - Journal of Materials Science Letters. 17(6):445-447, 1998.

**[33] PIEZOELECTRIC LITHIUM NIOBATE OBTAINED BY MECHANICAL ALLOYING**

Defigueiredo RS. Messai A. Hernandez AC. Sombra ASB. - J. Materials Science Letters. 17(6):449-451, 1998

**[32] DOPED TL-1223 SUPERCONDUCTORS**

Konig W. Mair M. Gritzner G. - Journal of Superconductivity. 11(1):107-108, 1998

Doped Tl-1223 superconductors of the composition  $Tl_{1-a}Bi_bPb_cBa_nSr_{2-n}Ca_2Cu_3O_y$  ( $a = 0.50 - 0.76$ ,  $b = 0, 0.16$  and  $0.3$ ,  $c = 0.5, 0.24$  and  $0$ ,  $n = 0.15 - 0.4$ ) were prepared from oxidic Ba-Sr-Ca-Cu precursor material. Upon calcination of the tartrate gels or the nitrates, the respective amounts of  $Tl_2O_3$ ,  $PbO$  and  $Bi_2O_3$  were added to the oxidic powders by milling. The samples were sintered in silver foil. The specimens consisted predominantly of the Tl-1223 phase with small amounts of Tl-1212 and secondary phases. T-c(0)-values ranged between 115 K and 119 K with transition widths around 1 K. Transport critical current densities up to  $1.4 \text{ kA cm}^{-2}$  at 77 K were measured for the as-sintered samples. Texturing was obtained by repressing and resintering of the superconducting material followed by annealing at 750 degrees C for 50 h in flowing oxygen. The transport critical current densities could be improved up to  $7 \text{ kA cm}^{-2}$  by the thermomechanical treatment. Microstructural studies yielded information on the alignment of the superconducting grains, on secondary phases and the porosities.

**[31] PROTON TRANSFER IN THE SOLID STATE - REACTIONS OF ORGANIC ACIDS AND AMINES**

Fernandezbertran J. Alvarez JC. Reguera E. - Solid State Ionics. 106(1-2):129-135, 1998

Grinding of crystalline organic acids and amines leads to proton transfer with ammonium salt formation or to hydrogen bonded complexes. Formation of amides is not achieved with these reagents even under strong impact. The mechanochemical processes were monitored by IR spectroscopy. Thirteen acids and four amines covering a wide range of acidity, basicity and hardness were employed.

**[30] SYNTHESIS AND SINTERING OF CORDIERITE FROM KAOLINITE AND BASIC MAGNESIUM CARBONATE**

Sumi K. Kobayashi Y. Kato E. - Nippon Seramikkusu Kyokai Gakujutsu Ronbunshi-Journal of the Ceramic Society of Japan. 106(1):89-93, 1998

Sintering behavior of the mixtures of kaolinite and basic magnesium carbonate (BMC) was investigated to obtain dense cordierite ceramics, Kaolinite and BMC were mixed by ball-milling in a molar ratio of  $nMgO \cdot Al_2O_3 \cdot 2SiO_2$  ( $n = 0.8-1.4$ ). Particularly fine mixtures were prepared by beads-milling after calcination. During firing of fine mixtures, magnesia disappeared completely by reaction with metakaolin to form amorphous particles below 900 degrees C. Since the amorphous particles were very sinterable, the pressed specimens were densified up to about 90% at 900 degrees C, and then mu-cordierite crystallized at about 940 degrees C. Dense alpha-cordierite ceramics with relative density of greater than or equal to 95% were obtained at 1300 degrees C from the mixtures of  $n = 1.0 - 1.4$ , and the lowest linear thermal expansion coefficient was  $2.2 \times 10^{-6}/K$  in the case of  $n = 1.0$ , which is close to the composition of cordierite.

**[29] RELATIONSHIP BETWEEN POWDER CHARACTERIZATION USING AN IMAGE ANALYSIS AND SINTERING CHARACTERISTIC [Japanese]**

Kinoshita M. Sato M. Yasunaga T. Uematsu K. - Nippon Seramikkusu Kyokai Gakujutsu Ronbunshi-Journal of the Ceramic Society of Japan. 106(1):94-98, 1998

This paper reports a new approach for characterization of the powder using image analysis. Through the use of image analysis for characterization the processing and properties of ceramics could be effectively controlled. Image analysis is based on the detailed particle shape analysis by SEM micrographs. We examined two kinds of  $SiO_2$ . These two  $SiO_2$  have same particle size distribution and zeta potential, but the green sheet density and sintering behavior are different. A comparison of the results of the image analysis revealed a deference in the shape and state of agglomeration of particles. In the ball-milling process, shape factor of particles affects the behavior of breaking-up of particles into small pieces. Green sheet density was found to depend on the state of the packing of particles, that is, the state and size distribution of agglomerates. Sintering behavior was also closely connected with green sheet density.

**[28] COOLING DSC ANALYSIS OF WATER ON THE SURFACE OF DIFFERENTLY-MILLED SILICA [Japanese]**

Nakamura M. Uematsu H. Shiomi H. - Nippon Seramikkusu Kyokai Gakujutsu Ronbunshi-Journal of the Ceramic Society of Japan. 106(1):103-105, 1998

The thermodynamical stability (i.e., bound strength from the solid surfaces) of water layer on the surface of differently milled silicas were evaluated by cooling DSC. The degradation in a crystallinity of silica due to milling caused the decrease in the hydrophilicity of the surface, then the bound force from the surface on the water was decreased and its long range distance force was critically decreased.

**[27] INFLUENCE OF AMORPHIZATION ON ELECTRODE PERFORMANCES OF AB(2) TYPE HYDROGEN STORAGE ALLOYS**

Yang XG. Lei YQ. Wang CS. Zhu GM. Zhang WK. Wang QD. - J. All. & Compounds. 265(1-2):264-268, 1998

It is generally accepted that the electrochemical discharge capacity of a hydrogen storage alloy is closely related to its crystal characteristics. From our experiment, the discharge capacity of AB(2) type Laves phase hydrogen storage alloy  $ZrCr_0.4Mn_0.2V_0.1Ni_{1.3}$  decreased sharply from  $324 \text{ mAh g}^{-1}$  to  $25 \text{ mAh g}^{-1}$  after amorphization by mechanically milling the crystalline (as-cast) alloy with stainless steel balls. We believe that for the as-cast alloy, hydrogen atoms stored in the tetrahedral interstitial sites of  $Zr_2B_2$  ( $B=Cr, V$  or  $Ni$ ) all contribute to its electrochemical capacity. However for the amorphous alloy only hydrogen atoms in low-energy Zr,B and Zr, tetrahedral interstitial sites contribute to its electrochemical capacity. We also believe that only half of the total sites in the crystalline or amorphous alloys can absorb and desorb hydrogen atoms reversibly, and that the process of ball milling manages to lower the barrier potential for the hydrogen discharge reaction by about  $60 \text{ kT (mol H)}^{-1}$ . We resolve the phenomenon into the finer particles including abundant hydrogen diffusion channels and the formation of a looser tetrahedral interstitial structure in the metal glass.

**[26] MULTICOMPONENT MECHANICAL ALLOYING OF FE-CU-NB-SI-B**

Yang JY. Wu JS. Zhang TJ. Cui K. - Journal of Alloys & Compounds. 265(1-2):269-272, 1998

The mechanical alloying (MA) process of an elemental powder mixture of Fe<sub>73.5</sub>CuNb<sub>3</sub>Si<sub>13.5</sub>B<sub>9</sub> was investigated in this paper. X-ray and electron diffraction results showed the MA product was an fcc solid solution with BCC structure. Transmission electron microscopy (TEM) dark field image revealed this Cu solid solution had a nanocrystalline structure and the grain size was about 10 nm. The results of Mossbauer analysis indicated that a part of the powders was superparamagnetic owing to the extremely fine size obtained by ball milling. The Fe atoms occupy four kinds of ferromagnetic local environments. The values of the hyperfine fields of three of the corresponding subspectra decreased with milling time because of the increasing alloying level. The fourth subspectrum could be attributed to the contribution of iron atoms in nanograin boundaries.

**[25] PHASE STABILITY AND MAGNETIC BEHAVIOR OF FE-DOPED CUO POWDERS**

Stewart SJ. Borzi RA. Punte G. Mercader RC. - Physical Review B - 57(9):4983-4986, 1998

We performed ball milling (BM) to powders of CuO and 0.25 mol. % of alpha-(Fe<sub>2</sub>O<sub>3</sub>)-Fe-57, and next annealed the samples in air in cumulative 40-h steps up to 1000 K. We analyzed the samples by x-ray diffraction (XRD) and Mossbauer spectroscopy. Up to the annealing at 800 K a significant part of the Fe-57 forms a Cu(Fe)O solid solution. The magnetic behavior of the CuO particles is reflected in the Mossbauer spectra that display an average value of 28 T of a broad magnetic hyperfine field distribution at 15 K. The XRD results show that the CuO particles have an average size of approximate to 7 nm and a significant degree of strain after BM. Their sizes increase with the successive thermal treatments, and the strain is gradually released. Small particles of CuFe<sub>2</sub>O<sub>4</sub> spinel are found to form after the 850-K annealing.

**[24] PREPARATION OF HYDROGENATION CATALYSTS [Review]**

Krylov OV. Navalikhina MD. - Russian Journal of Applied Chemistry. 70(8):1236-1253, 1997

Preparation of catalysts for hydrogenation of unsaturated and aromatic hydrocarbons and carbon monoxide is analyzed. Primary attention is given to nickel catalysts obtained by impregnation, including modified formulations. Metal carbides are discussed as a new class of hydrogenation catalysts. Among new preparation procedures, the mechanochemical methods, including in situ mechanochemical treatment during catalysis, are studied in more detail.

**[23] MECHANOCHEMICAL CHANGES OCCURRING UPON BREAKDOWN OF SOLIDS IN ALTERNATING ELECTRIC FIELD**

Ivakhnyuk GK. Shevchenko AO. Petrov SI. Ivakhnyuk VA. Denisov GA. Bolkunov OA. - Russian Journal of Applied Chemistry. 70(8):1324-1325, 1997

Laboratory and pilot-plant investigations of inorganic materials subjected to crushing and grinding under the action of frequency-modulated alternating electric fields were performed.

**[22] HARD MAGNETIC PROPERTIES OF NDFE10.5V1.5NX POWDERS WITH HIGH PERFORMANCE**

Yang JB. Cui B. Mao WH. Cheng BP. Yang YC. Ge SL. - J. Magn. & Magn. Materials. 182(1-2):131-136, 1998

High-performance powders of NdFe<sub>10.5</sub>V<sub>1.5</sub>N<sub>x</sub> with B<sub>x</sub> = 10.8 kG, H<sub>cJ</sub> = 4.3 kOe, (BH)<sub>max</sub> = 17.2 MGOe, and T<sub>c</sub> > 800 K were successfully prepared by using conventional milling process. The relationship of the crystallographic structure and the intrinsic magnetic properties to the nitrogen content is investigated. It is found that the nitrogen content is vital to obtain high-performance magnetic powders based on NdFe<sub>10.5</sub>V<sub>1.5</sub>N<sub>x</sub>. In comparison with quenching Nd-Fe-B powders, NdFe<sub>10.5</sub>V<sub>1.5</sub>N<sub>x</sub> powders are characterized by a larger maximum-energy product and a lower cost. Obviously, it is of significance in permanent magnet applications.

**[21] MAGNETIC PROPERTIES OF ISOTROPIC SRFE12O19 FINE PARTICLES PREPARED BY MECHANICAL ALLOYING**

Jin ZQ. Tang W. Zhang JR. Lin H. Du YW. - J. Magnetism & Magnetic Materials. 182(1-2):231-237, 1998

M-type Sr-hexaferites fine particles have been prepared by mechanical alloying. The influences of milling conditions on magnetic properties of SrFe<sub>12</sub>O<sub>19</sub> compounds have been systematically investigated. It can be found that annealing treatment at low temperature can play similar role in structural transformation as compared with long time milling process. For those samples annealed at about 750-800 degrees C, it is clear that saturation magnetization sigma(s), values are more sensitive to milling conditions than coercivity values H<sub>c</sub>. The maximum sigma(s) of 74.8 emu/g and H<sub>c</sub> of 5.6 kOe have been obtained in the isotropic powders annealed at 1000 degrees C after milling for 30 h by using high energy mill. With prolonged annealing time, little changes of magnetic saturation and coercivity in powders can be observed and short annealing time results in low properties. The coercive field H<sub>c</sub>, as determined from demagnetization curve, corresponds to the pinning or nucleation field.

**[20] MODIFICATION OF POLYPROPYLENE WITH MALEIC ANHYDRIDE - ULTRASONIC IRRADIATION EFFECTS**

Delossantos EA. Gonzalez MJL. Gonzalez MC. - Journal of Applied Polymer Science. 68(1):45-52, 1998

The mechanochemical reaction of modified polypropylene (PP) with maleic anhydride (MAH) has been studied by ultrasonic irradiation as an energy source at 60 degrees C. Through 2(3) factorial experimental design, three variables and their interactions were studied: the percentage of MAH, the percentage of benzoyl peroxide (BPO), and ultrasonic irradiation intensity (Watts). According to the results, an increase of wt % of MAH gave a negative effect in the grafting yield; in addition, this negative effect was observed in the interaction of MAH : BPO at a high range of wt %, this behavior is attributed to the homopolymerization of MAH at the experimental conditions employed. The higher positive effect onto the grafting yield was observed for the variable watts (ultrasonic irradiation intensity), even at low intensity. The better interaction of variables gave a MAH grafting degree of 4.65 wt % (93% yield). In addition, the effect of ultrasonic irradiation on the number-average molar mass (M<sub>n</sub>), weight-average molar mass (M<sub>w</sub>), and polydispersity index (M<sub>w</sub>/M<sub>n</sub>) was measured. It was observed that the M<sub>w</sub> decreased 13.73% and the M<sub>w</sub>/M<sub>n</sub> also decreased by 11.98%. The observed effect was attributed to the degradation mechanism induced by the ultrasound, which consists in the generation of macroradicals and their recombination. The product PP-g-MAH was characterized by infrared spectroscopy, also was used to prepare polypropylene-nylon-6 blends.

**[19] GRAIN SIZE DETERMINATION AND LIMITS TO HALL-PETCH BEHAVIOR IN NANOCRYSTALLINE NiAl POWDERS**

Volpp T. Goring E. Kuschke WM. Arzt E. - Nanostructured Materials. 8(7):855-865, 1997

Nanocrystalline NiAl powder with grain sizes in the range 7 to 80 nm was produced by mechanical alloying, followed in some cases by heat treatment. Microhardness and nanoindenter measurements as well as characterization by X-ray and TEM methods were carried out. It is found that, depending on the thermal history, the material exhibits "inverse Hall-Petch behavior" for grain sizes below 20 nm or a hardness increase until saturation at 7 nm. The grain sizes determined by TEM correspond closely to the coherence length measured by X-ray peak broadening. The results, including rms strains, are discussed in the light of existing theories.

**[18] BALL MILLING INDUCED BCT PHASE FORMATION IN IRON AND IRON ALLOYS**

Munitz A. Kimmel G. Rawers JC. Fields RJ. - Nanostructured Materials. 8(7):867-877, 1997

A variety of attritor ball milled Fe and Fe alloy powders, processed in an argon or a nitrogen environment, were studied using X-ray diffraction techniques. Broadened XRD spectra were obtained due to severe plastic deformation during ball milling. The broadening was non-uniform, displaying a systematic deviation from the average, with the (310) reflection peak being the broadest, and the (222) reflection peak being the sharpest. The systematic variation in broadening is interpreted as a tetragonal distortion. The tendency towards a tetragonal distortion occurred in all ball-milled samples.

**[17] XRD AND VSM STUDY OF BALL-MILLED SrFe12O19 POWDER**

Kaczmarek WA. Idzikowski B. Muller KH. - J. Magnetism & Magnetic Materials. 177(Part 2):921-922, 1998

The development of phases and the magnetic properties of nanostructural powder obtained by ball milling of SrFe12O19 in vacuum and air is presented.

**[16] ULTRAFINE BaFe12O19 POWDER SYNTHESISED BY MECHANOCHEMICAL PROCESSING**

Ding J. Tsuzuki T. McCormick PG. - J. Magnetism & Magnetic Materials. 177(Part 2):931-932, 1998

Ultrafine BaFe12O19 powder has been synthesised by a novel mechanochemical preparation method. Mechanical milling of  $1.2\text{BaCl}_2 + 12\text{FeCl}_3 + 38.4\text{NaOH}$  led to a mixture of NaCl and iron and barium hydroxide or oxide-hydroxide. The formation of BaFe12O19 required annealing at 800 degrees C in air. A significant reduction of particle size was achieved by dilution with NaCl. High coercivity values above 5 kOe were measured for BaFe12O19 platelets of 20-100 nm in diameter and 10-20 nm thick.

**[15] STRUCTURAL EVOLUTION OF Fe+Fe2O3 DURING MECHANICAL MILLING**

Ding J. Miao WF. Pirault E. Street R. McCormick PG. - J. Magn. & Magn. Mat.. 177(Part 2):933-934, 1998

The evolution of structure during the mechanical milling of the Fe + Fe2O3 mixture has been studied. Magnetite, Fe3O4, was initially formed after milling for short times. Nearly single-phase wustite, FeO, was found after milling for 30 h or longer. The kinetics of the phase transformations was studied by X-ray diffraction, Mossbauer spectroscopy and magnetic measurement. Nanocrystalline wustite formed during mechanical milling, decomposed into nanocrystalline Fe3O4 and Fe after annealing at 200-500 degrees C. Annealing at higher temperatures resulted in reformation of the wustite phase.

**[14] MAGNETIC BEHAVIOUR OF NANOCRYSTALLINE Fe**

Delbianco L. Hernando A. Navarro E. Bonetti E. - J. Magnetism & Magnetic Materials. 177(Part 2):939-940, 1998

The temperature dependence of magnetisation in nanocrystalline Fe obtained by ball milling has been studied. This analysis has been coupled to a Mossbauer spectroscopy investigation at room temperature. It has been found that the magnetic behaviour is strongly affected by the structure and volume fraction of the interfacial region between the crystallites (grain boundaries).

**[13] REMANENCE-ENHANCED Nd8Fe87M1B4 (M = Fe, V, Si, Ga, Cr) ALLOYS**

Miao WF. Ding J. McCormick PG. Street R. - J. Magn. & Magnetic Materials. 177(Part 2):976-977, 1998

The effect of additions of V, Si, Ga or Cr on the structure and magnetic properties of mechanically milled Nd8Fe88B4 has been investigated. Mechanical milling followed by suitable heat-treatment resulted in the formation of nanocomposites of Nd2Fe14B and alpha-Fe. For all compositions, optimally annealed samples exhibited remanence enhancement and single-phase magnetic behaviour, due to exchange interactions between Nd2Fe14B and alpha-Fe. However, no significant improvements in either remanence or coercivity were observed as a result of the additions.

**[12] MARTENSITIC TRANSFORMATION AND STRUCTURAL INHOMOGENEITY IN Fe72Pt28 INDUCED BY MECHANICAL MILLING**

Oba N. Takano H. Murayama S. Hoshi K. - J. Magn. & Magnetic Materials. 177(Part 2):1439-1440, 1998

The effect of mechanical milling on the structure and magnetic properties of ordered Fe72Pt28 has been studied. The X-ray diffraction results suggest the presence of two kinds of transformation under milling; order-disorder transformation and the martensitic one. Moreover, the mechanically milled Fe72Pt28 was transformed into a FCC structure by heating up to 750 K. Structural inhomogeneity in heated samples, that were FCC Fe72Pt28, is found to depend on milling time. Magnetic behavior is suggested to depend on, primarily, the structures and the structural inhomogeneity induced by milling.

**[11] MECHANICAL MILLING IN HEXAGONAL Fe-Y COMPOUNDS**

Takano H. Oba N. Murayama S. Hoshi K. - J. Magn. & Magnetic Materials. 177(Part 2):1445-1446, 1998

The intermetallic compound Y2Fe17 with a Th2Ni17-type hexagonal structure is mechanically milled. The structural changes and the magnetic properties are followed by X-ray diffraction and magnetization measurements. The results indicate that mechanical milling induces a hexagonal-to-BCC transformation and a partly amorphous state. This transformation leads to an increase in the Curie temperature.

**[10] A MOSSBAUER EFFECT STUDY OF BALL-MILLED STRONTIUM FERRITE**

Wu E. Campbell SJ. Kaczmarek WA. - J. Magnetism & Magnetic Materials. 177(Part 1):255-256, 1998  
The effects of milling SrFe<sub>2</sub>O<sub>19</sub> in air and vacuum for 800 h have been investigated by X-ray diffraction and Mossbauer effect spectroscopy measurements. Different levels of structural disorder along with partial decomposition of SrFe<sub>2</sub>O<sub>19</sub> to nanocrystalline grains of haematite, alpha-Fe<sub>2</sub>O<sub>3</sub>, and magnetite, Fe<sub>3</sub>O<sub>4</sub>, are obtained for the air and vacuum milling. Superparamagnetic relaxation effects due to the fine particles produced on milling are observed for a significant fraction (similar to 10% air milled, similar to 30% vacuum milled) of the milled samples.

**[9] EFFECT OF THE MECHANOCHEMICAL ACTIVATION ON THE REACTIVITY OF CARBON IN THE COURSE OF OXIDATION WITH OXYGEN**

Babenko VS. Molchanov VV. Konovalova TA. - Kinetics & Catalysis. 39(1):56-61, 1998  
The effect of the mechanochemical activation of carbon materials of a different nature on their reactivity in the course of oxidation with oxygen is investigated at 573-973 K. The mechanochemical activation is shown to cause a decrease in the apparent activation energy and a rise in the rate of carbon oxidation. The linear dependence of the oxidation rate on the number of strong electron-acceptor sites (EAS) is revealed. It is speculated that strong EAS of carbon materials are oxidation sites, comprising the carbon atoms with unsaturated bonds located on the sides that are perpendicular to the basal planes of the graphite lattice.

**[8] OLEFIN METATHESIS OVER SUPPORTED SILICA-MOLYBDENA CATALYSTS ACTIVATED BY GAMMA-IRRADIATION AND MECHANOCHEMICAL TREATMENT IN THE PRESENCE OF ALKANES**

Subbotina IR. Shelimov BN. Kazansky VB. - Kinetics & Catalysis. 39(1):80-85, 1998  
It is found that supported silica-molybdena catalysts (MoO<sub>3</sub>/SiO<sub>2</sub>) exhibit high catalytic activity in propene and 1-hexene metathesis at 293 K after gamma-irradiation or mechanochemical treatment (MCT) under an alkane atmosphere (methane, butane). Specific catalytic activities and productivities of the activated catalysts in the metathesis reactions are determined. On the basis of UV-Vis spectra and IR spectra of adsorbed CO, it is shown that gamma-irradiation and MCT of the catalysts in the presence of alkanes result in the reduction of Mo<sup>6+</sup> ions to Mo<sup>5+</sup> and Mo<sup>4+</sup>, in the formation of stable pi-complexes of Mo<sup>4+</sup> with olefins, and, probably, in the production of surface carbene complexes Mo=CH-R. The latter are supposed to provide high catalytic activity in olefin metathesis. A scheme of processes occurring under gamma-irradiation and MCT is proposed. A key step in this scheme is the formation of the Mo-C bond.

**[7] MICROWAVE DIELECTRIC PROPERTIES OF MAGNESIUM CALCIUM TITANATE CERAMICS PREPARED BY SEMI-ALKOXIDE METHODS**

Piagai R. Kim IT. Park JG. Kim Y. - J. Korean Physical Society. 32(Part 1 Suppl S):S 367-S 370, 1998  
(Mg<sub>0.95</sub>Ca<sub>0.05</sub>)TiO<sub>3</sub> powders were synthesized by two semi-alkoxide methods employing titanium isopropoxide and acetates, nitrates of magnesium and calcium. These powders without milling were fired in the temperature range of 1250 to 1500 degrees C. The sintered dense ceramics, with two phases (MgTiO<sub>3</sub> and CaTiO<sub>3</sub>), showed a much higher microwave dielectric quality factor compared to that prepared through a conventional mixed oxide method (Q = 7000 at 10.3 GHz). It was shown that the morphology of prepared powders plays an important role on the relative density and the grain size of MgTiO<sub>3</sub>. Dielectric constant was affected not by the grain size and oxygen deficiency but by the relative densities. Q was not affected by the relative density, oxygen deficiency and grain size. It was suggested the second phase and its distribution in the matrix of MgTiO<sub>3</sub> result in the Q deviation. The rapid grain growth causes a partial accommodation of second phase into grain. The samples with such accommodation revealed a higher reduction in microwave Q-factor than that the samples with accommodation of CaTiO<sub>3</sub> on the grain boundary.

**[6] PREPARATION AND RESISTIVITY-TEMPERATURE DEPENDENCE OF LSCO/CARBON BLACK/POLYETHYLENE COMPOSITES**

Liao J. Xiao DQ. Zhang W. Shen JW. - J. Korean Physical Society. 32(Part 3 Suppl S):S1060-S1062, 1998  
Carbon black (CB) filled high density polyethylene (HDPE) composites were prepared by thermal roll-milling technique, and the positive temperature coefficient (PTC) characteristics of the resistance of the composites were studied. The ternary LSCO-CB-HDPE composites using LSCO (La<sub>0.5</sub>Sr<sub>0.5</sub>CoO<sub>3</sub>) powder as the third phase filler were prepared, and the effect of LSCO powder on the PTC characteristics of CB-HDPE composites were investigated. It was found that LSCO powder strengthens the PTC effect, and decrease the negative temperature coefficient (NTC) effect of the composites, and consequently LSCO is a good candidate for PTC composite filler. It was discovered that the composites consist of the network structures which are caused by the filling of LSCO powder. The improvement of PTC effect of the composites is attributed to the network structure, the formation mechanism of which is discussed from hydrophilic nature points of view.

**[5] EFFECTS OF NANOMETER-SCALE STRUCTURE ON HYDRIDING PROPERTIES OF MG-NI ALLOYS - A REVIEW**

Orimo S. Fujii H. - Intermetallics. 6(3):185-192, 1998  
The materials, which are produced by mechanical grinding/alloying, possess superior hydriding properties depending on their nanometer-scale structures. In this review paper, we present our recent works on the hydriding properties and nanometer-scale structures of some mechanically produced Mg-Ni alloys. The first topic is the properties of some nanostructured Mg<sub>2</sub>Ni (Mg-33 at%Ni) consisting of nanometer-scale crystallite (intra-grain) and inter-grain regions. In this system, the existence of the inter-grain region gives rise to notable hydriding properties of the nanostructured Mg<sub>2</sub>Ni such as the enhanced hydrogen dissolution and low-temperature dehydriding. The second topic is the properties of the alloys Mg-33, 38, 43 and 50 at% Ni in which a different amount of the amorphous (a-)MgNi phase depending on Ni content is homogeneously dispersed around nanometer-scale Mg<sub>2</sub>Ni crystallites. In this system, the total hydrogen content increases with increasing Ni content. This experimental result is well explained by a model based on three nanostructural constituents of these alloys and their hydriding properties.

**[4] THERMAL ANALYSIS OF METASTABLE FE-CU-AG PREPARED BY MECHANICAL ALLOYING**

Pankhurst QA. Cohen NS. Odlyha M. - Journal of Physics-Condensed Matter. 10(7):1665-1676, 1998

The thermal properties of metastable Fe-Cu-Ag alloys have been investigated using differential scanning calorimetry, complementing an earlier x-ray diffraction and Mossbauer spectroscopy study. Samples were mechanically alloyed under nitrogen in a high-energy ball mill for 70 hours. DSC and x-ray data on milled and unmilled elemental powders show that Fe sustains more lattice distortion than Cu or Ag, with an rms strain of order 0.6%. In the equimolar binary alloys Fe-Cu, Fe-Ag and Cu-Ag the presence of DSC exotherms below 400 degrees C is found to correspond to a gradual decomposition of the alloy, while exotherms above 400 degrees C denote recrystallization and grain growth. The absence of low-temperature DSC exotherms in Fe-Ag confirms phase segregation in this granular alloy. In equimolar Fe-Cu-Ag, DSC curves after successive heat treatments indicate a highly disordered state, with fine-scale residual crystallinity. Heating promotes the decomposition of this metastable state into polycrystalline and segregated Fe, Cu and Ag.

**[3] DEBYE TEMPERATURE OF NANOCRYSTALLINE Zr1-XAlX SOLID SOLUTIONS WITH DIFFERENT GRAIN SIZES**

Herr U. Geigl M. Samwer K. - Philosophical Magazine A-77(3):641-652, 1998

In the Zr1-xAlx system a polymorphous crystal-to-glass transformation (CGT) has been found in earlier work. The CGT is characterized by a softening of the shear elastic constant as observed in both computer simulation and experiments. In this work we report studies of supersaturated Zr1-xAlx crystalline solid solutions with x = 0.1 and x = 0.16 which have been prepared by mechanical alloying or rapid quenching from the melt. From the specific heat measured at low temperatures, the Debye temperatures of the samples are calculated. A large reduction in the Debye temperature with decreasing grain size is found for both concentrations. It is concluded that the effect of grain size plays a major role in the elastic properties of the Zr1-xAlx solid solutions. The possibility of a local stabilization of the amorphous phase at the grain boundaries and the effect on the CGT is discussed.

**[2] COMMINATION OF GEOLOGICAL SAMPLES USING SYALON BASED MILLING VESSELS - COMPARISON WITH ESTABLISHED SAMPLE PREPARATION METHODS**

Allen MA. - Analytical Communications. 35(2):75-78, 1998

The productivity and reputation of analytical laboratories are in part underpinned by the standards of efficiency and quality applied when preparing samples for analysis, Sample milling vessels constructed from Syalon 101 (an aluminium-silicon-oxynitride alloy) have recently become available. This paper describes an assessment of their efficiency and contamination characteristics to assist the evaluation of Syalon as a possible alternative to agate for sample preparation prior to multi-element geochemical analysis, Samples of crushed quartz, quartz sand, garnet-bearing schist and marble were milled in Syalon vibrating-cup and planetary ball mill vessels to compare their comminuting efficiency with that of conventional hardened chromium steel and agate vessels, Contamination during milling was estimated by comparison with samples comminuted in agate vessels only, because metallic preparation equipment is known to introduce contaminants including Fe, Cr, W, Mn, Ni and Co to the sample. The comminuting efficiency of Syalon is superior to that of agate, Although some contamination does occur it may be less analytically critical than that derived from metallic comminution equipment.

**[1] HYDROGEN INTERACTION WITH ALLOYS AND INTERMETALLIC COMPOUNDS PREPARED BY MECHANOCHEMICAL METHODS [Review] [Russian]**

Konstanchuk IG. Ivanov EY. Boldyrev VV. - Uspekhi Khimii. 67(1):75-86, 1998

The published data on hydrogenating properties of mechanical alloys and intermetallic compounds obtained by mechanical alloying or mechanical treatment are surveyed. The mechanochemical methods are shown to be effective in solving a number of problems connected with metal and alloy hydrogenation as well as in synthesis of new hydrides and nanocomposite materials. A mechanism of hydrogenation of mechanical alloys is discussed.

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