



**RESEAU FRANÇAIS DE
MECANOSYNTHESE**

Lettre N°73

Avril 2001

182 Groupes de Recherche

(dont 109 à l'étranger / 32 Pays)

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Nouvelle Adhésion

Vladimir Sepelak

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Full Congress Announcements
Congress List (related to Nanomaterials)
Cooperation (PhD, Post Doc, International Relationships)
Books (related to Nanomaterials)
Bibliography
Annonce des JRFM'2001
Technical Announcements (from M.B.N. srl & Fritsch)
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Le site web du RFM est :

<http://www.bls.fr/amatech>

Rubrique Pages Sciences et Techniques pour l'Ingénieur (Rubrique Sciences)
? vous y trouverez les anciennes lettres du RFM (accessible par Adobe Acrobat)
les statuts du RFM ainsi que les annonces concernant les JRFM'2001 et quelques éléments mis à jour régulièrement
concernant les derniers résultats dans ce domaine.

Bulletin d'adhésion 2001 / Subscription Print

(à retourner à l'adresse suivante - to be sent at the following address) :

Eric GAFFET

CNRS UMR5060 « Métallurgies et Cultures »

Thème « Nanomatériaux : Elaboration et Transitions de Phases Hors Equilibre »

Site de Sévenans (UTBM)

F90010 - Belfort Cedex - France

Nom/Name :Prénom / First Name :

Adresse complète / Full Address :
.....

Téléphone/ Phone:Télécopie (Fax) :

e_Mel. / e-Mail :

désire adhérer au Réseau Français de Mécanosynthèse /want to become a member of the French Mechanical Alloying Network

Chèque ci joint / Check enclosed in the amount of 100FF

Lettre RFM N°73 - Avril 2001
Corresp. : <mailto:Eric.Gaffet@utbm.fr>

The check has to be to the order : Réseau Français de Mécanosynthèse
(Please do not use Eurocheck, the taxes do correspond to 40% of the amount of the check).

JRFM' 2001
6 émes Journées du Réseau Français de Mécanosynthèse
Amiens
Pôle Scientifique Faculté des Sciences
Les 21 et 22 mai 2001
<http://www.u-picardie.fr/colloque/jrfm>

Thématique 2001:
Influence de la Mécanosynthèse sur les Propriétés
Physico - Chimiques des Matériaux

Fiche d'Inscription

(à renvoyer à Luc AYMARD avant le 31.01. 2001)

Nom: Prénom:
Téléphone: Fax: E-mail:
Adresse de Facturation:

- * Pour les laboratoires propres, UMR ou associés au CNRS, indiquer le code et l'adresse complète de l'Unité. **Une facture sera établie directement à leur encontre.**
- * Pour les agents CNRS merci d'indiquer votre indice majoré:
(nécessaire pour obtenir un discount pour les déjeuners)

Frais d'inscription: (comprenant recueil des résumés, 2 déjeuners, un dîner)

Déjeuner du 21 mai oui / non
Banquet du 21 mai soir oui / non (merci d'entourer les réponses)
Déjeuner du 22 mai oui / non

Tarifs : **Etudiant(e)s de thèse : 100 Frs.** **Autres participant(e)s: 400 Frs.**

Mode de paiement :

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Conditions de résiliation: En cas de désistement, aucun règlement ne sera restitué.

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Fiches d'inscriptions et résumés à retourner avant le 31 02 2001 à Luc Aymard
(JRFM 2001) Faculté des Sciences, LRCS
33 rue Saint leu Amiens 80000
tel: 03 22 82 75 74 fax : 03 22 82 75 90 e-mail: luc.aymard@u-picardie.fr

Date limite d'Envoi des résumés: 02 avril 2001

IMPORTANT: Les frais d'inscription ne comportent pas l'adhésion au RFM au titre de l'année 2001. Pour participer aux JRFM2001, il est impératif d'envoyer votre cotisation de 100 Frs. à l'ordre du RFM (pour tout renseignement complémentaire sur cette adhésion contacter E. Gaffet)



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**Annnonce de congres et / Ou Ecoles
Congress and School Announcements**

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Science et Technologie des Poudres

Nancy - France

3 - 5 Avril 2001

website : <http://www.inpl-nancy.fr/stpoudres3.html>

e-Mail : <mailto:stpoudres@inpl-nancy.fr>

Australian Workshop on Nanotubes and Fullerenes

Australian National University, Canberra,

Mai 3- 4, 2001

Scope

Fullerenes, nanotubes and related nanomaterials are receiving great interest due to the new properties and to potential application in various fields. A workshop is designed to bring together research scientists and engineers working in various disciplines in the broad area of nanotube and Fullerene -related materials and to provide an opportunity to exchange new ideas and results. Students are encouraged to attend with free registration.

Topics

Thermodynamics and Modeling, Synthesis and Processing, Characterization, Properties and Applications

First announcement and call for paper

Send your abstracts and registration by e- mail attachment to [mailto:awnf200@ anu. edu. au](mailto:awnf200@anu.edu.au). Abstract format and registration form can be found at: <http://rsphysse.anu.edu.au/nanotube/awnf2001/>

For more information please contact Dr Ying Chen, Department of Engineering & Research School of Physical Science and Engineering, The Australian National University, ACT 0200.

Ph: 61 02 62490380, Fax: 61 02 62798338,

E- mail: [mailto:ying.chen@ anu. edu. au](mailto:ying.chen@anu.edu.au).

Partial list of invited speakers:

Prof. D. Tomanek, MSU, USA Prof. G. Wallace, University of Wollongong

Prof. H. M, Cheng, IMR, CAS, China Dr. L. M. Dai, CSIRO

Prof. M. Wilson, UTS

PM2 TEC2001

2001 International Conference on Powder Metallurgy

& Particulate Materials

13 - 17 Mai 2001 - New Orleans - USA

Contact : MPIF

JRFM'2001

21 et 22 Mai 2001 - Amiens - France

Thème : Influence de la mécanosynthèse sur les propriétés physico - chimiques des matériaux

Contact : Luc.Aymardsc.u-picardie.fr

ou <mailto:Eric.Gaffet@utbm.fr>

7th International Symposium on Agglomeration

29, 30, 31 May 2001

Albi - France

Website : <http://www.univ-inpt.fr/~agglom>

or <http://www.enstimac.fr/>

ISMANAM2001

University of Michigan, Ann Arbor, Michigan, USA

Ann Arbor, Michigan, 24-29 June, 2001

<http://www.ners.engin.umich.edu/ISMANAM2001>

Abstract deadline is March 1st, 2001.

Abstracts of 200-400 words should be submitted by e-mail to

E-Mail : <mailto:ISMANAM-2001@umich.edu>

COLLOQUE SUR LES INNOVATIONS

DANS LES MATERIAUX FRITTES

Poitiers-Futuroscope

3-4-5 juillet 2001

consulter le site <http://www.sf2m.asso.fr/>(rubriques sommaires puis conférences)



International Conference on the Applications of the Mossbauer Effect

Oxford, UK

2-7 September 2001

Abstracts are now invited for for the above meeting, which is the next in the ICAME conference series. You are asked to submit your abstract via the conference website <http://www.iop.org/IOP/Confs/ICAME/> by no later than 1 April 2001.

For further information or enquiries please contact the Conference Office at the Institute of Physics, 76 Portland Place, London W1B 1NT, UK.

E-mail should be directed to: <mailto:rebecca.chapple@iop.org>

International Conference

"FUNDAMENTAL DASES of MECHANOCHEMICAL TECHNOLOGIES"

Novosibirsk, Russia, August 16-18, 2001

Contact: Prof. N. Lyakhov

Institute of Solid State Chemistry

E-mail: <mailto:Conf@solid.nsc.ru>

Fax: +7 3832 32 28 47

The first circular is available on WEB-Site of the Institute:

<http://www.solid.nsc.ru/>

(IPCM 2001)

La 7eme conference internationale sur les phenomenes d'interface dans les materiaux composites (IPCM 2001) se tiendra au palais des congres d'Arcachon (40 km de Bordeaux) du 11 au 14 septembre 2001.

<http://www.arcachoncongres.com/ipcm2001/>

L A C A M E ' 2 0 0 2

EIGHTH LATIN AMERICAN CONFERENCE

ON APPLICATIONS OF THE MÖSSBAUER EFFECT

PANAMA, 22-27 SEPTEMBER, 2002. E-mail: <mailto:lacame2000@fisica.ciens.ucv.ve>

<http://www.up.ac.pa/Eventos/lacame2002/inicio.htm>

(IWSIS-3)

October, 7-12, 2001.

3rd International Workshop on Surface and Interface Segregation , Island of Porquerolles, French Riviera,

This Workshop is devoted to the study of the segregation phenomenon in defects of crystallized solids (surface, grain boundary, interface of interphase...)

INFOS : <http://www.crmc2.univ-mrs.fr/confs/iwsis>



SOUTENANCES DE THESE

Cooperative Research on Related Areas

Europe (6/03/2001)

The ESF, on the recommendation of the scientific Standing Committee for Physical and Engineering Sciences (PESC), will support, in fields related to PESC's remit, approximately 10 ESF Exploratory Workshops to be held in 2002.

Each workshop will allow 20-25 leading European scientists to explore novel ideas at the European level with the challenging aim to "spearhead" new and preferably inter-disciplinary areas of research.

In specific terms, PESC's 2001 Call is for workshop proposals on R&D subjects which are NOVEL AND PREFERABLY INTERDISCIPLINARY and which concern emerging fields within any of the following areas: chemistry, physics, mathematics, information sciences, fundamental engineering sciences, materials sciences, and technologies research in these areas.

The PESC Call is available at <http://www.esf.org/physical/WorkshopCalls/Call2001.htm>

COREE du SUD (19/01/2000)

From Professor Soon H. Hong

Dept. of Materials Science and Engineering - Korea Advanced Institute of Science and Technology

373-1 Kusung-dong, Yusung-gu - Taejon, 305-701, Korea

E-mail : <mailto:shhong@sorak.kaist.ac.kr> / <mailto:shhong@sorak.kaist.ac.kr>

Fax. : 82-42-869-3310 - Tel. : 82-42-869-3327

We are currently working on the mechanical alloying processes and the characterization of mechanical & thermal properties of nanocrystalline materials and composite materials, such as SiC/Al, WC/Co and W/Cu for structural or thermal management applications. We are very pleased to discuss for international cooperative research on related topics with Members of Mechanosynthese Group.

**Job Vacancies, Ph D Position and Post Doc Position
Requests – Proposals**

(From Paul J. Warren – 6/03/2001)

A Research Training Network on nanostructured Aluminium alloys is urgently looking for researchers. There are opportunities for Post-doctoral and Pre-doctoral researchers available immediately in Oxford(UK), Grenoble(F), Turin(I), Stockholm(S), Madrid(E), Waterford(IRL), Ioannina(G), Warsaw(PL), and Bratislava(SK). Please pass this information to anyone who may be interested.

For further details please visit the website <http://www.materials.ox.ac.uk/nano-al>.

Post Doctoral Fellow Positions - University of Toronto (5/03/2001)

The University of Toronto is seeking three postdoctoral fellows for a major new initiative in laser nanofabrication, material diagnostics, and nano-optics fabrication. State-of-the-art laser-processing facilities and optical material fabrication and diagnostic infrastructure are funded from various government and industrial sources. The research is centered in the Photonics Group of the Department of Electrical and Computer Engineering, and directed by Professor Peter R. Herman.

1 - F2-Laser Nanofabrication Facility The post doctoral fellow will drive the development of precise optical tools and nanofabrication processes in one of the world's forefront facilities for F2-laser nanofabrication research. The record short-wavelength light of 157 nm drives strong interactions in challenging materials at sub-micron feature sizes that are attractive for widespread application in fabricating photonic components, optical circuits, lab-on-a-chip systems, and wireless electronic circuits. Responsibilities include co-supervision of graduate students, coordination of research activities with scientists from academia and industry, and co-management of the novel facility. The \$1 million program also includes establishing state-of-the-art optical communication diagnostics. The research goals are new micromachining and photosensitivity processes for fabricating and/or tuning optical circuits, 3-D photonic devices, photonic bandgap structures, and binary optics. These studies are to be integrated with related program in ultrafast laser processing.

2 - Photonic-Bandgap Integrated Optical Circuits An outstanding candidate is sought for a collaborative project to integrate photonic bandgap structures into functional optical circuits. Three-dimensional diffractive optical structures offer in theory, powerful capabilities in managing light in optical circuits. The goal is to practically harness this capability within the structure of our existing photonics fabrication program (the F2-laser nanofabrication facility and ultrafast-laser processing laboratory) and through collaboration with a leading photonic-bandgap group at the University of Toronto. The project is suited to a technically strong and creative individual motivated to revolutionize the future manufacturing of photonic circuits.

3 - Laser-Induced Breakdown Spectroscopy of Aluminum A laser-spectroscopy specialist is required to drive an industrially sponsored research program in laser-induced breakdown spectroscopy of recycled aluminum. The goal is to develop novel laser and diagnostic technology for collecting accurate assays of aluminum metal for a future large-scale pilot project in automobile recycling by Alcan International. One project is the study of a new laser interaction - invented at the University of Toronto - that entails high-repetition 'bursts' of ultrafast laser pulses. This approach promises to cleanly remove surface oxides and precisely probe the underlying bulk aluminum within a single burst. Research centers on fundamental laser interactions and defining laser processing windows in cooperation with our industrial partner.

The research positions entail extensive academic collaboration within the Engineering Faculty, the Department of Physics, the Department of Chemistry, and Photonics Research Ontario (www.pro.on.ca) and with other academic research centers: Laser Laboratorium, Goettingen, Germany; National Research Council, Canada; and Optical Fibre Technology Centre,

Lettre RFM N°72 - Mars 2001

Corresp. : <mailto:Eric.Gaffet@utbm.fr>



Australia. Research also includes close interaction with world-leading photonics and manufacturing companies in Canada (i.e. JDS Uniphase, Mitel, Raytheon Elcan Optical Technology, Alcan International) and internationally (i.e. Photonics Integrated Research, Lambda Physik, MicroLas). Our principle goals are forefront science and engineering research for public dissemination in high-quality journals and the generation of intellectual property. Successful candidates will lead one of the following three research areas.

Required qualifications for all three positions include a Ph.D. in experimental Physics, Engineering Science, or Electrical Engineering, and experience with several of the following areas: F2 or excimer lasers, ultrafast lasers, optical and opto-mechanical design, photonic devices for optical communications, optical waveguide fabrication and modelling, optical communication diagnostics, photonic bandgaps, laser-matter interaction physics, spectroscopy, and material diagnostics (SEM, FTIR, AFM, SEM, EDX, ESR). An independent and highly motivated person with good technical and communication skills is required. Each position entails a supervisory role with graduate students and other researchers. The successful candidate will also be responsible for coordination and administration of research involving visiting scientists and industrial partners in the local booming Photonics industry.

The postdoctoral positions are available immediately and remain open until filled. Provide a CV, relevant publications, three references, and recent university transcripts by mail, electronically, or by fax:

Professor Peter R. Herman

10 King's College Rd. Tel: 416-978-7722 - Dept. of Electrical and Computer Engineering Fax: 416-971-3020

University of Toronto, Toronto, ON hermanp@ecf.utoronto.ca - M5S-3G4, CANADA

The University of Toronto is Canada's top university, located in the center of Canada's largest and most dynamic city.

Toronto is home to a large and diverse immigrant population and has low-crime rates. See more at:

<http://www.utoronto.ca/toronto.htm>

Further Employment Information: http://www.ecf.utoronto.ca/~hermanp/job_available.htm

From B. Mhohamed – UK – (10/01/2001)

Marie Curie Training Fellowships

Applications are invited for 3-12 month research fellowships supported by the Marie Curie Training Sites scheme. The successful candidates will be involved with the processing of alloys, intermetallics, nanostructures, or composites for high-temperature, biomedical and/or energy-storage applications. Processing techniques and facilities include ball milling, mechanical alloying, reaction synthesis, tape casting, slurry powder metallurgy, and vacuum cold/hot pressing. Materials characterisation will be carried out by TG/DTA, DSC, MS, optical microscopy, X-Ray, and SEM/TEM techniques. Complementary modelling activities for materials-design, processing, microstructural evolution, and/or property predictions may also be involved as part of the fellowship training programme. Modelling methodologies range from *ab initio* atomistic simulations to finite-element methods. The candidates must satisfy the basic criteria of the training scheme as outlined under <http://www.cordis.lu/improving>. As the fellowship forms part of a higher degree project, the candidates should be a registered full-time PhD research student in a well-recognised institution, working on materials synthesis, characterisation, and/or computer modelling of materials, of an EU nationality (non-UK) and under 35 years of age. Deadline for application: 30 February 2001.

For further details, please contact: Professor Z. Xiao Guo, phone: 0044-20-7882-5569; e-mail: x.guo@qmw.ac.uk; or visiting: <http://www.metallicmaterials.com/>.

QMW / University of London is an equal opportunity employer.

From A.R. Yavari - France (8/01/2001)

EU Postdoc/Ph.D. positions in fields of Nanostructured Materials and Bulk

Metallic Glasses are available immediately in France and several other EU

States. Please check the following web page

<http://www.inpg.fr/BMG-RTN/>

and contact the Coordinator A.R. Yavari at <mailto:euronano@ltpcm.inpg.fr>

From Dr. Jürgen Eckert Allemagbe (11/2000)

Ph D or Post Doc Position

We are looking for a PhD candidate / Postdoc to start as soon as possible in the framework of an European RTN network on bulk metallic glasses and nanostructured materials.

Dr. Jürgen Eckert

IFW Dresden - Institut für Metallische Werkstoffe

Postfach 27 00 16 - D-01171 Dresden -Germany

>Tel.: +49 (351) 4659-602/-324

>Fax: +49 (351) 4659-541

>E-mail: <mailto:j.eckert@ifw-dresden.de>



Bibliographie Récente

Livres ou "Special Issues"

(11/2000) Information from Fritsch (A. Kohler)

The subject of the sixth forum part Fritsch Forum Part VI scheduled for September 14/15th, 2000, will be "high-energy fine grinding". Research and Development demand general-purpose grinding processes which simultaneously exactly define the required energy and the type of stress. This is the only way that reliable results can be achieved when determining activation energies or the mechanical alloying. It must be possible to reproducibly adjust all of the grinding parameters affecting the grinding results.

Participants from research, development and industry will report on demands and novel technological solutions in developing innovative milling technologies. One of the highlights of the event will be FRITSCH's new Vario-planetary mill "pulverisette 4". This planetary ball mill can simulate ball mills of conventional construction, precisely copy the types of stresses that occur there, and thus reproduce or optimise grinding processes. Due to the great flexibility when selecting the grinding parameters, it is possible to produce results that are unattainable with other ball mills. It is the ideal mill for mechanical activation and alloying. The main applications are in the area of material research and naturally wherever a powerful, innovative laboratory planetary mill is needed.

An extensive report has been written about this event which details and makes readily available the relevant parts of the lectures and the extensive results of the discussions. Anyone interested can request a copy of the complete report for this forum part VI event on the topic "high-energy fine grinding". Please contact Andrea Köhler, FRITSCH GMBH, Industriestrasse 8, D-55743 Idar-Oberstein, (Phone: 0049/6784/7046, E-Mail: koehler@fritsch.de)

(7/07/2000) - From Victor Riecanaky Publisher

Cambridge International Science Publishing <http://www.demon.co.uk/cambsci/homepage.htm>

MACROMOLECULAR MECHANOCHEMISTRY

Volume 1: Polymer Mechanochemistry - by Cleopatra Vasiliu OPREA & Florin DAN

Department of Macromolecules, Gh. Asachi, Technical University, 6600 Iasi, Romania

Macromolecular Mechanochemistry presents from theoretical and experimental point of view the main problems of this field, including the results obtained in more than a century of research. It is organised in two volumes: Polymer Mechanochemistry and Polymers with Chemomechanical Functions, respectively. The present volume deals with: Chained Polystage Character of Mechanochemical Process (1), Mechanochemistry of Polymers Deformation (2); Mechanochemistry of Polymer Fracture (including also the Fracture of Composite Materials) (3), and Mechanochemical Processes for Energy Conversion (4). In this frame, the theoretical and experimental material is organised in correlation to the reaction mechanism, the type of mechanical solicitation, and the nature of environmental medium. This book is addressed to professors, students, and researchers involved in the field of polymer science, to engineers from the industry of synthesis and processing of plastic materials, elastomers and fibres, as well as to specialists from all technical domains that exploit polymer-based materials. They will find in the book examination of the theoretical, experimental and applied problems and wide access to the basic literature in this field. Contents

1. Chained polystage mechanism of mechanochemical processes
2. Mechanochemistry of polymers deformation
3. Mechanochemistry of Polymer Fracture
4. Mechanochemical Processes for Energy Conversion

Volume 1 (ISBN 189832672X) will be published in September 2000, approx. 500 pages, cased, approximate price £80.00; (volume 2 will be published at the end of - 2000)

Send your preliminary order to <mailto:orders@cisp.demon.co.uk>

(9/06/2000)

"Mechanical Alloying : FABRICATION OF ADVANCED MATERIALS AT ROOM TEMPERATURE" by M. Sherif El-Eskandarany

(ISBN: 977-299-089-7) Published by DAR AL-FIKR AL-ARABI, Cairo-Egypt.

The price of the book is \$50, and a special discount (20%) is offered to all the RFM member.

Preface

Mechanical alloying (MA) process using ball-milling and/or rod-milling techniques, has received much attention as a powerful tool for fabrication of several advanced materials, including equilibrium, nonequilibrium (e.g., amorphous, quasicrystals, nanocrystalline, etc.), and composite materials. In addition, it has been employed for reducing some metallic oxides by milling the oxide powders with metallic reducing agents at room temperature. The MA is unique process in that a solid state reaction takes place between the fresh powder surfaces of the reactant materials at room temperature. Consequently, it can be used to produce alloys and compounds that are difficult or impossible to be obtained by the conventional melting and casting techniques.

This book intended primarily to serve as an introduction to the MA process, including general description of the process, starting material requirements, the equipment, characterizations of the milled powders, and consolidation techniques, which used to compact the powder into fully-dense bulk materials.

The book contains several typical examples of selected advanced materials that have been fabricated by MA. This book is aimed at either senior undergraduate/post graduate students or materials scientists/metallurgists. - M. Sherif El-Eskandarany - April 2000 - Cairo - Egypt

Contents



Introduction - Background - History of Mechanical Alloying - Milling - Factors Affecting the Mechanical Alloying 8 - Types of Mills 8 - High Energy Ball mill 9 - Attritor Ball Mill 9 - Planetary Ball Mill 11 - Vibratory Ball Mill 12 - Low Energy Ball Mill 15 - Tumbler Ball Mill 15 - Tumbler Rod Mill 16 - Effect of Ball-to-Powder Weight Ratio 19 - Effect of Milling Atmosphere 22 - Mechanism of Mechanical Alloying 23 - Ball-Powder-Ball Collision 24 - Necessity of Mechanical Alloying 25 - References 27

PART I GRAIN REFINING, SIZE CONTROLLING AND HOMOGENIZATION

Fabrication of ODS Alloys - Introduction and Background - Applications and Examples - ODS Ni-Base Superalloys and Fe-Base High Temperature Alloys 34 - INCONEL MA 754 35 - INCONEL MA 6000 37 - INCOLOY MA 956 38 - ODS Al Base Alloys 38 - References 45 - Fabrication of Nanophase Materials - Introduction - Influence of Nanocrystalline on the Mechanical Properties: Strengthening by the Grain size Reduction - Formation of Nanocrystalline Materials by Ball Milling Technique - Mechanism(s) 52 - Selected Examples 53 - Formation of Nanocrystalline Ni_xMo_{100-x} 53 - Formation of Nanocrystalline FCC Metals 54 - Consolidation of the Nanocrystalline Milled Powders - References 59 - Fabrication of Nanocomposite Materials - Introduction and Background - Fabrication of SiCp/Al Composites by Mechanical Alloying - Properties of Mechanically Solid State Fabricated SiCp/Al Composites - Mechanism of Fabrication - References 82

PART II ROOM TEMPERATURE REACTIVE MILLING

Mechanically Induced Solid-State Carbonization - Introduction - Difficulties of Preparations - Fabrication of Nanocrystalline TiC by Mechanical Alloying Method - Properties of Mechanically Solid State Reacted TiC Powders - Other Carbides Produced by Mechanical Alloying - References 124 - Mechanically Induced Solid-Gas Reaction - Introduction - Fabrication of Nanocrystalline TiN by Reactive Ball milling - Properties of Reacted Ball Milled TiN Powders - Mechanism of Fabrication - Other Nitrides Produced by RBM - Fabrication of Nanocrystalline Solid Solution NiTiH by Reactive Ball Milling - References 157 - Mechanically Induced Solid-State Reduction - Introduction - Reduction of Cu₂O with Ti by Room Temperature Rod Milling - Properties of Rod-Milled Powders - Mechanism of MSSR - Fabrication of Nanocrystalline WC and Nanocomposite WC-MgO Refractory Materials by MSSR and Methods - References 189 - Mechanically Induced Solid-State Amorphi

Systems and Applications - Amorphous Austenitic Stainless Steel 254 - Fabrication of amorphous Fe₅₂Nb₄₈ Special Steel 257 - Fe-Zr-B 259 - Difference between Mechanical Alloying and Mechanical Disordering in the Amorphization Reaction of Al₅₀Ta₅₀ in a Rod Mill - Mechanically Induced Cyclic Crystalline-Amorphous Transformations During Mechanical Alloying - References 295 -

(05/05/2000)

Extractive Metallurgy of Activated Minerals

included in series Process Metallurgy, 10

by P. Balaz - Institute of Geotechnics, Slovak Academy of Sciences

ISBN : 0 - 444 - 50206 - 8 / Price USD 144, Euro 124.79)

[file://http /// www.elsevier.nl/inca/publication](http://www.elsevier.nl/inca/publication)

Description

Mechanical activation of solids is a part mechanochemistry, the science with a sound theoretical foundation exhibiting a wide range of potential application. Mechanical activation itself is an innovative procedure where an improvement in technological processes can be attained via a combination of new surface area and defects formation in minerals.

Mechanical activation is of exceptional importance in extractive metallurgy and mineral processing and this area forms the topic of this book and is a result of more than twenty years of research and graduate teaching in the field.

In pyrometallurgy, the mechanical activation of minerals makes it possible to reduce their decomposition temperatures or causes such a degree of disordering that the thermal activation may be omitted entirely. The potential mitigation of environmental pollutants is becoming increasingly important in this context.

The lowering of reaction temperatures, the increase of the rate and amount of solubility, preparation of water soluble compounds, the necessity for simpler and less expensive reactors and shorter reaction times are some of the advantages of mechanical activation in hydrometallurgy. The environmental aspects of these processes are particularly attractive.

Several industrial processes are examined and the flowsheets are presented as successful of activation. In these processes, the introduction of a mechanical activation step into the technological cycle significantly modifies the subsequent steps.

The book is designed for researchers, teachers, operators and students in the areas of extractive metallurgy, mineral processing, mineralogy, solid state chemistry and materials science. It will encourage newcomers to the mechanochemistry to do useful research and discover novel applications in this field.

(3/02/2000)

Two new books on mechanical alloying are now available from Cambridge International Science Publishing (infos fournies par Anne Porter - Publishing Manager - Cambridge International Science Publishing <http://www.demon.co.uk/cambsci/homepage.htm>)

1. MECHANICAL ALLOYING - FUNDAMENTALS AND APPLICATIONS <http://www.demon.co.uk/cambsci/book52.htm>

Contents

Introduction (history, benefits of mechanical alloying); Mechanical alloying (alloying mills, mills in practice, improved mills, the process, parameters);

Variations of mechanical alloying (reaction milling, cryomilling, repeated rolling, double mechanical alloying, repeated forging); Process control agents in mechanical alloying; Mechanical alloying mechanisms (ductile-ductile system, ductile-brittle system, brittle-brittle system, metastable phase formation, amorphisation, nanocrystallization, extension of solid solubility, activation of solid state chemical interaction);

Energy transfer and energy maps;

Consolidation of mechanically alloyed powders (consolidation techniques, thermomechanical treatment); Mechanical



properties of mechanically alloyed materials (tensile properties, fracture, creep, stress corrosion cracking susceptibility); Modelling mechanical alloying (mechanistic models, deformation, coalescence and fragmentation, evolution of particle size, milling time, powder heating, powder cooling, atomistic model, thermodynamic and kinetic model) Joining of mechanically alloyed materials; Rapid solidification and mechanical alloying; Applications (nickel-based superalloys, Al-based materials, supersaturated solutions, magnetic materials, mechanically alloyed powders for spray coatings, superplasticity, tribological materials, composites, amorphous solids, nanocrystalline materials, solid-state chemical reactions, etc). ISBN 1898326568, 160 pages 234x156 mm, cased, £45.00, 1999

DISPERSION STRENGTHENED ALUMINIUM PREPARED BY MECHANICAL ALLOYING, by M Besterçi - <http://www.demon.co.uk/cambsci/book51.htm>

1. Characteristics of dispersion-strengthened systems **2. Mechanical alloying** (kinetics and mechanism of preparation of the Al-C system by mechanical alloying; compaction of powders and heat treatment of compacts;
3. Microstructure and quantitative evaluation of parameters of dispersion-strengthened materials (definition and properties of interparticle distance; experimental possibilities of determination of structural objects; models of heterogeneous structures and their evaluation; simulation of model structures; analysis of the spatial distribution of particles in the Al-Al4C3 material)
4. Static and dynamic mechanical properties (mechanical properties at elevated temperatures; mechanical properties at 20 °C; effect of interface on the mechanical properties; superplastic properties of the system; thermal stability of the system; creep characteristics; creep-fatigue characteristics)

References - ISBN 189832655X, 90 pages, 234x156 mm, soft laminated cover, £25.00, 1999

"Mechanical Alloying : Fundamentals and Applications"

Prof. P.R. Soni (1999) - Cambridge International Science Publishing

web site : <http://www.demon.co.uk/cambsci/book52.htm>

"Non Equilibrium Processing of Materials"

R.W. Cahn - Elsevier Science - Volume 2 in the Pergamon Materials Series

A large number of technical papers have been published in reviews, monographs and conference proceedings, but have almost always been devoted to a single processing technique. This book, however, covers all the non equilibrium processing methods and their effects in a single volume.

web site : <http://www.elsevier.nl/locate/isbn/0080426972>

Bulk Amorphous Alloys : Preparation and Fundamental Characteristics

A. Inoue

Materials Science Foundation Vol. 4 - Trans Tech Publications : <http://www.sciencen.net>

Interest in bulk amorphous alloys has increased rapidly throughout the world and these materials have now gained a position of great importance in basic science and engineering materials technology bulk amorphous alloys based upon the Zr - Al - Ni - Cu, Zr (Ti,Nb) - Al - Ni - Cu and Zr - Ti - Ni - Cu - Be systems have already achieved wide commercial success as components of various technical accessories ranging from sporting goods to optical instruments.

Here is a state of the art reviews on this new group of materials, covering all areas of interest, ranging from the synthesis of these special alloys and their fundamental properties, to their engineering characteristics and applications.

This work will therefore be of equal interest to those who wish to become fully acquainted with the subject, and to those who are already actively engaged in the field.

DISPERSION-STRENGTHENED ALUMINIUM PREPARED BY MECHANICAL ALLOYING

Michal Besterçi, Institute of Materials Research, Slovak Academy of Sciences, Kosice

In the book, the author describes the theoretical and technological fundamentals of mechanical alloying the Al-C system. Special attention is given to material characteristics, the kinetics and mechanism of mechanical alloying, methods of mixture compaction and heat treatment of compacted parts. Models of dispersoid spatial arrangement, dispersoid evaluation and optimisation and experimental possibilities are discussed. The interpretation of the static and dynamic mechanical properties, especially strength and ductility properties at 20 °C, mechanical properties at elevated temperatures are discussed, with emphasis on the effect of interface, superplasticity, creep and creep-fatigue characteristics. Content

Introduction

1. Characteristics of dispersion-strengthened systems
2. Mechanical alloying (kinetics and mechanism of preparation of the Al-C system by mechanical alloying; compaction of powders and heat treatment of compacts;
3. Microstructure and quantitative evaluation of parameters of dispersion-strengthened materials (definition and properties of interparticle distance; experimental possibilities of determination of structural objects; models of heterogeneous structures and their evaluation; simulation of model structures; analysis of the spatial distribution of particles in the Al-Al4C3 material)
4. Static and dynamic mechanical properties (mechanical properties at elevated temperatures; mechanical properties at 20°C; effect of interface on the mechanical properties; superplastic properties of the system; thermal stability of the system; creep characteristics; creep-fatigue characteristics)

Index : ISBN 189832655X, 80 pages, 234x156 mm, soft laminated cover, £22.00, January 1999

Cambridge International Science Publishing 7 Meadow Walk, Great Abington, Cambridge CB1 6AZ, England Fax +44 1223 894539; Tel +44 1223 893295 Email: cisp@cisp.demon.co.uk

<http://www.demon.co.uk/cambsci/homepage.htm>

"Mechanical Alloying"



Lettre RFM N°72 - Mars 2001
Corresp. : <mailto:Eric.Gaffet@utbm.fr>

Auteurs : Li Lü & Man On Lai (National University of Singapore)

Kluwer Academic Publishers

Contents : Preface - Introduction to Mechanical Alloying - Experimental Set - Up - The Mechanical Alloying Process - Formation of New Materials - Characterization of Powders - Densification - Mechanical Properties - Mechanisms of Mechanical Alloying - Modeling of Mechanical Alloying - Index

"Surface-Controlled Nanoscale Materials for High-Added-Value Applications"

Editors: Kenneth E. Gonsalves, Marie-Isabelle Baraton, Rajiv Singh, Heinrich Hofmann, Jerry X. Chen, and Joseph A. Akkara.

Materials Research Society, Symposium Proceedings Volume 501, 1998

MRS, Warrendale, Pennsylvania, USA (website: <http://www.mrs.org/>)

"Nanomatériaux"

Auteurs : E. Gaffet, S. Begin - Colin, O. Tillement

Editeur : Innovation 128 - 24 Rue du Quatre Septembre - 75002 Paris - France - Fax : 33 1 42 65 47 76

Les dernières années ont vu apparaître dans le monde des matériaux avancés le préfixe "nano" (nanostructuré, nanocristallins, nanophase ou nanométrique) ; les conférences et les forums sur Internet se multiplient où s'échangent des informations sur les avancées scientifiques et technologiques dans ce domaine des matériaux nanostructurés qui se distinguent des matériaux polycristallins conventionnels par la dimension des cristallites les composant ou par la dimension des hétérostructures présentes : ces dimensions sont de quelques dizaines d'angströms, voire de quelques nanomètres. A ces dimensions, les propriétés des matériaux changent radicalement.

Au début des années 90, les japonais ont été les premiers à lancer d'ambitieux programmes de R & D puisque le MITI a consacré aux nanomatériaux près de 200 millions de dollars pour la période 1990 - 2000 et que la Science & Technology Foundation a investi presque la même somme pour co-financer des projets de laboratoires publics et privés. Les Etats Unis puis les pays européens ont investi plus tardivement mais déjà ont obtenu des résultats prometteurs (.....) Certaines applications existent déjà au niveau international, quelque 400 sociétés se partagent aujourd'hui un marché voisin de 1 milliard de dollars mais qui devrait tripler, voire quintupler à l'horizon 2001.(.....)

(...) Pour aider les industriels concernés à imaginer les applications qu'ils pourraient s'approprier et identifier les acteurs internationaux, la présente étude dresse un état de l'art complet des nanomatériaux en décrivant leurs procédés d'élaboration actuels ou envisagés et en détaillant leurs différentes propriétés physico-chimiques et les géométries que l'on peut obtenir.

Enfin l'étude permet de cerner les applications actuelles et potentielles...

CHEMISTRY FOR SUSTAINABLE DEVELOPMENT

Vol. 6, No. 2-3, MARCH-JUNE 1998

Proceedings of 2d International Conference on Mechanochemistry

(INCOME-2), which was held in Novosibirsk in 1997.

Contact : Prof. • N.Z. Lyakhov, Inst. Sol. State Chem.- Russian Acad Sci. - Kutaleladze, 18 - Novosibirsk - 630128 Russia - The Proceedings will be available by the price 80 USD.

Mechanochemistry of Materials

Cambridge International Science Publishing

Emmanuel Gutman - Materials Eng. Dpt - Ben Gurion University - Beer Sheva - Israel

Considerable advances have been made in mechanochemistry in the last couple of decades. Training of experts in this field with a background in materials science, chemical and mechanical engineering, etc. requires study of the fundamentals of mechanochemistry. There is a need for a textbook in the general and compressed form which would cover many aspects and would be used as a basis for understanding the fundamental principles to control mechanochemical phenomena. This textbook is based on lectures given by Prof. Gutman in a graduate course in the mechanochemistry of materials at the Ben - Gurion University of the Negev. The book contains examples of experimental results to illustrate the mechanochemical phenomena and technologies.

BIBLIOGRAPHY ON MECHANICAL ALLOYING AND MILLING

Suryanarayana (Inst for Materials and Advanced Processes, University of Idaho, USA)

The present bibliography covers information on mechanical alloying and milling of materials starting from 1970 (when it was recognized that MA has become a commercial/viable material processing technique instead of just a grinding method) to 1996. All the available references will be presented in a chronological fashion. Under each year, (.....)

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Proceeding du Congrès "Mechanically Alloyed, Metastable and Nanocrystalline Materials"- Barcelone (1997)

Editor : M.D. Baro, S. Surinach - Materials Science Forum 269 - 272 (1998)



Patent / Brevet

ONE STEP SYNTHESIS AND CONSOLIDATION OF NANOPHASE MATERIALS

Z.A. Munir, F. Charlot, F. Bernard, E. Gaffet – International patent WO 0112366 (publié le 22.02.2001)

Solid reaction products with a dense nanocrystalline structure are formed from reactant particles with diameters in the nano – scale range by compacting the particles into a green body, then passing an electric current through the body causing Joule heating sufficient to initiate the reaction to form the reaction product while simultaneously applying pressure to the reacting body to densify it to a density approaching the theoretical density of the pure product. Surprisingly, this process results in a reaction product that retains the nanocrystalline structure of the starting materials, despite the fact that a reaction has occurred and the materials have been subjected to highly stringent conditions of electric current, heat and pressure.

L'adresse du site web où trouver le texte complet du brevet...

<http://12.espacenet.com/dips/bnsviewer?CY=ep&LG=en&DB=EPD&PN=WO0112366&ID=WO+++0112366A1+I+>

Périodiques

(Rubrique réalisée grâce aux moyens de la bibliothèque de
l'Université de Technologie de Belfort - Montbéliard / UTBM)

[47] MECHANOCHEMICAL MILLING - INDUCED REACTIONS BETWEEN GASES AND SULFIDE MINERALS. II REACTIONS OF CO₂ WITH ARSENOPYRITE, PYRRHOTITE AND PYRITE

Mark G. Aylmore and Frank J. Lincoln - Journal of Alloys and Compounds 314 (2001) 103-113

Abstract: X-ray diffractometry, scanning electron microscopy and mass spectrometry have been utilised to study mechanochemical milling of arsenopyrite, pyrite and pyrrhotite, separately, in the presence CO₂ gas. Arsenopyrite alters to the iron arsenide phase, westerveldite, through an intermediate arsenopyrite-type phase and pyrite decomposes to pyrrhotite, which appears to be stable in CO₂, although it does undergo a phase transformation to the hexagonal form.

[46] THE ECCENTRIC VIBRATORY MILL - INNOVATION OF FINEST GRINDING

E Gock, KE Kurrer - MINERAL PROCESSING ON THE VERGE OF THE 21ST CENTURY, 2000, pp 23-25 - 8TH INTERNATIONAL MINERAL PROCESSING SYMPOSIUM (IMPS-2000); ANTALYA, TURKEY. OCTOBER 16-18, 2000

A new single-tube vibratory mill, the Eccentric Vibratory mill, is introduced. It resulted from a joint development of the Institute for Processing and Disposal Technology of the Technical University Clausthal and the Siebtechnik GmbH, Mulheim. The Eccentric Vibratory mill is excited single-sided by an unbalanced power unit which is flanged directly to the grinding tube. The mass compensation is achieved by a counterbalance. This arrangement causes the mill filling to perform elliptical, circular, and linear vibrations in contrast to the homogeneous circular vibrations of conventional vibratory mills. Due to its modular design, units of different lengths are available, allowing the adaptation to any desired milling target. Milling results achieved in industrial applications with balls and rods as grinding media proof that the specific power consumption is reduced by approx 50 % as compared to conventional vibratory tube mills and that the throughput is increased by the factor 2.

[45] OPTIMIZATION OF GRINDING TIME IN A BALL MILL-ATTRITION BEAD MILL PROCESS

R Tuunila - MINERAL PROCESSING ON THE VERGE OF THE 21ST CENTURY, 2000, pp 55-58 - 8TH INTERNATIONAL MINERAL PROCESSING SYMPOSIUM (IMPS-2000); ANTALYA, TURKEY. OCTOBER 16-18, 2000

Optimization of grinding time of comminution processes is very important due to economical aspects. In this study, the grinding time of limestone in a ball mill - attrition bead mill process was optimized with laboratory tests. The limestone was firstly ground in a continuous ball mill with five different residence times after which the products of ball mill were fed into the batch attrition bead mill, in which the limestone was ground as wet. The energy consumption of grinding was measured in each stage, and the whole energy consumption for different thought grinding processes was determined. By that the optimized grinding times of both mills can be found when the specific energy consumption of the whole process is minimized if the material is ground to the certain fineness. This study showed clearly that by optimizing grinding time at each stage significant economical advantages are reached.

[44] THE EFFECTS OF VARIOUS SURFACE-ACTIVE AGENTS ON THE BREAKAGE OF CALCITE IN A LABORATORY PORCELAIN MILL

A Ozkan, M Yekeler - MINERAL PROCESSING ON THE VERGE OF THE 21ST CENTURY, 2000, pp 71-74 - 8TH INTERNATIONAL MINERAL PROCESSING SYMPOSIUM (IMPS-2000); ANTALYA, TURKEY. OCTOBER 16-18, 2000

A study has been made of grinding of calcite in a laboratory size porcelain mill as dry, wet and wet grinding with chemicals using standard S and B test technique. The dry, wet and wet grinding with chemicals were performed for the fresh feeds of 30x40 mesh (-600+425 µm) calcite samples. The surface active agents used for the grinding tests were aimed to contribute the Rehbinder effect during the milling. The grinding of calcite with and without chemicals gave both first order and non-first order breakage after 16 minutes of grinding. The specific rates of breakages (Si) values obtained were in the range of 0.26 and 0.35 min⁻¹. The highest Si value obtained was 0.35 min⁻¹ when using sodium dodecyl sulphate emphasizing the Rehbinder effect more pronounced among the other chemicals used, while the dry grinding gave 0.26 min⁻¹. The primary breakage distribution function (B-i, B-j) values remained almost the same for the grindings studied.

[43] SYNTHESSES OF ZEOLITE-A AND ZEOLITE-X FROM KAOLINITE ACTIVATED BY MECHANOCHEMICAL TREATMENT

WT Kim, QW Zhang, FM Saito - SECOND INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, 2000, pp 449-452 - 2ND INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES; SAN FRANCISCO, CALIFORNIA. NOVEMBER 5-8, 2000

A novel mechanochemical processing technique for the preparation of zeolites from kaolinite in NaOH solution was investigated. Dry and wet mechanochemical treatments combined by subsequent moderate heat treatment could accelerate



the synthetic reaction for zeolites from kaolinite. This stimulating process produced zeolite-A and zeolite-X from activated kaolinite at extremely lower reaction temperature than conventionally applied for zeolites production. Conversion to zeolite-A and Zeolite-X was strongly dependent on the activated state of kaolinite. Wet mechanochemical treatment modified the chemical composition of activated solids. Rapid dissolution of AlO species rather than SiO ones in the reactant solution was accelerated by wet milling together with NaOH that promoted the formation of zeolite-X of high specific surface area.

[42] THE EFFECT OF PREPARATION CONDITIONS ON THE ULTRAFINE COPPER POWDER CHARACTERISTICS [SLOVAK]

Durisinova K. Durisin J. Orolinova M. - Kovove Materialy-Metallic Materials. 39(1):11-19, 2001.

Ultrafine Cu-3vol.%CuO . Al₂O₃ powder system with the mean copper crystallite size of 28 nm was prepared by combination of mechanical milling with phase transformations of the powder system. The final preparation operation was a strongly exothermic reaction of chemical reduction of CuO-CuO . Al(2)O₃, mixture to Cu-3vol . %CuO . Al₂O₃, during which the clustering of fine-sized Cu particles and of secondary phase nanoparticles can take place. By 8 hours intensive milling of the mixture prepared in such a way, the mean size of the copper crystallites decreased to 11 nm. The work analyses the influence of the preparation conditions on the morphology and the microstructural parameters of the Cu-matrix in each stage of preparation with the emphasis on the formation of such characteristics of the resulting powder that will ensure the thermal stability of the interfaces and will be advantageous from the viewpoint of subsequent compacting of the powder mixture.

[41] MECHANICALLY ACTIVATED RECIPROCAL ISOMERIZATION IN THE NH₄NCS-(NH₂)₂CS SYSTEM

Urakaev FK. Bazarov LS.- Russian Journal of Inorganic Chemistry. 46(1):47-48, 2001

The kinetics of mechanochemical transformation of isomers in the (ammonium thiocyanate)-thiourea system was investigated. Nonsymmetry in the kinetics of reciprocal transitions between isomers is found

[40] FAST SYNTHESIS OF YBa₂Cu₃O₇ SUPERCONDUCTOR AT LOW TEMPERATURES OF ITS ORTHORHOMBIC MODIFICATION EXISTENCE USING MECHANICALLY ACTIVATED AND DENSIFIED TWO-POWDER PRECURSORS

Goodilin EA. Pyoryshkov D. Knot'ko AV. Lennikov VV. Oleynikov NN. Tretyakov YD. - Physica C. 349(3-4):278-288, 2001

The possibility of developing a fast (10-30 min) and low-temperature (500-600 degreesC) synthesis of YBa₂Cu₃O₇ superconductor with a T_c up to 90 K appearing immediately after preparation is discussed. Mechanically activated and densified two-powder precursors have reproducibly yielded 80-90% XRD-pure YBa₂Cu₃O₇ phase when using internal oxygenation of soft-chemistry produced Cu₂O by YBa₂O_{3.5} (containing BaO₂) in their mixture (Y:Ba:Cu = 1:2:3) mechanically activated in a planetary mill and warmly compacted at 250 degreesC into a dense pellet. Such advantages allowed us to obtain trial samples of aluminum-sheathed chemistry tapes with the YBa₂Cu₃O₇ core

[39] SYNTHESIZING OF NANOCOMPOSITE WC/MGO POWDERS BY MECHANICAL SOLID-STATE REDUCTION AND SUBSEQUENT PLASMA-ACTIVATED SINTERING

El-Eskandarany MS. Omori M. Konno TJ. Sumiyama K. Hirai T. Suzuki K. - Metallurgical & Materials Transactions A-Physical Metallurgy & Materials Science. 32(1):157-164, 2001

A ceramic/ceramic nanocomposite powder of WC/MgO has been fabricated by high-energy ball milling a mixture of elemental Mg and powders of C with WO₃ under an argon gas atmosphere at room temperature. During the early stage of milling (at 1.8 ks), the WO₃ and C powders are embedded into the soft matrix of Mg (the reducing agent) particles to form coarse composite powders of the reactant materials. Increasing the milling time (to 22 ks) leads to the formation of fresh active surfaces of Mg, which have a high reducing potential and react with the WO₃ in a typical oxidation/reduction reaction. At the end of this stage (at 43 ks), the Mg powders are oxidized to MgO, whereas the WO₃ is reduced completely to metallic W. During the last stage of milling (86 to 173 ks), a solid-state reaction takes place between W and the unreacted C powders to yield nanocomposite WC/MgO particles. This end-product was consolidated in vacuum at 1963 K with a pressure of 19.6 to 38.2 MPa for 0.3 ks, using a plasma-activated sintering (PAS) method. The sintered sample is fully dense (above 99.5 pct of the theoretical density) and contains nanocrystalline grains of less than 50 nm in diameter. This fine grain structure offers an opportunity for the composite material to combine high values of two opposite properties, i.e., hardness and fracture toughness (K_{1c}), of 15 GPa and 14 MPa rootm, respectively. Here, we propose this nanocomposite material for a wide range of industrial applications, including tips for cutting tools and tips for oil drilling equipment

[38] SYNTHESIS AND CHARACTERIZATION OF A TiAl/Ti₅Si₃ COMPOSITE WITH A SUBMICROCRYSTALLINE STRUCTURE

Senkov ON. Cavusoglu M. Froes FH. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 300(1-2):85-93, 2001

A Ti-47Al-3Cr/Ti₅Si₃ composite with a submicrocrystalline structure was produced by mechanical alloying (MA) and hot isostatic pressing (HIP). Blends of elemental and pre-alloyed powders were used for the MA, Intimate mixing of the elements and powder amorphization occurred during MA. HIP of the MA powder resulted in a fully dense material with a submicron grain size and a homogeneously distributed mixture of gamma-TiAl and Ti₅Si₃ grains. The average grain size increased from 140 to 540 nm when the HIP temperature was increased from 850 to 1050 degreesC. Grain growth in the composite in the temperature range 850-1100 degreesC was described by the equation $D - D_0(4) = K - o \exp(- Q/RT)t$ where Q = 330 kJ mol(-1) and K-o = 3.0 x 10(-18) m(4) s(-1). The kinetic behavior was similar to that for a nanocrystalline Ti-47Al-3Cr alloy annealed in the same temperature range, i.e. the Ti₅Si₃ phase had little effect on grain growth

[37] HYDROGEN EVOLUTION ON HOT AND COLD CONSOLIDATED NI-MO ALLOYS PRODUCED BY MECHANICAL ALLOYING

Kedzierzawski P. Oleszak D. Janik-Czachor M. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 300(1-2):105-112, 2001

Ni₈₀Mo₂₀ and Ni₅₇Mo₄₃ alloys produced by mechanical alloying (MA) were used as the electrode materials for hydrogen evolution from NaOH within a limited temperature range of 20-60 degreesC. To form the electrodes, the Ni-Mo alloys were consolidated in two different ways. One was 'cold pressing', which retained the original nanocrystalline structure of Ni₈₀Mo₂₀, and the amorphous structure of Ni₅₇Mo₄₃, and another one was 'hot pressing', which produced multiphase

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Corresp. : <mailto:Eric.Gaffet@utbm.fr>



systems (Ni₄Mo + MoO₂) and improved the mechanical properties of the resulting electrodes too. Appreciable cathodic current densities of similar to 100 mA cm⁻²) were measured at these electrodes. The estimated values of the apparent activation energy for cold consolidated materials were much lower, whereas those for the exchange current were much higher than the apparent activation energy values for a smooth, polycrystalline Ni plate

[36] STRUCTURAL EVOLUTION OF THE Ti70Ni15Al15 POWDERS PREPARED BY MECHANICAL ALLOYING

Kim KB. Yi S. Kim SH. Kim WT. Kim DH. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 300(1-2):148-152, 2001

Amorphization and crystallization behaviors of Ti₇₀Ni₁₅Al₁₅ powders during mechanical alloying (MA) and subsequent heat treatments are studied. Amorphous phase that cannot be obtained in the rapidly quenched ribbon is formed in the powders after MA for 60 h. Upon continuous heating of the amorphous powders in DSC, two exothermic events are observed. The first exothermic event corresponds to the crystallization of the amorphous matrix into a supersaturated alpha - Ti phase of hexagonal close-packed structure. The growth kinetic of the alpha -Ti phase is sluggish, resulting in the formation of nanostructured alpha -Ti matrix. The second exothermic event corresponds to the solid state transformation of the meta-stable alpha -Ti into the equilibrium phases, Ti₂Ni and Ti₃Al. Using the amorphous powders. Ti-based bulk materials with novel microstructures can be developed for structural applications

[35] HREM OBSERVATIONS OF THE SYNTHESIZED PROCESS OF NANO-SIZED SiC BY BALL MILLING OF SI AND C MIXED POWDERS

Yang XY. Huang ZW. Wu YK. Ye HQ. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 300(1-2):278-283, 2001

The synthesis of nano-sized SiC through ball milling (BM) of elemental Si and graphite mixed powders at room temperature has been reported, and detailed reaction process has been characterized by high-resolution electron microscopy (HREM). High-resolution electron microscopy (HREM) observations presented herein suggest that amorphous graphite (a-graphite), amorphous silicon (a-Si) and nano-sized crystalline Si (c-Si) with many defects are produced during BM, which is prerequisite to the reaction. In some areas, SiC is synthesized through a diffusion of C atoms into the a-Si/and c-Si. In the former, a-Si(C) forms, and then mechanically-driven crystallization of the a-Si(C) occurs to form SiC. In the latter, C atoms directly replace Si atoms to form SiC with an orientation relationship of (111)(SiC)//(111)(Si). In other areas, localized self-sustained reaction occurs to form slightly larger SiC grains

[34] THE INFLUENCE OF WASHING AND CALCINATION CONDITION ON UREA-DERIVED CERIA-YTRIA-DOPED TETRAGONAL ZIRCONIA POWDERS

Lin JD. Duh JG. Chiou BS. - Materials Chemistry & Physics. 68(1-3):42-55, 2001

The influence of washing and calcination conditions on the powder characteristics of urea-derived ceria-ytria-doped tetragonal zirconia powders (Ce-Y-TZP) ceramics are studied. The use of urea hydrolysis followed by acetone-toluene-acetone (ATA) washing can produce a finer and more sinterable Ce-Y-TZP powder as compared to that washed by alcohol. It is observed that as the calcination temperature is raised to 800 degreesC for 2 h, the sintered density achieves the highest value regardless of the increase of monoclinic content in as-derived powders. The higher the calcination temperature, the more the monoclinic content. The transformability of tetragonal phase is related to the A, temperature and tetragonality. The monoclinic content in as-derived powders after calcination and ball-milling processes is proportional to the A, temperature and tetragonality of tetragonal phase

[33] A MATHEMATICAL ANALYSIS OF MILLING MECHANICS IN A PLANETARY BALL MILL

Chattopadhyay PP. Manna I. Talapatra S. Pabi SK. - Materials Chemistry & Physics. 68(1-3):85-94, 2001

A detailed mathematical analysis is presented to advance the current understanding of the mechanics of milling operation in a planetary ball mill in terms of a global Cartesian reference space. The ab initio calculations have identified the role of milling parameters in determining the condition of detachment of the ball from the vial wall. The condition of an 'effective' impact has been identified in terms of the vial-to-disk speed ratio. It emerges from the analysis that the role of velocity components of the ball at the instant of its impact on the vial wall warrants proper consideration, because the tangential force determines the lower bound of the vial-to-disk speed ratio conducive for effective transfer of impact energy to the powder charge in the mill. Finally, a comparison of the experimental results of grain size reduction during milling of elemental Fe and Cu-Al powder blend with the similar predictions of the present analysis demonstrates for the first time that elastic properties of the balls and vials play an important role in determining the rate of structural refinement during ball milling

[32] X-RAY STUDIES ON THE KINETICS OF MICROSTRUCTURAL EVOLUTION OF Ni3Al SYNTHESIZED BY BALL MILLING ELEMENTAL POWDERS

Pradhan SK. Shee SK. Chanda A. Bose P. De M. - Materials Chemistry & Physics. 68(1-3):166-174, 2001

Synthesis of intermetallic compound of Ni₃Al by ball milling elemental blends of Ni and Al in the proportion of 3:1 has been done with a view to study the mechanism of alloying during ball milling. Systematic study on the kinetics of transformation in the intermediate stages of milling from 1 to 64 h has been contemplated by characterizing the microstructures in terms of various defect-related parameters viz. stacking fault, crystallite size, root mean square (rms) strain, dislocation densities, percentage of different phases formed as a function of milling time. The methodology used is the powerful Rietveld's whole X-ray profile fitting technique. The results reveal the formation of two phases, solid solution of Ni-Al transforming gradually to Ni₃Al (disordered). Complete transformation is achieved after 57 h of milling. The second phase forming disordered Ni₃Al has smaller crystallite size (nano-order), larger rms strain, higher stacking fault and dislocation density compared to those of Ni-Al solid solution. Study of grain structure by transmission electron microscopy (TEM) further corroborates the value of the nano-order crystallite diameters as evaluated from the X-ray study

[31] SUPERPARAMAGNETISM AND TRANSPORT PROPERTIES OF ULTRAFINE La₂/3Ca₁/3MnO₃ POWDERS

Li RW. Xiong H. Sun JR. Li QA. Wang ZH. Zhang J. Shen BG. - Journal of Physics-Condensed Matter. 13(1):141-148, 2001

Magnetic and transport properties of ultrafine La₂/3Ca₁/3MnO₃ (LCMO) powders synthesized by mechanical alloying with a grain size of about 18 nm have been investigated. It is found that the powder sample is superparamagnetic above 95 K. The blocking temperature (T-B) Obtained from the characteristic peak in the zero-field-cooled magnetization decreases with the measuring applied field, and can be well fitted by T-B = a ln(mu H-0) - b. The spontaneous magnetization of the powder



sample is only 38% of that in the corresponding bulk LCMO. Unlike conventional bulk LCMO, the powder compact is insulating from 5 K to 300 K. The low-temperature magnetoresistance (MR), defined as $MR = \Delta R/R(0)$ ($R(0)$ being the zero-field resistance), is approximately 100% under a field of 6 T, much higher than that of the conventional bulk LCMO (50-60%). When the temperature is above T-B, the low-field MR associated with the spin-polarized tunnelling between grains cannot be observed; however, the high-field MR increases linearly with the applied field. The small grain size and the surface layer in which many oxygen vacancies and defects induced by high-energy milling exist are suggested to be responsible for the present observations

[30] SELECTIVE MECHANOCHEMICAL REACTIONS ON DRY GRINDING STRUCTURALLY DIFFERENT SILICATES
Mendelovici E. - Journal of Materials Science Letters. 20(1):81-83, 2001

[29] OPTICAL PROPERTIES OF $Bi_{12}SiO_{20}$ (BSO) AND $Bi_{12}TiO_{20}$ (BTO) OBTAINED BY MECHANICAL ALLOYING
Vasconcelos IF. Pimenta MA. Sombra ASB. - Journal of Materials Science. 36(3):587-592, 2001

Mechanical alloying has been used successfully to produce nanocrystalline powders of BTO and BSO. The milled BTO and BSO were studied by x-ray powder diffraction, DTA, infrared and Raman scattering spectroscopy. After 7 hours of milling the formation of BTO and BSO was confirmed by x-ray powder diffraction. The infrared and Raman scattering spectroscopy results suggest that the increase of the milling time lead to the formation of ferroelectric BTO and BSO, as seen by x-ray diffraction analysis. These materials are attractive for various electro-optical devices, including optical data processing. They present a number of attractive features as reversible recording materials for real-time holography and image processing applications. This milling process presents the advantage, that melting is not necessary, and the powder obtained is nanocrystalline with extraordinary mechanical properties. The material, can be compacted and transformed in solid piezoelectric ceramic samples. The high efficiency of the process, opens a way to produce commercial amount of nanocrystalline piezoelectric powders. Due to the nanocrystalline character of this powder, their mechanical properties have changed and for this reason a pressure of 1 GPa is enough to shape the sample into any geometry.

[28] SYNTHESIS BY BALL MILLING AND CHARACTERIZATION OF NANOCRYSTALLINE Fe_3O_4 AND Fe/Fe_3O_4 COMPOSITE SYSTEM

Bonetti E. Del Bianco L. Signoretti S. Tiberto P. - Journal of Applied Physics. 89(3):1806-1815, 2001

Nanocrystalline Fe_3O_4 and a composite system constituted by nanocrystalline Fe and Fe_3O_4 have been synthesized by ball milling commercial magnetite and an equimolar mixture of iron and magnetite powders. The physical parameters governing the milling process have been strictly controlled so as to achieve the nanocrystalline state of the precursor material and to avoid chemical reactions. X-ray diffraction and Mossbauer spectroscopy measurements have been carried out both on as-milled powders and on samples previously subjected to annealing treatments in the 100-600 degreesC temperature range. The results, providing information on the structural and compositional features of the produced samples, are discussed in terms of structural disorder which is healed by subsequent annealing. In the case of the composite system, this analysis indicates that a high mixing degree between the constituent phases has been reached. In particular, the presence of a sextet with anomalous hyperfine parameters in the Mossbauer spectrum of as-milled $Fe+Fe_3O_4$ has been associated with an alteration of the magnetite structure at the interface with bcc Fe. For both sets of samples, the influence of the structural features on the macroscopic magnetic behavior has been investigated by performing magnetic hysteresis loop measurements at room temperature

[27] ROOM TEMPERATURE MECHANICAL BEHAVIOR OF SILICON-DOPED TiAl ALLOYS WITH GRAIN SIZES IN THE NANO- AND SUBMICRON-RANGE

Bohn R. Klassen T. Bormann R. - Acta Materialia. 49(2):299-311, 2001

Nano- and submicron-grained intermetallic compounds consisting of γ -TiAl and α_2 -Ti-5(Si,Al)(3) were produced by high energy milling and hot isostatic pressing. Owing to the pure and controlled processing conditions, the mechanical properties may be indubitably related to the microstructure. Both yield strength and hardness show a Hall-Petch-type dependence on grain size, resulting in extremely high flow and fracture stresses under compression of up to 3 GPa. With a reduction of grain size, the coefficient of strain hardening as well as the compressive fracture strain decrease and drop to zero for alloys with grain sizes of about 150 nm. Deformation at room temperature is accomplished by dislocation glide and mechanical twinning, with twinning attaining more and more importance as the grain size is further reduced. Diffusion-controlled deformation mechanisms can be ruled out even for intermetallics with crystallite sizes as small as 50 nm. A room temperature ductilization of intermetallic compounds by switching to a nanocrystalline microstructure seems to be rather unlikely

[26] MICROSTRUCTURE EVOLUTION AND THERMAL PROPERTIES IN NANOCRYSTALLINE Fe DURING MECHANICAL ATTRITION

Zhao YH. Sheng HW. Lu K. - Acta Materialia. 49(2):365-375, 2001

The microstructural evolution and thermal properties of nanocrystalline (nc) Fe during mechanical attrition were investigated by using quantitative X-ray diffraction and thermal analysis techniques. Upon milling of the Fe powders with coarse grains, grain refinement takes place gradually and a steady-state grain size in the nanometer regime is reached after a certain period of milling. With the further milling of the nc Fe within the stage of the steady-state grain size, we observed a grain boundary relaxation process that was manifested by evident decreases in the thermal expansion coefficient and the stored enthalpy, as well as slight decreases in the lattice strain and the Debye-Waller parameter. The grain boundary enthalpy of the nc Fe was estimated, showing a decreasing tendency with the milling time. The present work indicated with clear experimental evidence that the nc materials with the same grain size may exhibit very different properties that depend upon the microstructure of the numerous metastable grain boundaries

[25] DEFECT PROPERTIES OF MECHANICALLY ALLOYED La-SUBSTITUTED $PbWO_4$

Takai S. Karita Y. Nakanishi T. Esaka T. - Solid State Ionics. 138(1-2):161-168, 2000

Mechanical alloying (MA) technique has been applied to prepare the $PbWO_4$ -based scheelite-type solid solutions at room temperature. In the case of La-substitution, the scheelite-type single phase can be obtained by 12 h milling. The solubility range of lanthanum ions was 0 less than or equal to x less than or equal to 0.4 in the form $Pb_{1-x}La_xWO_{4+x/2}$ and 0 less than or equal to x less than or equal to 1.0 in the composition of $Pb_{1-x}La_{2x/3}WO_4$. The latter case includes $La_{2/3}WO_4$, which cannot be obtained by the conventional sintering method. From the powder density measurements, the mechanically



alloyed samples were supposed to prefer the charge compensation by forming cation vacancy rather than by forming oxide ion interstitials, in these lanthanum-substituted PbWO₄s

[24] OXIDATION OF ALIPHATIC ALCOHOLS WITH THE LEAD TETRAACETATE - METAL HALIDE SYSTEM UNDER MECHANICAL ACTIVATION

Kapustina NI. Sokova LL. Makhaev VD. Borisov AP. Nikishin GI. - Russian Chemical Bulletin. 49(11):1842-1845, 2000
The mechanochemical oxidation of n-pentanol, n-hexanol, and n-octanol with the Pb(OAc)₄-MHal system (M = Li, K; Hal = Cl, Pr) in the absence of a solvent affords esters, and secondary alcohols with the composition C₈H₁₇OH and C₉H₁₉OH five ketones

[23] AN X-RAY DIFFRACTION STUDY OF STRAIN LOCALIZATION AND ANISOTROPIC DISLOCATION CONTRAST IN NANOCRYSTALLINE TITANIUM

Chatterjee P. Sen Gupta SP. - Philosophical Magazine A-Physics of Condensed Matter Defects & Mechanical Properties. 81(1):49-60, 2001

A detailed X-ray line broadening study in a ball-milled Ti sample is presented. It has been observed that ball milling leads to the formation of nanocrystalline grains and transforms partially to a fcc Ti phase after milling for 10 h. Milled samples show an inhomogeneous strain which increases with increasing milling time. The origin of such high strains is probably the dislocations present in the sample. The presence of a small number of stacking faults is also noticed, which, however, do not vary much with the milling time. Anisotropic line broadening of the fault-unaffected reflections is explained in terms of anisotropic dislocation contrast corresponding to [a] and [a + c] dislocations. Both edge and screw dislocations were predicted with a significant basal slip. A high dislocation density of about 10¹¹ cm⁻³ has been found in the milled samples

[22] PHYSICOCHEMICAL AND ELECTROCHEMICAL HYDRIDING-DEHYDRIDING CHARACTERISTICS OF AMORPHOUS MGNiX (X=1.0, 1.5, 2.0) ALLOYS PREPARED BY MECHANICAL ALLOYING

Zhang SG. Hara Y. Suda S. Morikawa T. Inoue H. Iwakura C. - Journal of Solid State Electrochemistry. 5(1):23-28, 2001

Physicochemical and electrochemical hydriding-dehydriding characteristics of amorphous MgNi_x (x = 1.0, 1.5, 2.0) alloys prepared by mechanical alloying have been investigated. It was found that the increase of Ni content in the alloys resulted in greatly enhanced kinetics for both absorption and desorption of hydrogen, while the saturation capacity showed the reverse tendency. Charge-discharge tests showed that the increase in Ni content lead to a significant enhancement in cycle performance of MgNi_x alloy electrodes. X-ray photoelectron spectroscopic and X-ray excited Auger electron spectroscopic investigations indicated the existence of a significantly thicker Ni-enriched layer for the MgNi_{1.5} and MgNi_{2.0}, alloys than for the MgNi alloy. These results reveal that excess of Ni in MgNi_x alloys may improve the cycle performance of alloy electrodes by suppressing the segregation of Mg during electrochemical cycling, and the Ni in the topmost surface layer is mainly responsible for the improvement in the kinetics of hydrogen absorption

[21] MECHANICAL ALLOYING AND THERMAL DECOMPOSITION OF (ZrO₂)(0.8)-(ALPHA-Fe₂O₃)(0.2) POWDER FOR GAS SENSING APPLICATIONS

Cao W. Tan OK. Zhu W. Jiang B. - Journal of Solid State Chemistry. 155(2):320-325, 2000

The mechanical alloying process of (ZrO₂)(0.8)-(alpha -Fe₂O₃)(0.2) powder during high-energy ball milling at room temperature and the thermal decomposition of (ZrO₂)(0.8)-(alpha -Fe₂O₃)(0.2) powder at high temperature were studied by XRD, TEM, and differential thermal analysis. It was found that monoclinic zirconia transforms to cubic zirconia stabilized by Fe³⁺ after a milling time of 60 h. With the increased milling time up to 120 h, the powder appeared to consist of amorphous-like conglomerates. This metastable compound decomposed at a temperature of 650 degreesC. The expulsion of the alpha -Fe₂O₃ from the cubic ZrO₂ correlated directly with the current conductivity behavior and the oxygen gas sensing property of the thick film devices screen printed from this powder. The substitutional model Fe₂O₃ reversible arrow 2Fe(Zr)⁺V⁻O₃ was adapted to explain both the mechanical alloying and thermal decomposition processes.

[20] MECHANOCHEMICAL MILLING-INDUCED REACTIONS BETWEEN GASES AND SULFIDE MINERALS: II. REACTIONS OF CO₂ WITH ARSENOPYRITE, PYRRHOTITE AND PYRITE

Authors Aylmore MG. Lincoln FJ. - Journal of Alloys & Compounds. 314(1-2):103-113, 2001

X-ray diffractometry, scanning electron microscopy and mass spectrometry have been utilised to study mechanochemical milling of arsenopyrite, pyrite and pyrrhotite, separately, in the presence CO₂ gas. Arsenopyrite alters to the iron arsenide phase, westerveldite, through an intermediate arsenopyrite-type phase and pyrite decomposes to pyrrhotite, which appears to be stable in CO₂, although it does undergo a phase transformation to the hexagonal form

[19] MECHANICAL ACTIVATION EFFECT ON THE SELF-SUSTAINING COMBUSTION REACTION IN THE MO-SI SYSTEM

Gras C. Vrel D. Gaffet E. Bernard F. - Journal of Alloys & Compounds. 314(1-2):240-250, 2001

Nanostructured molybdenum disilicide (MoSi₂) was synthesized using an alternative route called MASHS (mechanically activated self-propagating high-temperature synthesis). This original process combines a short duration ball milling (MA) with a self-sustaining combustion (SHS). These two steps were investigated. The microstructure evolution of the powder mixture during mechanical activation was monitored using XRD profile analysis and TEM investigations. Short duration ball milling of (Mo+2Si) powder produces Mo and Si nanocrystallites into micrometric particles. It was demonstrated that pure alpha -MoSi₂ with nanometric structure (D-MoSi₂ = 88 nm) could be produced via a very fast combustion front in contrast to the classical SHS process

[18] MICROSTRUCTURE AND SOFT MAGNETIC PROPERTIES OF NANOCRYSTALLINE FE-SI POWDERS

Ding J. Li Y. Chen LF. Deng CR. Shi Y. Chow YS. Gang TB. - Journal of Alloys & Compounds. 314(1-2):262-267, 2001

In this work, fine Fe-Si powders with a nanocrystalline structure were prepared by mechanical alloying (high-energy ball milling) and subsequent heat treatment (in order to optimize their magnetic properties). Good soft magnetic properties were obtained in mechanically alloyed Fe-Si powders. The Fe₇₅Si₂₅ powder annealed at 450 degreesC possessed a magnetization of 149 Am²/kg and a coercivity of 0.2 kA/m. The coercivity model for soft magnetic nanocrystalline materials could be well applied to the Fe-Si powders in this work The mechanically alloyed Fe-Si possessed significantly higher magnetic



permeability than that of commercially available Fe-Si powder, The permeability of the mechanically alloyed Fe₇₅Si₂₅ powder was comparable with that of mechanically alloyed pure Fe powder. Considering of lower density and better chemical stability of Fe-Si, the mechanically alloyed Fe-Si may be interesting for soft magnetic application including magnetic shielding and electromagnet noise suppression.

[17] STRUCTURAL AND HYDRIDING PROPERTIES OF THE INTERMETALLIC Y₁-XNi₂ SYNTHESIZED BY MECHANICAL ALLOYING OR SUBMITTED TO MECHANICAL GRINDING

Nakhl M. Chevalier B. Bobet JL. Darriet B. - Journal of Alloys & Compounds. 314(1-2):275-280, 2001

The sample 'YNi₂' and the powder mixture (Y+2 Ni) were submitted to a milling process under an argon atmosphere. X-ray powder diffraction and microprobe analysis revealed the formation of the phase Y_{0.97}Ni₂ by mechanical alloying (MA). This compound, after a heat treatment at 823 K, decomposes into two phases having the following Formula composition: Y_{0.92}Ni₂ and YNi_{1.84}. The hydriding propert-ies were studied at T=373 K and P-H₂ = 1.1 MPa; it absorbs congruent to 3 H mol(-1) and decomposes into four phases: yttrium hydrides YH₂ and YH₃, Ni metal and an amorphous phase. The hydriding properties of the ground sample 'YNi₂' were also studied, its hydrogen absorption capacity has increased at 373 K but only for mechanical grinding (MG) performed for 3 h. X-ray diffraction did not reveal in this case any amorphization after hydrogenation at 373 K.

[16] MECHANICAL SOLID-STATE REDUCTION OF HAEMATITE WITH MAGNESIUM

El-Eskandarany MS. El-Bahnasawy HN. Ahmed HA. Eissa NA. - Journal of Alloys & Compounds. 314(1-2):286-295, 2001

Single-step displacement reaction has occurred during ball milling a mixture of haematite and magnesium powders at room temperature. During the early stage of milling (0-43 ks), the Fe₂O₃ particles are embedded into the soft matrix of Mg (reducing agent) particles to form coarse composite powders of the reactant materials. Increasing the milling time (86 ks) leads to the formation of fresh active surfaces of Mg which have high reducing potential and reacts with the Fe₂O₃ in a typical oxidation/reduction reaction. After 432 ks the Mg powders are completely oxidized to MgO, whereas the Fe₂O₃ is reduced successfully to metallic Fe. Increasing the milling time to 540 ks leads to the formation of ultrafine powders that have excellent morphological characteristics (spherical-like shape morphology) with an average diameter of 0.5 μm. The powders of these end-product contain very fine cells of MgO that are embedded into the metallic matrix of Fe.

[15] CORROSION PROTECTION OF NANOCOMPOSITE ND-FE-B/ALPHA-Fe MAGNETS

Jakubowicz J. - Journal of Alloys & Compounds. 314(1-2):305-308, 2001

The magnetic properties and corrosion behaviour of two phase nanocomposite Nd₂(Fe,Co,M)(14)B/alpha -Fe-type (M=Zr, AlCr) magnets have been investigated. In this work magnetic hardening was achieved by high-energy ball-milling (HEBM) of the Nd,Fe,,B-type hard magnetic phase with 37.5 vol% of alpha -Fe as soft magnetic phase, followed by annealing. Fully dense Nd₂(Fe,Co,M)(14)B/alpha -Fe-type magnets have been produced by hot pressing. The corrosion behaviour has been studied by potentiostatic measurements. For the Nd_{12.6}Fe_{66.6}Co_{11.6}Al₁Cr₂B₆/37.5 vol% alpha -Fe magnet, the corrosion rate was 0.037 mm year(-1) Effective protection against corrosion for nanocomposite Nd-Fe-Co-Al-Cr-B/alpha -Fe magnets was realised by surface coating with Zn metal

[14] CONSOLIDATION AND MECHANICAL BEHAVIOUR OF NANOPHASE IRON ALLOY POWDERS PREPARED BY MECHANICAL MILLING

Ma E - Powder Metallurgy. 43(4):306-310, 2000.

This special feature presents a brief overview of the recent developments in preparing and characterising bulk nanocrystalline metallic alloys from mechanically milled powders, focusing on the work on iron alloys conducted in the author's laboratory. The strategies and procedures used for consolidating the powders into full density compacts while maintaining the grain sizes in the nanophase regime (< 100 nm) are summarised. The unusual mechanical properties observed of the fully dense nanophase alloys, as well as their potential applications, are discussed in comparison with those of conventional coarse grained counterparts

[13] SINTERING, MICROSTRUCTURE, AND MECHANICAL PROPERTIES OF PM MANGANESE-MOLYBDENUM STEELS

Youseffi M. Mitchell SC. Wronski AS. Cias A. - Powder Metallurgy. 43(4):353-358, 2000

The effects of 0.5 wt-%Mo addition on the processing, microstructure, and strength of PM Fe-3.5Mn-0.7C steel are described. Water atomised and sponge irons, Astaloy 1.5Mo, milled ferromanganese, and graphite were the starting powders. During sintering in 75H(2)/25N(2) or pure hydrogen the dewpoint was controlled and monitored; in particular the effects of improving it from -35 to -60 degreesC were investigated. Faster heating rates (greater than or equal to 20 K min(-1)), sufficient gas flowrates, milling the ferro alloy under nitrogen, a low dewpoint (<-60<degrees>C), and a getter powder can all contribute to the reduction or prevention of oxidation of the manganese, in particular formation of oxide networks in the sintered steels. For 600 MPa compaction pressure densities up to 7.1 g cm(-3) were obtained; these were not significantly affected by sintering at temperatures up to 1180 degreesC. The sintered microstructures were sensitively dependent on the cooling rate. Irrespective of the presence of Mo, slow furnace cooling at similar to 4 K min(-1) resulted in mainly pearlitic structures with some ferrite and coarse bainite, whereas fast cooling at similar to 40 K min(-1) produced martensite and some retained austenite, very fine pearlite, bainite, and some ferrite. Young's modulus, determined by tensile and ultrasonic tests, was in the range 110-155 GPa. Sintering with -60 degreesC dewpoint resulted in tensile and transverse rupture strengths of 420 and 860 MPa for the Mn steel, rising to 530 and 1130 MPa as a result of the Mo addition. This contrasts with strength decreases observed when processing included use of high oxygen containing ferromanganese and sintering with -35 degreesC dewpoint. PM/0811

[12] PREPARATION AND CORROSION BEHAVIOR OF BULK MG₇₅NI₁₅SI₁₀ AMORPHOUS ALLOY BY MECHANICAL ALLOYING AND PULSED CURRENT SINTERING

Ozaki K. Matsumoto A. Sugiyama A. Nishio T. Kobayashi K. - Materials Transactions Jim. 41(11):1495-1500,

Amorphous Mg₇₅Ni₁₅Si₁₀ powders synthesized by mechanical alloying were consolidated into bulk pieces by pulsed current sintering. An investigation was also done on the corrosion behavior of the pieces by measuring the corrosion rate and the polarization curve. The mechanically alloyed powder was examined by X-ray diffraction and TEM with selected area electron diffraction and differential scanning calorimetry. The amorphous powder could be made by milling for 2520ks.



However, the powder included Si particles and nano-crystals in addition to the amorphous phase. The composition of the amorphous phase has been determined to be Mg_{71.5}Ni_{13.5}Si_{15.0} by TEM-EDS. The crystallization temperature was 571 K. The bulk alloys sintered at 473 K and 523 K kept the amorphous phase, but Mg crystals grew in the alloy. The sintering density increased with increasing die pressure and reached to at 94% under 500 MPa at 473 K. The real density was calculated to be 2588 kg/m³. No corrosion of the bulk amorphous alloy could be observed when exposed to 5 mass% NaCl solution for a period of 86.4 ks (24 h) because of the passive film formed on the surface of the amorphous alloy. It was confirmed by the measurement of the polarization curve in 5 mass% NaCl solution that the corrosion rate of the amorphous alloy was a quarter or one-fifth that of AZ91D alloy

[11] HIGH HYDROSTATIC PRESSURE CONSOLIDATION OF AMORPHOUS TI-37.5 AT%SI POWDER PREPARED BY MECHANICAL ALLOYING AND MECHANICAL PROPERTIES OF THE COMPACT

Matsumoto A. Kobayashi K. Takagi M. Imura T. - Materials Transactions Jim. 41(11):1545-1549, 2000

Ti-37.5 at%Si powder mixtures were mechanically alloyed in a planetary ball mill under an argon atmosphere. The powder milled for 180 ks consisted of amorphous and nano-sized titanium and/or silicon grains. Crystallization temperature of the powder was about 780 K. It was consolidated using a cubic-type anvil apparatus under a high hydrostatic pressure of 5.4 GPa (HHPC method). The obtained compact consolidated at below 663 K was fully densified with the retention of amorphous phase, while the compact prepared at above 723 K almost crystallized. The compressive strength of the compact prepared by HHPC method at 623 K was measured to be 2.52 GPa at room temperature. The value was about 0.5 GPa higher than that of the compact prepared by HHPC method at 723 K. It suggests amorphous phase is attributed to toughening of the compact

[10] MECHANICAL BEHAVIOR AND SUPERPLASTICITY OF A SEVERE PLASTIC DEFORMATION PROCESSED NANOCRYSTALLINE Ti-6Al-4V ALLOY

Mishra RS. Stolyarov VV. Echer C. Valiev RZ. Mukherjee AK. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 298(1-2):44-50,

Mechanical behavior of a severe plastic deformation (SePD) processed nanocrystalline Ti-6Al-4V alloy has been studied in the temperature range 25-675 degreesC. Compared with the microcrystalline state, the nanocrystalline state material had higher strength up to 400 degreesC and comparable strength above that. The ductility was significantly higher for the nanocrystalline state above 500 degreesC, including superplasticity above 600 degreesC. Transmission electron microscopy showed considerable grain growth and dislocation activity during superplastic deformation. A comparison of the superplastic data across the nanocrystalline and microcrystalline range showed an interesting discrepancy in the kinetics of superplastic deformation. Contrary to the general expectation, the kinetics of superplastic deformation was slower in ultrafine grained materials after normalizing the data for grain size and temperature dependence. The slower superplastic deformation kinetics in the nanocrystalline materials is discussed in terms of the difficulty associated with slip accommodation of grain boundary sliding

[9] SYNTHESIS AND PROPERTIES OF CUBIC ZIRCONIA-ALUMINA COMPOSITE BY MECHANICAL ALLOYING

Kwon NH. Kim GH. Song HS. Lee HL. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 299(1-2):185-194,

Synthesis of 8mol% Y₂O₃-ZrO₂ (8YSZ) powder with Al₂O₃ by mechanical alloying (MA) and the sintering behavior of this powder were investigated. The solubility of Al₂O₃ in 8YSZ was 1.15 wt.% after MA for 48 h. Large agglomerated particles formed during MA resulted in a slow densification rate of the compact. After eliminating the agglomerates by sedimentation, the relative density of 97% was obtained by sintering the compact at 1400 degreesC for 2 h. Sintered microstructure of mechanically alloyed 3wt.% Al₂O₃-8YSZ (3A8YSZ) consisted of 8YSZ grains in the size range of 0.5-1.2 μm and 20-400 nm size Al₂O₃ particles dispersed uniformly in the 8YSZ. Fracture toughness and hardness of the composite was improved due to intragranular dispersion of Al₂O₃ particles. Electrical conductivity of the composite was 6.4 x 10⁻⁵ S cm⁻¹ at 400 degreesC and also exhibited significant increase over monolithic 8YSZ. Improvement in lattice conductivity was unique in this composite and attributed to the role of intragranular Al₂O₃ particles, which provided strong lattice distortion of 8YSZ matrix. (C) 2001 Elsevier Science B.V. All rights reserved. [References: 21]

[8] SUBSTRUCTURES OF DEFORMATION TWINS AND TWIN INTERSECTIONS IN A Ti-45Al-8Nb-2.5Mn ALLOY HEAVILY DEFORMED AT ROOM TEMPERATURE

Zhang LC. Chen GL. Ye HQ. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 299(1-2):267-274,

Substructures of deformation twins and twin intersections have been investigated by transmission electron microscopy (TEM) in a heavily-deformed Ti-45Al-10Nb-2.5Mn (at.%) alloy. The deformation twins become severely bent after blocking numerous matrix dislocations. The (111)(DT) plane in the twins exhibits a misorientation angle with the (111)(M) plane in the matrix, and numerous 1/3[111] Frank partial dislocations appear in the twin boundaries. Furthermore, the barrier twins also become bent after being intersected by numerous incident twins. The barrier twin boundaries in two types of twin intersections show different tilting directions due to different orientations of the incident twinning dislocations relative to the barrier twins. Some special nano-scale substructures appear simultaneously at the intersection area in order to relax the large stress concentration of several twin-band intersections. The propagation of several incident twin tips in the same direction could induce the formation of small-angle tilting grain boundaries in the intersection area of the type-I. The opposite propagation of several incident twin tips could induce a triangular striated region near the intersection area. Some nanotwins nucleate and propagate with a homogeneous twinning shear mechanism, and were limited mostly in the triangular striated region

[7] EFFECT OF MECHANOCHEMICAL TREATMENT ON GASIFICATION OF CARBON BY CARBON DIOXIDE IN STIRRED MILL REACTOR [JAPANESE]

Ido T. Mori M. Jin G. Goto S. - Kagaku Kogaku Ronbunshu. 27(1):121-126, 2001

The Boudouard reaction, that is, reaction of activated carbon with carbon dioxide to carbon monoxide, is carried out at 773 K in a stirred mill reactor. The mean diameter of activated carbon changes from 44 to 1.2 μm by the grinding. The reaction occurs by grinding activated carbon in the reactor and the reaction rate increases with the increase of stirring rate of ball. The reaction rate also increases by addition of iron powders as the catalyst and the catalytic activity of iron powders is changed by the kinds of ball (iron or zirconia) and the diameter of iron powders. This catalytic activity is preserved after the



stirring of ball is stopped. However, the reaction rate decreases with time and the decrease rate is dependent on the kinds of ball and the diameter of iron powders. Nickel oxide powders show catalytic activity by mixing with iron ball but not with zirconia ball. To investigate the interaction between activated carbon and iron, the surfaces are observed by using a scanning electron microscope (SEM) and energy dispersive X-ray analyzer (EDX)

[6] MOSSBAUER STUDY OF MECHANICAL ALLOYING FE-TI AND FE-TI-N ALLOYS

Popovich TA. Arestov OV. Popovich AA. Kuchma AS. - Journal of Materials Science & Technology. 17(1):1-2, 2001
Mossbauer spectrometry was used to study the peculiarity of formation of nonequilibrium phase in Fe-Ti and Fe-Ti-N systems by mechanical alloying. Mossbauer spectra of powders show the formation of nonequilibrium crystalline phase and intermetallic compounds during a mechanical alloying process depending on the alloy composition and the milling time

[5] SYNTHESIS OF MoSi₂ BY MECHANICAL ALLOYING

Li MW. Zhu JC. Yin ZD. Li XQ. Liu ZY. Jeon JH. - Journal of Materials Science & Technology. 17(1):15-16, 2001
The microstructure evolution of mechanical alloyed Mo-66.7%Si powder using the high-energy ball mill has been studied by X-ray diffraction and scanning electron microscopy. The results showed that MoSi₂ can be synthesized by MA of Mo-66.7%Si powder mixtures. Cold welding behavior between Mo and Si powders plays an important role in the preparation of MoSi₂ by the MA

[4] KINETICS AND STRUCTURE OF REFRACTORY COMPOUNDS AND ALLOYS OBTAINED BY MECHANICAL ALLOYING

Popovich AA. Reva VP. Popovich TA. Arestov OV. - Journal of Materials Science & Technology. 17(1):63-64, 2001
Refractory compounds are material with interesting properties for structural applications. However, the processing of such material is a great challenge because of their high melting temperature and limited ductility. Mechanical alloying is a novel technique of producing refractory compounds with specific properties. Kinetic and structural peculiarities of refractory compounds and alloys obtained by mechanical alloying are discussed.

[3] ENHANCED DISSOLUTION OF TANTALITE/COLUMBITE FOLLOWING MILLING

Welham NJ. - International Journal of Mineral Processing. 61(3):145-154, 2001
A tantalum/niobium concentrate has been ball-milled for up to 50 h in a laboratory mill without apparent phase change, other than a decrease in unit cell symmetry and some amorphisation. The extent of dissolution in a mixture of hydrochloric acid and sodium fluoride increased with milling time. For a powder milled for 50 h, over 95% of the concentrate were solubilised in 24 h compared with similar to 50% in 48 h for a 2-h milled powder. The kinetics of dissolution changed with the milling time, indicating a change in the rate-determining step due to milling. These effects were attributed to the decrease in crystallinity of the powder, giving a substantial increase in the lattice strain and in unsatisfied surface bonds where dissolution was thought to occur.

[2] THE EFFECT OF ULTRAFINE GRAINED MICROSTRUCTURES ON THE HOT-WORKABILITY OF INTERMETALLIC/CERAMIC COMPOSITES BASED ON GAMMA-TiAl

Fanta G. Bohn R. Dahms M. Klassen T. Bormann R. - Intermetallics. 9(1):45-49, 2001
Intermetallic/ceramic composites are prepared by mechanical alloying and subsequent powder consolidation. The bulk material of the composition Ti-45Al 2.4Si (at.%) exhibits a homogeneous microstructure of equiaxed gamma-TiAl grains (d(gamma) = 196 nm) with a volume fraction of about 10% xi-Ti-5(Si,Al)(3)-silicides finely dispersed along the grain boundaries. Large fully dense specimens (m = 500 g) allow for the demonstration of the easy hot-workability of ultrafine grained materials by industrial processing techniques like isothermal forging and extrusion. The temperatures for isothermal forging can be kept between 800 and 900 degreesC for maximum strain rates in the range of 10(-4) s(-1). Deformations up to 75% at stresses below 160 MPa are achieved. Due to the stabilizing effect of the Ti5Si3-silicides, only slight grain coarsening is observed. Taking into account the high strain rate sensitivity of the material, extrusion tests (epsilon = 1.5 s(-1)) are performed at temperatures between 1025 and 1250 degreesC. While significant coarsening of both the gamma-TiAl matrix and the silicide dispersion is observed at high deformation temperatures, extrusion at 1025 degreesC retains the fine grained and homogeneous microstructure

[1] SYNTHESIS OF NANO-RuAl BY MECHANICAL ALLOYING

Liu KW. Mucklich F. Birringer R. - Intermetallics. 9(1):81-88, 2001
Single phase RuAl has been synthesised directly by an abrupt reaction during mechanical alloying (MA). The structural evolution during MA and subsequent thermal stability of as-milled powders have been analysed by thermal analysis (DSC) and isothermal annealing. The results indicate that there are two stages of alloying and reaction between Ru and Al in MA before single phase RuAl is obtained under the present milling conditions, and that the as-milled single phase RuAl undergoes reordering, strain relaxation and grain growth at high temperatures. The grain size of 20-40 nm after annealing at 1073 K for 0.5 h shows a strong stability of the nano-grained RuAl.



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Mécanosynthèse et Activation Mécanique"

CNRS UMR 5060 Université de Technologie de Belfort Montbeliard (UTBM) - 90010 Belfort Cedex

2) M. Boudina

synthèse réactive des matériaux pour des applications aéronautiques à base de Ti-Al-Nb en utilisant de l'hydrogène.

3) Fumio Saito

Title: Mechanochemical Dissociation of HBB

Authors: Qiwu Zhang, Hiroki Matsumoto, Fumio Saito and Michel Baron*

Affiliations: IAMP, Tohoku University (Japan), *Ecole des Mines d'Albi (France)

Conférences orales

11) J. Focf, A. Legris, R.S. de Figueiredo

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Laboratoire de Métallurgie Physique et Génie des Matériaux - (L.M.P.G.M.) - UMR CNRS 8517 / Université des Sciences et Technologies de Lille

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"Etude des corrélations entre les conditions de broyage et la nanostructure dans le composé magnéto-résistif Cu₈₀(Fe_{0.3}Co_{0.7})₂₀"

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9) Sylvie Begin-Colin, T. Girot, G. Le Caër, F. Radjai, X. Devaux

"Mécanismes et modélisation de transformations de phase induites par broyage dans TiO₂"

Laboratoire de Science et Génie des Matériaux Métalliques

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Laboratoire de Magnétisme et Applications, Groupe de Physique des Matériaux

UMR CNRS 6634 Faculté des Sciences de Rouen

76821 Mont St Aignan Cedex

7) A. Fnidicki, C. Lemoine, J. Teillet

Effets de la contamination en oxygène et en azote gazeux sur les propriétés structurales et magnétiques des alliages Fe-Cr obtenus par mécanosynthèse.

Magnétisme et Applications - UMR 6634 CNRS

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6) B. Chevalier, J-L. Bobet et J. Etourneau

Influence du broyage énergétique sur les propriétés magnétiques d'intermétalliques à base de gadolinium et de manganèse

B. Chevalier, J-L. Bobet et J. Etourneau.

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Groupe IV : Matériaux Magnétiques et Déterminations Structurales

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Graphite broyé sous hydrogène ou sous oxygène: propriétés électrochimiques

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sur la synthèse de nanoparticules de maghémite par broyage mécanique

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Activation Mécanique de Précurseurs pour la Projection Thermique

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La préparation, par mécanosynthèse d'hydrures de rubidium et de césium



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