

RESEAU FRANÇAIS DE MECANOSYNTHESE

Lettre N°68

Novembre 2000

181 Groupes de Recherche
(dont 108 à l'étranger / 32 Pays)

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

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E. Ivanov - Tosoh - USA
M. Senna - Faculty of Science and Technology - Japan
L. Takacs - Dpt Physics - Univ. Maryland - USA

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SOMMAIRE

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

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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'99 et quelques éléments mis à jour régulièrement
concernant les derniers résultats dans ce domaine.

JRFM'2001

21 et 22 Mai 2001 - Amiens - France

Thème 2001 :

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

Contact :

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Technical Announcement

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M.B.N.srl
via Roma, 4
I-31020 San Vendemiano (TV) - Italie

- **MBN srl**, based in Italy, announces the availability of laboratory (**kg range**) as well as industrial quantities (**ton range**) of materials produced by **mechanosynthesis**.
- More information are available at the Web site: <<http://www.mbn.it/>> .
- **Batches on-demand could be considered**

Contact : E-mail: info@mbn.it

Web site: <http://www.mbn.it>

Phone Number : +39 0422 718956

Fax Number : +39 0422 718964

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<p>VARIO-PLANETARY MILL "pulverisette 4"</p> <p>The "pulverisette 4" vario-planetary mill is capable of emulating ball mills of conventional design, precisely simulating the types of stress entailed and thus reproducing or optimising grinding processes. Due to the high flexibility available for selecting the grinding parameters, it is possible to achieve results unattainable with any other ball mills.</p> <p>This is the ideal mill for mechanical activation and alloying. The main applications are in the field of materials research and, of course, wherever a powerful, innovative planetary mill is required.</p> <p>When particles < 10 mm are fed in, a final fineness up to 0.1 µm can be achieved. The useful capacity is between 2 x 30 ml in the case of 80 ml grinding bowls and 2 x 125 ml when 250 ml grinding bowl are used.</p> <p>Method of operation:</p> <p>With standard planetary ball mills the grinding bowls are rotating and mounted eccentrically on a rotating support disc. The rotational speed of the supporting disc can be selected at will; the grinding bowl rotates at a fixed transmission ratio.</p> <p>Due to the overlapping of grinding bowls and supporting disc, the material to be ground and the grinding balls execute movements and trajectories in the grinding bowl, which are defined by the transmission ratio.</p> <p>With the "pulverisette 4" vario-planetary mill the rotational speeds of grinding bowls and supporting disc can be adjusted completely independently of each other. By varying the transmission ratio it is possible to control the movements and trajectories of the grinding balls at will so that the balls strike the inner wall of the bowl vertically (high impact energy), approach each other tangentially (high friction) or just roll down the inner wall of the bowl (centrifugal mills).</p>	<p>All intermediate levels and combinations of frictional and impact pressures can be set as required. By changing the transmission ratio it is therefore possible for the first time to carry out mechanical activation as well as mechanical alloying.</p> <p>Furthermore, it is also possible for the first time to optimally adjust a planetary ball mill to the material to be ground, the size of the grinding bowls and the grinding balls.</p> <p>Features of performance:</p> <ul style="list-style-type: none">• for the first time, all grinding parameters can be selected at will for optimal preparation of sample• Programming of the grinding parameters by PC software as desired• RS232 interface for programming and to transfer grinding parameters to the PC• Real-time display of the speeds to monitor the grinding process• Reversing option (direction of rotation reversed periodically) to improve the grinding results• Emulation of various ball mills• Variably adjustable pressure on sample (friction and/or impact)• Final fineness << 1 µm• Simultaneous grinding in up to 4 small or 2 large grinding bowls• Quick, secure fastening of the grinding bowls• Ease of cleaning <p>contact: Fritsch GmbH (Andrea Köhler- Manufacturers of Laboratory Instruments Industriestrasse 8 D-55743 Idar-Oberstein Phone: ++49/ 67 84/70-46 Fax: ++49/ 67 84/70-11 E-Mail: info@fritsch.de Internet: http://www.fritsch.de</p>
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**ANNONCE DE CONGRES ET / OU ECOLES
CONGRESS AND SCHOOL ANNOUNCEMENTS**

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PM 2000

**Powder Metallurgy World
Congress & Exhibition**

12 - 16 Novembre 2000 Kyoto - Japon
Contact : Fax : 81 - 3 - 3423 - 1600

**The 1st International Conference on Advanced Materials Processing
Rotorua, New Zealand, 19-23 November 2000.**

Secretary, ICAMP 2000,
Department of Materials and Process Engineering The University of Waikato
Private Bag 3105, Hamilton, New Zealand
Fax: 64-7-838 4835, e-mail: d.zhang@waikato.ac.nz
Or visit the conference web site:
<http://mape.waikato.ac.nz/conferences/icamp>

"Scattering Studies of Mesoscopic Scale Structure and Dynamics in Soft Matter"

Messina Italy
22th to 25th of November 2000
(for details see LRFM60)

2000 MRS Fall Meeting

27 Nov - 1 Dec. 2000
Boston - Massachusetts - USA
(for details see LRFM60)

**International Conference on Trends in Mechanical Alloying Science, Technology and
Applications (TMA-2001)**

Janpur, India Feb. 21-23, 2001.

Secretariat of Int. Conf. TMA-2001
Organizer : Dr. P. R. Soni
Department of Metallurgical Engineering,
Malaviya Regional Engineering College
Jaipur-302017, India
Tel : +91-0141-702042
Fax : +91-0141-702954
E-mail : psmt@arya.recjai.ernet.in
Contact Persons : Dr. P. R. Soni - Prof. T. V. Rajan

Particles 2001

24-27 February 2001
Rosen Center Hotel, Orlando, FL
<http://www.nanoparticles.org>

Science et Technologie des Poudres

Nancy - France
3 - 5 Avril 2001
website : <http://www.inpl-nancy.fr/stpoudres3.html>
e-Mail : stpoudres@inpl-nancy.fr

PM2 TEC2001

**2001 International Conference on Powder Metallurgy
& Particulate Materials**

13 - 17 May 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 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
on 24-30 June 2001.

Abstract deadline is March 1st, 2001.
Abstracts of 200-400 words should be submitted by e-mail to
E-Mail : ISMANAM-2001@umich.edu
Web site : <http://www-ners.engin.umich.edu/ISMANAM2001>.

COLLOQUE SUR LES INNOVATIONS
DANS LES MATERIAUX FRITES

Poitiers-Futuroscope
3-4-5 juillet 2001

consulter le site www.sf2m.asso.fr (rubriques sommaires puis conférences)

SOUTENANCES DE THESE

N. LORRAIN

Poudres Nanocomposites Ag - SnO₂ préparées par broyage réactif : mise en oeuvre, frittage et évolution microstructurale

30 Octobre 2000 - Université de Grenoble I

Jury : E. Gaffet (Rapp.), F. Thévenot (Rapp.), D. Bouvard, G. Le Caër, C. Carry (Dir. Thèse), L. Chaffron

J.Ph. BRAGANTI

Synthèse d'alliages amorphes Al-Ni-Zr par broyage mécanique :
- étude de la cinétique de cristallisation par calorimétrie,
- analyse du chemin réactionnel par diffraction des rayons X

20 octobre 2000 – Université Henri Poincaré – Nancy I – Vandoeuvre lès Nancy

Jury : C. Bergman (Rapp.), J.P. Bros (Rapp.), J.M. Moreau, S. Colin-Bégin, J.C. Gachon, F.A. Kuhnast (Dir)

Le travail de cette thèse est consacré à l'étude de la cristallisation d'alliages amorphes binaires ou ternaires Al-Ni-Zr préparés par broyage mécanique. Ces alliages amorphes sont caractérisés par leur état thermodynamique hors équilibre. Pour envisager des applications, il est nécessaire de connaître leur évolution vers l'état d'équilibre final.

Il est possible d'aborder deux aspects de la cristallisation, cinétique et chemin de cristallisation, grâce aux techniques expérimentales suivantes :

- la microcalorimétrie différentielle à balayage très adaptée à l'étude de la cinétique de cristallisation,
- la diffraction X classique et la diffraction X en temps réel pour l'étude des chemins de cristallisation.

M. NAKHL

Le broyage énergétique appliqué à :
l'obtention de mélanges composites à base de magnésium utilisables pour le stockage de l'hydrogène,
la modification des propriétés magnétiques d'intermétalliques à base de gadolinium

16 OCTOBRE 2000 - UNIVERSITE DE BORDEAUX I - BORDEAUX

Jury : G. Le Caër (Rapp.), E. Gaffet (Rapp.), B. Chevalier, J.-L. Bobet, J. Etourneau

CH. GRAS

Réactivité et Thermodynamique dans le procédé MASHS
(Mechanically Activated Self - Propagating High - Temperature Synthesis) :
Application aux systèmes Mo / Si et Fe / Si

6 Septembre 2000 - Univ. de Bourgogne - Dijon

Jury : Y. Bienvenu (Rapp.), G. Le Caer (Rapp.), G. Bertrand, JP Bonnet, M. Gailhanou, JP Larpin, F. Bernard (Co - directeur) & E. Gaffet (Co - Directeur)

M. ZOUGGAR

"Effets du broyage sur les propriétés structurales et mécaniques de poudres de fer pur et sur l'activation de la nitruration"

4 Septembre 2000 - LMP - Poitiers

Jury : A. Fnidiki(Rapp.), E. Gaffet (Rapp), P. Goudeau (Inv.), M. Grosbras (Inv.), A. Straboni , P. Chartier (Co - Dir) & J. Mimault (Co - Dir)

C. GOUJON

"Elaboration par cryobroyage et métallurgie des poudres de nanocomposites à matrice d'alliage d'aluminium renforcée par des particules de nitrure d'aluminium"

25 Mai 2000 - ENSMSE

Jury : P. Goeuriot (Dir. Thèse), G. Le Caer (Rapp.), D. Michel (Rapp.), F. Bernard, Y. Laurent, M. Suery, F. Thévenot, S. Vicens

J. JOARDAR

**"Synthesis of nanocrystalline aluminides in Al - Ni - Fe system
by Mechanical Alloying"**

Avril 2000

Thesis Supervisor : B.S. Murty et S.K. Pabi (IIT, Kharagpur)

Thesis Examiners : C.C Koch (North Carolina State University) , P. Ramakrishnan (IIT, Bombay)

Christine BARBEAU

(Laboratoire de Métallurgie Physique - Futuroscope)

**Sructure dans les matériaux élaborés sous HIP : cas des alliages à base tungtène par frittage et
du carbure de titane par combustion auto-propagée**

13 mars 2000

Thèse de Doctorat de l'Université de Poitiers

Jury: A. TRAVERSE, Directeur de Recherche, LURE Orsay, Rapporteur - F. NARDOU, Professeur, Université de Limoges, Rapporteur, D. VREL, Chargé de Recherche, Université de Villeneuve - Examineur, M.F. BEAUFORT - Chargé de Recherche CNRS, LMP Poitiers - Examineur, M. GROSBRAS - Chargé de Recherche CNRS, LMP Poitiers, Examineur - J. MIMAULT, Professeur, Université de Poitiers, Examineur et Directeur de Thèse

Hugues GUÉRAULT

**PROPRIÉTÉS STRUCTURALES ET MAGNÉTIQUES DE POUDRES DE FLUORURES
NANOSTRUCTURÉES MF₃ (M=Fe, Ga)
OBTENUES PAR BROUAGE MÉCANIQUE**

28 Janvier 2000

THÈSE DE DOCTORAT - Université du Maine - Physique des Matériaux et des Surfaces

Jury : Gérard Le CAER, Directeur de Recherche, Ecole des Mines - Nancy (Rapporteur), Marc NOGUES, Chargé de Recherche, Université de Versailles (Rapporteur), Jean-François BÉRAR, Ingénieur de Recherche, CNRS - Grenoble, Frédéric BERNARD, Maître de Conférence, Université de Bourgogne - Dijon, Jean-Yves BUZARÉ, Professeur, Université du Maine - Le Mans, Marc LEBLANC, Professeur, Université du Maine - Le Mans, Jean-Marc GRENÈCHE, Directeur de Recherche, Université du Maine (Directeur de thèse)

Cyril LENAIN

**APPLICATION DE LA MECANOCHIMIE A LA PREPARATION D'ALLIAGES HYDRURABLES
NANOCRISTALLINS AB₅, MG-NI, AB₂ (M) ET DE COMPOSITES M-C, M-Cu : ETUDE DE LEURS
PROPRIETES ELECTROCHIMIQUES.**

THESE DE DOCTORAT - Specialite: sciences des materiaux presentee a l'Universite de Picardie Jules Verne

Jury : M. le Prof. J. Etourneau (Universite Bordeaux) M. D. Fruchart (DR, Lab. Cristallographie, Grenoble) Mme A. Percheron - Guegan (DR, LCMTR, Thiais) M. le Prof. L. Schlappach (Universite de Fribourg) M. le Prof. J.-M. Tarascon (Universite de Picardie) M. L. Aymard (Universite de Picardie)

Cooperative Research on Related Areas

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 : HYPERLINK mailto:shhong@sorak.kaist.ac.kr / 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**

ESPAGNE (25/09/2000) POSTDOCTORAL POSITION (From M.D. Baro)

Universitat Autònoma de Barcelona

The Group de Física de Materials II of the Physics Department of the UAB announces the availability of a 18 months full-time Postdoctoral Research position. Applicants should hold a PhD degree in Materials Science, Physics or in a related field. The position requires:

Knowledge of glasses, metastable and nanocrystalline materials.

Fundamental understanding of the nucleation and crystal growth theories.

Knowledge of calorimetry and thermostability.

Experience in electron, optical and x-ray based characterisation techniques and practices.

Computer literacy.

Citizenship of EU (except Spain) or Associated states.

Under 35 years old.

Proficient level of English

The position begins with effect from January 2001. The research programme includes a close co-operation with other partners of the Project. Applicants should submit a CV, and a statement describing your interest in the position with two references to:

Professor M.D. Baro,
Dept. Physics, Edifici Cc,
08193 Bellaterra,
Barcelona, Spain;
Tel: 34 93 5811657.

Electronic applications can be sent to dolors.baro@uab.es"

ANGLETERRE (21/09/2000) - From Paul Warren (paul.warren@materials.oxford.ac.uk)

Job vacancies in a Research Training Network.

Research Training Network on Manufacture and Characterisation of Nanostructured Al alloys

Pre-doctoral/post-doctoral researchers required at 9 institutions across Europe.

The research positions will involve aspects of : materials processing by gas atomization, rapid solidification and mechanical alloying, followed by compaction; microstructural and microchemical characterisation by XRD, DSC, TEM, STEM, APFIM ; thermodynamic / kinetic modelling and molecular dynamic simulation ; mechanical property evaluation by tensile testing, fatigue testing and high strain rate impact testing.

See Network Homepage <http://www.materials.ox.ac.uk/nano-al/> for more details.

FRANCE (14 / 02 / 2000)

Ph D Thesis Proposal

A partir de septembre 2000 (Bourse du Ministère)

"Obtention par mécanosynthèse de mélanges composites à base de magnésium ayant des propriétés d'hydruration optimisées. Caractérisation de leurs propriétés structurales et physiques.

En résumé, le sujet proposé portera sur les deux points suivants :

- 1 - Etude de mélanges composites Mg (ou Mg₂Ni) + intermétalliques élaborés par mécanosynthèse (structure, composition chimique, capacités d'absorption d'hydrogène, morphologie, surface, granulométrie,) ;
- 2 - Réalisation d'électrodes négatives à partir de ces mélanges et études électrochimiques.

Les techniques utilisées au cours de ce travail seront* :

Préparation : - Broyeur planétaire - Four à lévitation - Four à arc - Banc d'hydruration (construction de courbe PCT)

Caractérisation : - Diffraction des rayons X sur poudres - Microsonde électronique - Microscopie électronique (à balayage et en transmission) - Mesures de surfaces spécifiques (BET) - Granulométrie (diffraction Laser - "Mesures" électrochimiques - Mesures calorimétriques XPS, EPMA, ...

* ceci est une liste non exhaustive des différentes techniques que le candidat devra utilisé

Contact :

Jean-Louis BOBET

Associate professor - Institut de Chimie de la Matière Condensée de Bordeaux Avenue du Dr A. Schweitzer
33608 Pessac Cedex FRANCE

Tel : 33-(0)5-56-84-26-53 Fax : 33-(0)5-56-84-24-80 e mail : bobet@icmcb.u-bordeaux.fr

USA (8 / 02 / 2000)

Rutgers University is seeking a **postdoctoral associate** with demonstrated expertise in powder synthesis and processing (forming and sintering methods) to work on research focused on textured ceramic ferroelectric materials. The candidate must be able to work as part of a multidisciplinary team involving industry and academia focused on making transducer and actuator materials. The candidate should demonstrate the ability to work independently, publish in archival journals and present their work in a public forum. The candidate should send a curriculum vitae, three representative publications (preferably with the candidate as a first author) and the names, addresses, email and phone numbers of three references that can comment on the candidate's capabilities. The position is available immediately at a salary of \$32,000 with health benefits included. The position is available immediately. Placement is preferred prior to August with priority given to a qualified candidate with earlier availability.

Interested candidates should send correspondence to: Professor Richard E. Riman, Rutgers University, Department of Ceramic and Materials Engineering, 607 Taylor Road, Piscataway, NJ 08854-8065, riman@alumina.rutgers.edu / 732-445-4946 / 732-445-6264

COREE du SUD (10 / 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 : [HYPERLINK mailto:shhong@sorak.kaist.ac.kr](mailto:shhong@sorak.kaist.ac.kr) /shhong@sorak.kaist.ac.kr

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

The Composite Materials Laboratory at Korea Advanced Institute of Science and Technology is looking for a postdoctoral position. The postdoctoral contract will be one year on the field of modeling and simulation of mechanical & thermal properties of composite materials or on the field of fabrication process of nano-composite materials. Applicant should be within three years of receipt of Ph.D. degree on related field. For more information, please contact :

Bibliographie Récente

Livres ou "Special Issues"

(7/07/2000) - From Victor Rieckansky 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 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 Ni₃Mo_{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 Amorphization - Mechanical Solid State Amorphization of Fe₅₀W₅₀ Binary System - Special 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)

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 234 **156 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, 234 **156 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 : 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.ttp.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, 234 **156 mm**, **soft laminated cover**, £22.00, January 1999

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

"Mechanical Alloying"

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

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

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

PERIODIQUES

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

[66] MECHANICAL ALLOYING: A METHOD TO OBTAIN METALLIC POWDERS AND COMPOSITE MATERIALS [REVIEW] [SPANISH]

Ruiz-Navas EM. da Costa CE. Lopez FV. Castello JMT. - Revista de Metalurgia (Madrid). 36(4):279-286, 2000
This work deals with the mechanical alloying process as a method for powder production. The main aspects involved are as well as the fundamentals and their particular application to the metal powder production.

[65] ACCELERATION OF MECHANICAL SIZE REDUCTION OF CHROMIUM CARBIDE POWDERS AND MIXTURES BASED ON CHROMIUM CARBIDE

Maslyuk VA. - Powder Metallurgy & Metal Ceramics. 39(1-2):1-6, 2000
We have investigated how mechanical activation by rolling on smooth rollers affects the dispersion kinetics of chromium carbide powder and mixtures of chromium carbide powders with nickel in a ball mill. We have shown that preliminary double rolling of chromium carbide powder on a rolling mill accelerates particle size reduction in the ball mill down to a size of 1.4-1.5 μm by a factor of 4.6 compared with unrolled powder. In this case, the size reduction increases from 36 to 91 in relative units. The mean particle diameter for the powders and mixtures decreases exponentially as the grinding time increases from 12 h to 84 h.

[64] FORMATION OF NANOCRYSTALLINE FE-CO POWDERS PRODUCED BY MECHANICAL ALLOYING

Kim YD. Chung JY. Kim J. Jeon H. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 291(1-2):17-21, 2000

The structural and magnetic properties of Fe-Co alloy powders produced by mechanical alloying of elemental powders were investigated. In this research, two kinds of milling methods (cyclic and conventional operation) were adopted to optimize the milling process. Consequently, the alloy powder with average grain size 10-15 nm was obtained. The cyclic operation had an advantage over conventional milling in that a smaller-grained structure could be obtained with less milling time. Maximum M-s was obtained at the composition of 30 at.% Co. Due to the high amount of internal strain introduced during milling, relatively high coercivities were obtained. The coercivity was decreased fairly through the relief of the internal strain by heat treatment. Over 95% of the theoretical density was attained after the spark plasma sintering at 900 degrees C for 5 min with applying pressure of 60 MPa. The sintered specimen remains nanostructured with a grain size of about 30 nm.

[63] MICROSTRUCTURE AND MECHANICAL PROPERTIES OF MECHANICALLY ALLOYED AND SOLID-STATE SINTERED TUNGSTEN HEAVY ALLOYS

Ryu HJ. Hong SH. Baek WH. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 291(1-2):91-96, 2000

The mechanical properties of solid-state sintered 93W-5.6Ni-1.4Fe tungsten heavy alloys fabricated by mechanical alloying were investigated. Blended W, Ni and Fe powders were mechanically alloyed in a tumbler ball mill at a milling speed of 75 rpm employing a ball-to-powder ratio of 20:1 and a ball filling ratio of 15%. A nanocrystalline size of 16 nm and fine lamellar spacings of 0.2 μm were obtained in mechanically alloyed powders at a steady state milling stage. Mechanically alloyed powders were consolidated into green compacts and solid-state sintered at 1300 degrees C for 1 h in a hydrogen atmosphere. The alloys sintered from mechanically alloyed powders showed fine tungsten particles (about 3 μm in diameter) and a relative density above 99%. The volume fraction of the matrix phase was 11% and the tungsten/tungsten contiguity was determined to be 0.74. The alloys exhibited high yield strengths (about 1100 MPa) due to their fine microstructures, but exhibited reduced elongation and impact energy due to a large area fraction of tungsten/tungsten boundaries and the low volume fraction of matrix phase.

[62] DEFORMATION INDUCED MARTENSITE AND SUPERELASTICITY IN A BETA-METASTABLE TITANIUM ALLOY

Grosdidier T. Philippe MJ. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 291(1-2):218-223, 2000

This work investigates the formation of deformation induced martensite and shape-memory effects of water quenched P-rich microstructures of a beta metastable titanium alloy denominated beta-Cez (developed by the Cezus company). In highly beta metastable microstructures - solution treatments for 1 h at 920 (beta domain) or 860 degrees C (alpha+beta domain) - the beta phase transforms to a martensite that is stress-assisted in nature. Solution treatment at a slightly lower temperature (850 degrees C) increases the stability of the beta phase and the martensite thus becomes a strain-induced type. Decreasing the solution treatment temperature further (800 degrees C) leads to a sufficiently stable beta phase so that no martensite is formed under tensile deformation and only slip is activated. These different ways of accommodating deformation result in various mechanical responses. In particular, the stress-assisted martensite in this alloy is partly reversible under unloading, which produces significant superelasticity.

[61] HREM OBSERVATIONS OF KINKING IN SiC INDUCED BY BALL MILLING

Yang XY. Wu YK. Ye HQ. - Materials Characterization. 44(4-5):403-406, 2000
Kinking in SiC during ball milling (BM) at room temperature has been reported in this article. High-resolution electron microscopy (HREM) has been employed to characterize the microstructure at the atomic level. HREM observations show that partial dislocations can be introduced into SiC and glide on the primary (0001) planes under BM at room temperature. When numbers of the gliding partials are piled up along one direction, a kink boundary forms, which will initiate a crack. However, when gliding partials are not piled up, glide of the partials changes the stacking sequence and transformation from 6H-SiC \rightarrow 3C-SiC occurs.

[60] REACTION OF LI WITH GRAIN-BOUNDARY ATOMS IN NANOSTRUCTURED COMPOUNDS

Beaulieu LY. Larcher D. Dunlap RA. Dahn JR. - Journal of the Electrochemical Society. 147(9):3206-3212, 2000
Intermetallic compounds react with Li to produce high capacity negative electrodes for lithium-ion batteries. Because of the violent reactions occurring during the alloying process between lithium atoms and the active alloy, the cycle life

of these materials is generally poor. In this paper we show that nanostructured SnMn₃C, which has a low affinity for lithium, behaves differently from any intermetallic system reported to date. Using in situ X-ray diffraction, in situ Sn-119 Mossbauer spectroscopy, and electrochemical experiments on mechanically alloyed samples of nanostructured SnMn₃C, we show that the grain boundaries apparently act as channels to allow Li to enter the particles. The lithium atoms then reversibly react with Sn atoms at and within the grain boundaries to deliver a working capacity of approximately 150 mAh/g with no capacity loss with cycle number.

[59] THE REACTION OF LITHIUM WITH SN-MN-C INTERMETALLICS PREPARED BY MECHANICAL ALLOYING

Beaulieu LY. Dahn JR. - Journal of the Electrochemical Society. 147(9):3237-3241, 2000

Intermetallic phases and mixtures of intermetallic phases in the Sn-Mn-C ternary system were prepared by mechanical alloying. The reaction of lithium with these phases was studied using in situ X-ray diffraction and electrochemical methods. Studies concentrated on Sn₂Mn, SnMn_{1.77}, SnMn₃, and SnMn₃C. Nanoscale two-phase mixtures of Sn₂Mn/SnMn_{1.77} and Sn₂Mn/SnMn₃C were also prepared and studied. When Sn₂Mn is mixed with sufficient amounts of a second phase, electrodes capable of delivering over 200 mAh/g for more than 50 cycles can be prepared. Grain boundary tin atoms in nanostructured SnMn₃C appear to be able to react reversibly with lithium for hundreds of cycles.

[58] PRESSURELESS SINTERING OF METAL-BONDED DIAMOND PARTICLE COMPOSITE BLOCKS

Hsieh YZ. Chen JF. Lin ST. - Journal of Materials Science. 35(21):5383-5387, 2000

Metal-bonded diamond particle composite blocks were fabricated by pressureless sintering, using multi-phase copper based alloys as the bonding materials. The processing sequences included ball-milling the diamond particles and metallic powders, uniaxially pressing the milled powder mixtures into green compacts, and sintering the green compacts in vacuum. The bonding materials, constituted of Cu, Sn, Ti, Mo and TiC, were prepared by blending various elemental and prealloyed powders. Addition of Ti as an active element effectively enhanced the interfacial cohesion strength, by developing an intermediate layer between the diamond particles and the matrix phase. This resulted in the observation that the failure mode of the composite blocks in a bending test was predominantly cleavage of diamond particles instead of pull-out of diamond particles.

[57] MECHANOCHEMICAL SYNTHESIS OF HYDROXYAPATITE FROM CA(OH)(2)-P2O5 AND CAO-CA(OH)(2)-P2O5 MIXTURES

Kim W. Zhang QW. Saito F. - Journal of Materials Science. 35(21):5401-5405, 2000

Dry grinding of Ca(OH)(₂)-P₂O₅ and CaO-Ca(OH)(₂)-P₂O₅ mixtures was conducted by a planetary ball mill to investigate the mechanochemical solid-phase reaction for the synthesis of hydroxyapatite (Ca-10(PO₄)(₆)(OH)(₂), HAp). HAp was synthesized by grinding of the two sets of mixtures. The formation of HAp from the Ca(OH)(₂)-P₂O₅ mixture was more advantageous than that from the CaO-Ca(OH)(₂)-P₂O₅ one. This synthesis reaction from the former mixture was almost completed within 30 min of grinding. The presence and amount of H₂O contained in the starting mixtures played a key role to promote the formation of HAp. Especially, in the former mixture, the prolonged grinding assisted the solid-phase reaction of the intermediate DCPD and Ca(OH)(₂) to produce HAp more effectively.

[56] PLASMA-ASSISTED DEPOSITION OF NANOSTRUCTURED FILMS AND COATINGS

Girshick SL. - High Temperature Material Processes. 4(3):379-384, 2000

Recent work is reviewed on plasma-assisted deposition of nanostructured films and coatings. Several methods are being developed. These include conventional plasma spray in which nanostructure is induced in the coarse feed powder by mechanical milling before spraying; thermal plasma spray pyrolysis; plasma flash evaporation of fine powders injected into an RF torch; hypersonic plasma particle deposition; and low-pressure plasma synthesis and deposition of nanoparticles to produce thin films.

[55] PEROVSKITE CATALYSTS FOR THE CATALYTIC FLAMELESS COMBUSTION OF METHANE - PREPARATION BY FLAME-HYDROLYSIS AND CHARACTERISATION BY TPD-TPR-MS AND EPR

Leanza R. Rossetti I. Fabbrini L. Oliva C. Forni L. - Applied Catalysis B-Environmental. 28(1):55-64, 2000

A new method was employed for the preparation of a set of lanthanum cobaltites of general formula La_{1-x}M_xCoO_{3+δ} with M=Ce, Eu and x=0, 0.05, 0.1, 0.2. All the samples thus prepared were nanostructured, thermally very stable and characterised by highly crystalline perovskite-like structure and high surface area. Their activity as catalysts for the catalytic flameless combustion (CFC) of methane was by ca. one order of magnitude higher than that of their analogues, prepared through the usual calcination-milling (CM) procedure. Adsorption of oxygen was accompanied by formation of paramagnetic species. Desorption of preadsorbed oxygen was dependent on the nature of the doping element and on the value of the stoichiometric coefficient x of their formula. A correlation between the temperature of the maximal rate of oxygen release and catalytic activity was found. The following scale of activity for the title reaction versus x values could be set up: 0.1Ce>0.05Ce>0>0.05Eu>0.1 Eu congruent to 0.2Ce. The higher activity of Ce-doped catalysts as compared to those doped with Eu was found to be related to the strength of the bond between oxygen and Co ions.

[54] ECO-POLISHING OF HARD MATERIALS BY APPLYING MECHANOCHEMICAL EFFECTS

N Yasunaga - ABRASIVE TECHNOLOGY: CURRENT DEVELOPMENT AND APPLICATIONS I, 1999, pp 371-377 - 3RD INTERNATIONAL CONFERENCE ON ABRASIVE TECHNOLOGY; BRISBANE, AUSTRALIA. NOVEMBER 22-24, 1999

Ecological polishing process that is desirable for keeping the earth and the working environment clean and safe would be more required in the next century. Mechanochemical polishing method which uses no chemical liquid will be suitably applicable to this request. Machining features and superiority of dry polishing and pure-water based wet polishing of Si single crystal and sapphire are described.

[53] FEASIBILITY OF SYNTHESISING LIGHTWEIGHT NANOPHASE AL MATERIALS BY MECHANICAL ALLOYING

WJ Vine, PS Goodwin - ALUMINIUM ALLOYS: THEIR PHYSICAL AND MECHANICAL PROPERTIES, PTS 1 - 3 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 331-3, 1-3, pp 1145-1150 - 7TH INTERNATIONAL

CONFERENCE ON ALUMINIUM ALLOYS (ICAA7); CHARLOTTESVILLE, VIRGINIA. APRIL 9-14, 2000

The current research is aimed at producing kilogram quantities of Al nanomaterials, derived from mechanically alloyed (MA) and atomised precursors. Although Mn was a time intensive process, it gave bulk quantities of fine powders featuring a smaller grain size (greater than or equal to 14nm) than found in atomised material. Consolidation was achieved at 350 degrees C by HIP/forging and extrusion methods but produced grain growth; despite this growth, MAed materials remained >40% harder than atomised specimens, which was attributed to a fine grain structure (<160nm diameter) in the former material.

[52] IN SITU DISPERSION OF YTTRIUM AND CALCIUM OXIDES IN MECHANICALLY ALLOYED AL-Y AND AL-CA ALLOYS

J Kaneko, M Sugamata, M Okubo - ALUMINIUM ALLOYS: THEIR PHYSICAL AND MECHANICAL PROPERTIES, PTS 1 - 3 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 331-3, 1-3, pp 1209-1214 - 7TH INTERNATIONAL CONFERENCE ON ALUMINIUM ALLOYS (ICAA7); CHARLOTTESVILLE, VIRGINIA. APRIL 9-14, 2000

With a purpose of attesting preferential oxidation of alloying elements which have low solid solubility in aluminum, Al-5at%Y and Al-5at%Ca alloys were mechanically alloyed with or without addition of metal oxides, CuO and Fe₂O₃. Yttrium and calcium were chosen as the alloying elements since they have a higher oxidation tendency than Al and low maximum solid solubility. Mechanically alloyed powders were consolidated to the P/M materials by hot-extrusion. The constituent phases, microstructures and mechanical properties were examined for the mechanically alloyed powders, as-extruded acid heat-treated P/M materials. It has been shown that the added oxygen, either from the milling agent or from the added oxide powders, acted as the oxygen sources for internal oxidation. Yttrium in Al was shown to be preferentially oxidized to Y₂O₃ and Al₅Y₃O₁₂, while calcium in Al to CaO and CaAl₄O₇. Thus, in-situ dispersion of Y₂O₃, Al₅Y₃O₁₂, CaO and CaAl₄O₇ has been attained by the solid state reactions induced in Al-Y and Al-Ca alloys. The Al-Y based PIM materials with addition of oxide show high tensile strength of above 600MPa at room temperature.

[51] MICROSTRUCTURE AND MECHANICAL PROPERTIES OF 2024AL-FE-NI PM ALLOYS CONSOLIDATED BY EQUAL CHANNEL ANGULAR PRESSING

K Matsuki, T Aida, T Takeuchi, J Kusui - ALUMINIUM ALLOYS: THEIR PHYSICAL AND MECHANICAL PROPERTIES, PTS 1 - 3 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 331-3, 1-3, pp 1215-1220
7TH INTERNATIONAL CONFERENCE ON ALUMINIUM ALLOYS (ICAA7); CHARLOTTESVILLE, VIRGINIA. APRIL 9-14, 2000

Experiments were conducted on 2024Al-3mass%Fe-5mass%Ni (3F5N) alloy powder to investigate the feasibility of the producing a compaction with very homogeneous fine microstructure using equal-channel angular (ECA) pressing and of forging the compaction superplastically. It is shown that ECA pressing is capable of obtaining the compaction almost without pores and with very high hardness even after single pressing. Repetitive pressings were conducted on the same samples, up to a total of 3 passages through a die, with the samples pressed without rotation (R=0 deg) and after rotating through 90 deg or 180 deg between each pressing. The results suggest that, ECA pressing with R=90 deg rotation is most effective in producing a reasonably homogeneous microstructure consisted of fine intermetallic particles and equiaxed fine subgrains, and such microstructure formation could contribute to the superplastic-like deformation behavior at high strain rate.

[50] PREPARATION OF AL-FE-V-SI NANOCRYSTALLINE POWDERS BY DOUBLE MECHANICAL ALLOYING

LJ Zheng, JX Lin, BS Li, BJ Zhang, MK Tseng - ALUMINIUM ALLOYS: THEIR PHYSICAL AND MECHANICAL PROPERTIES, PTS 1 - 3 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 331-3, 1-3, pp 1225-1227

A new synthesis technique, namely double mechanical alloying (DMA), has been developed to prepare Al-Fe-V-Si nanocrystalline powders, and during the DMA, XRD result indicate that a transformation from alpha-Al-13(Fe,V)(3)Si + fcc-Al phase to quasicrystalline + fcc-Al phase was observed.

[49] FRACTURE MECHANISM OF DISPERSION STRENGTHENED AL-AL4C3 MATERIALS

M Besterici, J Ivan, L Kovac - ALUMINIUM ALLOYS: THEIR PHYSICAL AND MECHANICAL PROPERTIES, PTS 1 - 3 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 331-3, 1-3, pp 1469-1472 - 7TH INTERNATIONAL CONFERENCE ON ALUMINIUM ALLOYS (ICAA7); CHARLOTTESVILLE, VIRGINIA. APRIL 9-14, 2000

Dispersion strengthened Al-Al₄C₃ materials prepared by mechanical alloying possess good high-temperature properties at low specific weight. Their structure is heterogeneous and consists of fine grained matrix and Al₄C₃ particles created by chemical reaction between Al and C. The particles are incoherent, different in size. The failure mechanism was analyzed by "in situ tensile test in SEM" for Al-Al₄C₃ composites with 8 vol.% of Al₄C₃. Strain rate 6.6 10⁻⁴ s⁻¹ was applied by direct loading of the thinned test piece in the scanning electron microscope in vacuum at 20 degrees C. The crack creation, coalescence, and propagation in the test piece was analyzed. The first cracks were shown to create by failure of large Al₄C₃ particles in the process of loading. Further load increase caused further crack propagation by particle cracking, and matrix-particle interphase boundary decohesion. Cracks propagated also in the direction of load through the concentration of smaller particles grouped in bands. The fracture ended by tearing the ligaments between the bands. Failure mechanism model has been introduced.

[48] STRUCTURAL RESPONSE OF NANOSCALE MECHANOSYNTHESIZED ZINC FERRITE TO CHANGES IN TEMPERATURE

V Sepelak, U Steinike, DC Uecker, KD Becker - EUROPEAN POWDER DIFFRACTION, PTS 1 AND 2 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 321-3, 1&2, pp 357-362

6TH EUROPEAN POWDER DIFFRACTION CONFERENCE; BUDAPEST, HUNGARY. AUGUST 22-25, 1998

The structural response of nanoscale mechanosynthesized zinc ferrite to changes in temperature has been studied in this work using in situ X-ray powder diffraction at several elevated temperatures. Kinetics of the transition of mechanosynthesized zinc ferrite from the inverse to the normal spinel structure are approximated by the first order

kinetics model. The range of the thermal stability of the mechanically induced defects in the structure of mechanosynthesized spinel is determined and the activation energy of the re-equilibration is calculated.

[47] X-RAY POWDER DIFFRACTION STUDY OF MULTILAYER POLYTYPES FORMATION INDUCED BY MECHANICAL MILLING OF LAVES PHASES CO₂+XNB

TA Sviridova, NP Djakonova, EV Shelekhov, YA Skakov - EUROPEAN POWDER DIFFRACTION, PTS 1 AND 2 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 321-3, 1&2, pp 647-652

6TH EUROPEAN POWDER DIFFRACTION CONFERENCE; BUDAPEST, HUNGARY. AUGUST 22-25, 1998

The transformations of the initial C15-type Laves compound Co(2+x)Nb into multilayer Laves phase polytypes induced by processing in planetary ball mill have been studied by means of X-ray diffraction analysis. The method has been proposed for fast simulation of X-ray powder diffraction patterns of any complex Laves phase polytype both containing stacking faults and faultless. It is shown that stacking sequence correlates with energy intensity of the process rather than with integrated energy dose transferred to the powder.

[46] PREPARATION AND ANALYSIS OF QUASICRYSTALLINE PHASES BY HIGH ENERGY BALL MILLING AND X-RAY DIFFRACTION

AI Salimon, AM Korsunsky, EV Shelekhov, TA Sviridova - EUROPEAN POWDER DIFFRACTION, PTS 1 AND 2 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 321-3, 1&2, pp 676-681

6TH EUROPEAN POWDER DIFFRACTION CONFERENCE; BUDAPEST, HUNGARY. AUGUST 22-25, 1998

The consequences of solid-state reactions in mechanically alloyed Al-Cu-Fe powders were studied using advanced techniques of X-ray diffraction pattern interpretation. A set of intermetallic phases was identified which appeared as a result of mechanical alloying and subsequent annealing. These intermetallics were the intermediate products formed during to gradual mechanical and thermal homogenisation and excitation. The quantitative phase composition of mechanically alloyed powders was determined using interactively controlled database phase analysis, fitting procedures and modelling of X-ray patterns for different structures. The analysis allowed us to optimise the processing route, and identify the conditions promoting the formation of single phase quasicrystalline powder. Single phase powders of the quasicrystalline Al₆Cu₂Fe intermetallic (ψ -phase) were obtained from the mixture of elemental powders Al₇₀Cu_{20.3}Fe_{9.7} after a short time milling and annealing at 800 degrees C under argon.

[45] DISORDERED STRUCTURE OF VOHPO₄ x 0.5 H₂O BY MECHANICAL TREATMENT

U Steinike, B Muller, A Martin - EUROPEAN POWDER DIFFRACTION, PTS 1 AND 2 (Series: MATERIALS SCIENCE FORUM), 2000, Vol 321-3, 1&2, pp 1078-1083

6TH EUROPEAN POWDER DIFFRACTION CONFERENCE; BUDAPEST, HUNGARY. AUGUST 22-25, 1998

The mechanical treatment of VOHPO₄ x 0.5 H₂O catalyst precursor has induced a significant decrease (from 1000 Angstrom to 250 Angstrom) and homogenization of the primary crystallite size. The habit of the crystallites is changed from plate-shaped to cube-shaped. The calculated microstrains vary from 0.7 x 10⁻³ to 1.7 x 10⁻³. The as-treated samples are transformed into catalysts. The mechanically induced disturbances in the structure of VOHPO₄ x 0.5 H₂O have influenced its reactivity during phase transformation. The temperature of the transformation from VOHPO₄ x 0.5 H₂O into (VO)₂P₂O₇ under nitrogen is decreased and the rate of the transformation from VOHPO₄ x 0.5 H₂O into [(NH₄)₂((VO)-O-IV)₃(P₂O₇)₂] + (V_xO_y)-O-IV/V under NH₃-air-H₂O flow is increased. The induced imperfections are existent in the newly generated phases (memory effect). The catalytic activity of the formed catalysts is changed significantly.

[44] AMORPHIZATION AND NANOSCALE REFINEMENT OF HIGH NITROGEN CONTAINING FE-BASED CRYSTALLINE MATERIALS BY MECHANICAL ALLOYING

H Ogawa, K Omuro, H Miura - HIGH NITROGEN STEELS '98 (Series: MATERIALS SCIENCE FORUM), 1999, Vol 318-3, pp 687-694 - 5TH INTERNATIONAL CONFERENCE ON HIGH NITROGEN STEELS; STOCKHOLM, SWEDEN. MAY 27-28, 1998

Mechanical alloying(MA) of elemental powder mixtures, with Fe-9.85mass%N alloy powders as the nitrogen source, of Fe (1 0 0 - x - y) A (y) N (x) (at.%) (A=Co,Cr,Nb,Ta,etc.; x=3-25; y=0-25) materials and stainless steel type materials such as Fe (8 7 - x - y) Cr (1) (3) A (y) N (x) (at.%) (type 405)(A=Nb,Ta; x=3-25; y=0-5) and Fe (7 4 - x - y) Cr (1 8) Ni (8) A (y) N (x) (at.%) (type 304) (A=Nb,Ta; x=0-20; y=0-15) was performed in an argon atmosphere using a planetary ball mill. In the MA processing of the Fe-A-N materials, the additives A such as Nb, Ta, and Cr with the negative values of WAN markedly enhance the solid-state reactions in MA powder products, leading to amorphization of the MA powders after 720ks of processing, in contrast to the additive Co with the positive value of W (A N); the parameter W AN represents the difference in bonding energy of A-N atomic pairs (U (A N)) and Fe-N pairs (U (F e N)) in the ternary Fe-A-N solutions, i.e. W (A N) = U (A N) -U (F e N). In addition, refinement of the ternary crystalline materials with the additive element like Ta or Nb was strongly promoted during MA for 360-720ks and the grain size of MA powders reduced to ca. 2-3nm before the crystalline-to-amorphous transition occurs. Such effects of additive elements on amorphization and refinement of MA materials seen in the ternary Fe-A-N systems also held for MA of high nitrogen containing stainless steel type powder materials.

[43] NITROGEN ADDITION TO BCC-Fe BY ATTRITION MILLING

J Rawers, R Krabbe, D Cook - HIGH NITROGEN STEELS '98 (Series: MATERIALS SCIENCE FORUM), 1999, Vol 318-3, pp 695-700 -5TH INTERNATIONAL CONFERENCE ON HIGH NITROGEN STEELS; STOCKHOLM, SWEDEN. MAY 27-28, 1998

To enhance the nitrogen solubility in bcc-Fe, iron powder and blends of iron and iron nitride powders were attrition-milled in nitrogen gas. X-ray diffraction and Mossbauer spectroscopy were used to characterize the milled microstructure and to characterize the nitrogen distribution. After processing for 150 hours, the infused nitrogen was determined to be interstitial (locally deforming the bcc-Fe lattice to a bct-Fe lattice) and associated with the outer layer of the bcc-Fe nanograin. Nitrogen stabilized the milled grain structure but at elevated temperatures rapidly came to thermodynamical equilibrium transforming from bcc-Fe(N) to bcc-Fe and Fe₄N.

[42] HOT-PRESS COMPACTION OF HIGH NITROGEN CONTAINING AUSTENITIC STAINLESS STEEL POWDERS MECHANICALLY ALLOYED

K Omuro, H Miura, H Ogawa - HIGH NITROGEN STEELS '98 (Series: MATERIALS SCIENCE FORUM), 1999, Vol 318-3, pp 701-706 - 5TH INTERNATIONAL CONFERENCE ON HIGH NITROGEN STEELS; STOCKHOLM, SWEDEN. MAY 27-28, 1998

High nitrogen containing MA-processed powder materials with the atomic compositions (at%) of Fe (6 8) Cr (2 0) Ni (8) N (4) (I), Fe (6) (2) Cr (2 0) Ni (1 1) N (7) (II), Fe (6) (0) Cr (2 0) Ni (1 1) Ta (2) N (7) (III), Fe (5 8.) (2) Cr (1 8. 8) Mn (17 . 8) MO (1. 7) N (3. 5) (i.e., Fe (5 0. 1) Cr (1 8) Mn (1 8) Mo (3) N (0 . 9) (mass%))(IV) Fe (9 6) N (4) (V), and Fe (8 8) Ni (8) N (4) (VI) were consolidated into disc samples using uniaxial hot die pressing in vacuum. Nitrogen contained in the MA materials I - IV with austenitic stainless steel type compositions is retained at temperatures up to 1273K during hot-press compaction, in contrast to the MA materials V and VI with Cr-free compositions. The presence of Cr in the MA materials I - N retards their grain growth during hot compaction, retaining nanostructures developed by the MA processing in the compact samples.

[41] PREPARATION OF HIGH NITROGEN CR-NI AND CR-MN STAINLESS STEEL POWDERS BY MECHANICAL ALLOYING AND THEIR COMPOSITIONAL DEPENDENCE OF AUSTENITIZING

H Miura, H Ogawa, K Omuro -HIGH NITROGEN STEELS '98 (Series: MATERIALS SCIENCE FORUM), 1999, Vol 318-3, pp 707-714 - 5TH INTERNATIONAL CONFERENCE ON HIGH NITROGEN STEELS; STOCKHOLM, SWEDEN. MAY 27-28, 1998

Mechanical alloying(MA) of elemental powder mixtures, with Fe-9.85mass% N alloy powders, of high nitrogen Cr-Ni and Cr-Mn stainless steel(SS) type compositions was performed in an argon atmosphere using a planetary ball mill. Using the MA process, high nitrogen Cr-Ni and Cr-Mn SS powders with nanostructures are readily prepared after ca. 300ks of processing. In the MA processing of Fe (8 0 - x - y) Cr (2 0) Ni (y) N (x) (X=0-20, y=2-17) and Fe (7 9 . 3 - x - y) Cr (1 9) Mo (1 . 7) Mn (y) N (x) (x=0-7, y=5-24)(at.%) materials, nitrogen markedly promotes austenitizing of the MA powders in both systems, the effect particularly being striking up to near x=4(ca. 1 mass%). The noticeable effect of N is also supported from the Gladman's equation indicating that in austenitic SSs the addition of N or C is most effective in lowering the onset temperature of the strain-induced martensite formation. The austenitic compositional region of MA materials of Fe-Cr-Ni-N is considerably wide compared with that of Fe-Cr-Mn-Mo-N. The austenitizing of MA materials of the Fe (9 6 - y - z) Cr (z) Ni (y) N (4) (y=4-16, z=20-26) and Fe (8 6 . 7 - z) Cr (z) Mn (8) Mo (1 . 7) N (3 . 6) (z=13-19) (at%) systems increases with increased Cr content.

[40] MOSSBAUER AND SMALL-ANGLE NEUTRON SCATTERING STUDY OF FE-POWDER MECHANICALLY ALLOYED IN NITROGEN AND ARGON GAS ENVIRONMENT

VM Nadutov, VM Garamus, JC Rawers - HIGH NITROGEN STEELS '98 (Series: MATERIALS SCIENCE FORUM), 1999, Vol 318-3, pp 715-720 -5TH INTERNATIONAL CONFERENCE ON HIGH NITROGEN STEELS; STOCKHOLM, SWEDEN. MAY 27-28, 1998

Fe-powder after mechanical alloying in N and Ar gases in high energy ball mill was studied by means of Mossbauer spectroscopy to characterize the change in the local iron environment. Small-angle neutron scattering (SANS) was used to examine the character of inhomogeneities in the mechanically processed alloyed iron powder.

[39] MECHANOSYNTHESIS OF FE16N2, FROM THIS SPECIAL CASE TO GENERAL PRINCIPLES

J Foct - NITRIDES AND OXYNITRIDES (Series: MATERIALS SCIENCE FORUM), 2000, Vol 325-3, pp 99-104 - 2ND INTERNATIONAL SYMPOSIUM ON NITRIDES; LIMRICK, IRELAND. JUNE 9-11, 1998

Magnetic properties of alpha " Fe16N2 have stimulated research and development efforts devoted to the synthesis of this compound. In comparison with other techniques, mechanosynthesis appeared especially promising for making large amounts of single phase product under cost effective conditions. Results obtained for FeNx nitrides and solid solutions are summarized. It was shown that mechanosynthesized Fe16N2 presents a cubic symmetry and is therefore a new superferite alpha"". Principles deduced from the experimental results are discussed and appear to apply to the general case of mechanosynthesis.

[38] NIAL SHAPE MEMORY ALLOY BY POWDER METALLURGY METHOD

CH Man, CY Chung - SHAPE MEMORY MATERIALS (Series: MATERIALS SCIENCE FORUM), 2000, Vol 327-3, pp 497-500 - INTERNATIONAL SYMPOSIUM AND EXHIBITION ON SHAPE MEMORY MATERIALS (SMM 99); KANAZAWA, JAPAN. MAY 19-21, 1999

Mechanical alloying in high-energy ball-milling machine was used to fabricate the NiAl shape memory alloy. The effect of milling time on the mechanical properties was investigated. The microstructures and phase transformations of NiAl were studied by scanning electron microscope (SEM), x-ray diffraction (XRD), differential scanning calorimetry (DSC) and dynamic thermal analysis (DTA). Lamella micro-structures was found in the SEM examination and they were confirmed to have the martensite structure by XRD analysis. Results from DSC thermal analysis revealed that the sintered-compact exhibited thermoelastic transformation. Besides, the martensitic transformation was found to have suppressed by the presence of Ni5Al3 precipitates in some of the ball-milled specimens.

[37] SYNTHESIS AND CHARACTERIZATION OF NANOPARTICLES

AK Arora - SOLID STATE PHYSICS, VOL 41, 1998, 1999, pp 26-29 - 41ST DAE SOLID STATE PHYSICS SYMPOSIUM; KURUKSHETRA, INDIA. DECEMBER 27-31, 1998

Nanoparticles are synthesized either as isolated particles dispersed in suitable hosts (composites) or as single-phase powders. Controlling and terminating chemical precipitation in a colloid is an important factor that determines the nanoparticle size and its distribution. Other synthesis techniques include precipitation from solid solution and mechanical alloying. Nanoparticles can also be obtained in the form of thin films using ion implantation and cosputtering. The nanoparticle size and its distribution are traditionally obtained from high-resolution transmission electron microscopy or small-angle X-ray scattering X-ray diffraction is used for determining the structure. Low-frequency Raman spectroscopy has also been used to estimate the particle size from the frequencies of confined acoustic phonons, while longitudinal-optic phonon frequencies are used for obtaining the composition nano-mixed crystals.

[36] GRAIN BOUNDARIES OF NANOCRYSTALLINE MATERIALS

B Fultz, HN Frase - ULTRAFINE GRAINED MATERIALS, 2000, pp 3-12 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

Nanocrystalline materials contain sufficiently many atoms at and near grain boundaries to make a clear contribution to a Mossbauer spectrum. By measuring the fraction of atoms contributing to the grain boundary component in a Mossbauer spectrum, and by measuring the grain size of the material with x-ray diffractometry and transmission electron microscopy, the average widths of grain boundaries in metallic alloys are deduced. It is found that these widths are approximately 0.5 nm for fcc alloys and slightly larger than 1.0 nm for bcc alloys. The internal structure of grain boundaries in nanocrystalline materials prepared by high energy ball milling is found to be unstable. After cryogenic exposure or annealing at 100 degrees C, the Mossbauer spectra and small angle neutron scattering profiles (SANS) showed changes attributable to movements of grain boundary atoms. The changes in grain boundary structure induced by cryogenic exposure and annealing at low temperature were found to be somewhat different, but both were consistent with a sharper density gradient between the crystalline

[35] SYNTHESIS OF NANOCRYSTALLINE NITI SHAPE MEMORY ALLOY BY SHOCK CONSOLIDATION OF MECHANICALLY AMORPHIZED NITINOL POWDER

X Xu, NN Thadhani -ULTRAFINE GRAINED MATERIALS, 2000, pp 23-31 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

In this study, pre-alloyed Nitinol (Ni50.88Ti49.12) powder was mechanically amorphized using a SPEX 8000 mixer/mill in an Ar atmosphere, and subsequently shock consolidated to prepare compacts of bulk nanocrystalline alloy. The shock consolidation experiments were performed using a single-stage gas gun at a peak shock pressure of 5-9 GPa. The shock-consolidated compacts showed partial crystallization to B2 phase with a nano-scale microstructure. The compacts were subsequently annealed to fully crystallize the amorphous phase and obtain a material with nanocrystalline microstructure. In this paper, we will present the microstructural characteristics of the nano-structure formed in the bulk NiTi compacts and its transformation and shape memory response as a function of nanocrystalline grain size.

[34] KINETICS OF GLASS FORMATION AND NANOCRYSTALLIZATION IN AL-RE-(TM) ALLOYS

RI Wu, G Wilde, JH Perepezko - ULTRAFINE GRAINED MATERIALS, 2000, pp 63-72 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

Aluminum-rich amorphous alloys have attracted considerable attention in recent years for their superior mechanical properties compared with conventional Al-based alloys. Often, the occurrence of a precursor crystallization reaction during heating of rapidly solidified amorphous samples leads to the formation of microstructures with finely dispersed nanocrystalline Al in an amorphous phase and offers effective dispersion strengthening. While many amorphous alloys are produced by rapid solidification processing (RSP) mechanical intermixing also provides an alternative route to synthesize metallic glasses. In the present study, characterization results on the Al-based metallic glasses by the transmission electron microscopy (TEM) and modulated-temperature calorimetry (DDSC) indicate that the glassy state has actually been attained by rapid melt-quenching as well as by deformation mixing. Annealing studies on the glassy samples produced by different processing pathways indicate a completely different nanocrystallization behavior and suggest that the quenched-in nuclei which originate from the rapid melt-quenching process initiate the premature nanocrystallization. Moreover, glass formation appears to be controlled by the suppression of growth of nuclei formed during rapid melt quenching for Al-based systems. With the aim of enhancing the mechanical properties of Al-based nanocrystalline materials, the incorporation of insoluble elements (e.g. Pb) during RSP has successfully yielded an increase in the nanocrystal particle density developed during primary crystallization. The study of the heterogeneous nucleation kinetics has provided new microstructural control in Al-based metallic glasses.

[33] THERMAL SPRAYING OF NANO-COMPOSITE COATINGS

R Rodriguez, J He, M Ice, G Kim, EJ Lavernia - ULTRAFINE GRAINED MATERIALS, 2000, pp 73-87 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

Recent advancements developed in the thermal spraying of nanocrystalline materials have attracted scientific and industrial interest. Due to the relatively short dwell time of the powder particles during the thermal spray process and their inherent thermal stability, the feedstock powders are able to preserve the unique properties of nanocrystalline materials in the as-sprayed coatings. The use of nano-cermet powders such as WC-Co has produced coatings with increased microhardness while maintaining toughness values as compared to conventional coatings. In the present study, nano-composite Al-10% SiC, WC-12%Co, and Cr3C2-25(Ni20Cr) coatings were produced by thermal spraying. The feedstock, nanocrystalline powders were synthesized by mechanical milling in liquid nitrogen for 8 hours of gas atomized 3003-Al, with the addition of 10 vol.% SiC, while WC-12%Co and Cr3C2-25(Ni20Cr) were mechanically milled in methanol and hexane respectively. The milled powders were thermally sprayed by vacuum plasma spraying to produce Al-composite coatings and high velocity oxygen fuel spraying to produce nano-cermet coatings of WC-12%Co and Cr3C2-25(Ni20Cr). The properties of the nanostructured coatings were compared to those of the conventional coatings of the same composition. The results will be rationalized based on the microstructural features observed by scanning electron microscopy analyses. In addition, the coating mechanical properties were characterized by microhardness test and compared to those of conventional coatings.

[32] FABRICATION OF ULTRA FINE GRAINED BULK IRON THROUGH MECHANICAL MILLING OF IRON POWDER

S Takaki, K Kawasaki, Y Kimura - ULTRAFINE GRAINED MATERIALS, 2000, pp 247-255 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

Mechanical milling of metallic powders is a useful technique for giving ultimate severe deformation to the metal and

producing nanosized grains within the powder particles. If the mechanically milled metallic powders were successfully consolidated to bulk without losing the fine grained structure, we ought to be able to obtain ultra fine grained bulk materials. In practice, bulk iron materials with ultra fine grained structure were fabricated by consolidating the mechanically milled iron powder which had previously been hardened to Hv750 by milling treatment (Mechanical Milling & Consolidation; MMC process). The minimum grain size obtained in bulk iron was 0.18 μm . In this bulk iron, 0.2% proof stress and tensile strength were increased to 1.6GPa and 1.8GPa, respectively. Tensile tests of bulk iron with various grain size revealed the fact that the Hall-Petch relationship is realized to such an ultra fine grain size region in iron. Comparison with the results of the other metals made it clear that the locking parameter (the Hall-Petch slope) is identical regardless of the crystal structure of iron (fcc or bcc) and that it is proportional to the shear modulus of metals.

[31] PROCESSING, CHARACTERIZATION, AND PROPERTIES OF NANOCRYSTALLINE ZINC

X Zhang, CC Koch - ULTRAFINE GRAINED MATERIALS, 2000, pp 289-298 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

Nanocrystalline (nc) Zn was prepared by mechanical attrition at 40 degrees C and -180 degrees C. The powders milled at 40 degrees C formed pellets 3 to 6 mm in diameter with an internal nanoscale grain size of about 30 nm. Milling at -180 degrees C provided powder samples with a final grain size of about 20 nm. Differential scanning calorimetry and x-ray diffraction were used to follow the structural changes with milling time and subsequent annealing. Maxima in both stored enthalpy and microstrain on the Zn basal planes were observed at the same milling time. This implies that dislocation density on the basal planes is responsible for both phenomena. As milling continues and the grain size becomes nanoscale, the dislocation density decreases because of the dislocation free nanograins. The hardness of the nc Zn prepared in this study is about twice that of conventional polycrystalline Zn but about one-half that for nc Zn of the same grain size made by a gas condensation method.

[30] COMPRESSIVE, TENSILE, AND DYNAMIC BEHAVIOR OF NANOPHASE IRON

D Jia, KT Ramesh, E Ma - ULTRAFINE GRAINED MATERIALS, 2000, pp 309-318 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

The mechanical behavior of bulk nanophase Fe has been studied using uniaxial compression testing, micro-sample tensile testing, and the Kolsky bar technique. The nanophase Fe samples, with an average grain size of about 80 nm, were consolidated using sinter forging to near full density (99.2% of theoretical density) from nanocrystalline Fe powders prepared by mechanical attrition. Uniaxial compression tests showed high strength (2.5 GPa), a few percent elongation before fracture, and no strain hardening. The morphology of the deformed samples was studied using optical microscopy. A shear zone consisting of numerous narrow shear bands was observed, indicating strongly inhomogeneous deformations. These behaviors are similar to those observed in indentation and bending tests by other groups. In tension, the material failed in a brittle manner at a stress far below that under compression. The premature failure is believed to be due to insufficient bonding between Fe powder particles, and perhaps also residual porosity or surface defects. Interestingly, the compression data indicate that over a wide strain rate range (10^{-4} to $3 \times 10^{+3}$ s $^{-1}$), there is practically no change in flow stress for nanophase Fe, in sharp contrast to the 100% flow stress increase over the same strain rate range observed in conventional coarse-grained Fe. It is hypothesized that in such ultrafine-grained metals the dominant deformation mechanism is localized shear deformation, which initiates at a threshold stress with weak rate dependence, rather than slip deformation controlled almost entirely by dislocation kinetics.

[29] EFFECTS OF HEATING AND AGING IN BULK METASTABLE NANOSTRUCTURED ALLOYS

VV Stolyarov, RZ Valiev - ULTRAFINE GRAINED MATERIALS, 2000, pp 351-360 - SYMPOSIUM ON ULTRAFINE GRAINED MATERIALS AT THE 2000 TMS ANNUAL MEETING; NASHVILLE, TENNESSEE. MARCH 12-16, 2000

This paper focuses on processing by high pressure torsion straining (HPTS) of several metastable Al, Ti and hard magnetic Pr₂Fe₁₄B based alloys. The processed HPTS alloys are characterized by very small grain sizes, specific defect structures, high internal stresses and a formation of supersaturated solid solutions and amorphization of intermetallics phases. During further heating the aging effects take place and the processed alloys demonstrate unique mechanical (microhardness, high ultimate strength, superplasticity) and magnetic hysteric properties.

[28] MICROSTRUCTURAL EVOLUTION OF AN AL₉₂MN₆CE₂ ALLOY DURING MECHANICAL ALLOYING, HOT EXTRUSION AND HEAT-TREATMENTS

Ji Y. Kallio M. Tiainen T. - Scripta Materialia. 42(11):1017-1023, 2000

[27] DECOMPOSITION BEHAVIOR OF MGH(2) PREPARED BY REACTION BALL-MILLING

Wang P. Wang AM. Wang YL. Zhang HF. Hu ZQ. - Scripta Materialia. 43(1):83-87, 2000

[26] MECHANICAL ALLOYING OF ALUMINA-YTRIA POWDER MIXTURES

Alkebro J. Begin-Colin S. Mocellin A. Warren R. - Journal of the European Ceramic Society. 20(12):2169-2174, 2000

Mechanical alloying has been used to prepare powder mixtures of alumina and yttria as a means to create composites with a dominant matrix phase together with small particles of a dispersed second phase. The yttria-alumina system, containing five possible phases, has the potential for creating eight combinations of matrix and dispersed phases. Here compositions designed to give YAlO₃ (YA) dispersed in Y₃Al₅O₁₂ (Y(3)A(5) i.e. YAG) or Y₄Al₂O₉ (Y(2)A) were studied. After milling with steel tools for times up to 8 h, the powders were subjected to thermal cycles up to 1500 degrees C during which the phase evolution was monitored using X-ray diffractometry (including high-temperature XRD) and differential thermal analysis. During milling the original crystal structures were quickly broken down, in some cases partially replaced by an intermediate structure after milling. Upon subsequent heating the milled mixtures crystallized to give the expected phases, YA in Y(3)A(5) and YA in Y(2)A respectively, but the reaction route was seen to be different depending on the amount of amorphization of the yttria. Contamination by iron was seen to affect the phase distribution and the lattice parameters.

[25] MECHANOCHEMICAL REACTIONS IN THE SN-ZN-S SYSTEM: FURTHER STUDIES

Bakhshai A. Soika V. Susol MA. Takacs L. - Journal of Solid State Chemistry. 153(2):371-380, 2000
Although ball milling initiates self-sustaining thermal reaction (combustion) in both Sn-S and Zn-S powder blends, the reaction may be gradual when Sn-Zn-S mixtures are processed under the same conditions. Milling experiments were carried out at several Sn-Zn-S compositions, using different milling balls and ball-to-powder ratios. The ignition time was measured and the phase composition was determined at different stages of the process. The activation time before ignition scales with the ball-to-powder ratio in most cases, showing that the "mechanical dose" is suitable to describe the degree of activation. More energetic milling results in earlier ignition, but it also intensifies the formation of reaction products before ignition, thereby promoting gradual kinetics. The initiation and propagation of a combustion front is similar to self-propagating high-temperature synthesis in a powder compact, but heat transfer to the milling tools is a more important factor.

[24] THE NOVEL ACID CATALYSTS - FRAMEWORK ZIRCONIUM PHOSPHATES: THE BULK AND SURFACE STRUCTURE

Pavlova SN. Sadykov VA. Zabolotnaya GV. Kochubey DI. Maximovskaya RI. Zaikovskii VI. Kriventsov VV. Tsybulya SV. Burgina EB. Volodin AM. Chaikina MV. Kuznetsova NN. Lunin VV. Agrawal D. Roy R. - Journal of Molecular Catalysis A-Chemical. 158(1):319-323, 2000

Structural features and surface properties of framework zirconium phosphates synthesized via mechanochemical activation (MA) and sol-gel (SG) route were studied using XRD, TEM, P-31 MAS NMR, IR and ESR spectroscopy and compared with their catalytic performance in the reaction of hexane isomerization. A high initial isomerization activity of crystalline zirconium phosphates prepared via MA can be determined by a larger share of the strong Lewis centers probed by TEMPON test molecule.

[23] STRUCTURAL AND THERMAL STUDY OF MECHANICAL ALLOYED FE70-XNIXCU1V6SN2SI14B7

Ji YL. Wang GH. Li F. Wang GQ. Zhao JW. Zhang SY. - Journal of Materials Science Letters. 19(18):1641-1644, 2000

[22] NANOGRAINED YCO5-BASED POWDERS WITH HIGH COERCIVITY

Tang N. Chen ZM. Zhang Y. Hadjipanayis GC. Yang FM. - Journal of Magnetism & Magnetic Materials. 219(2):173-177, 2000

Highly-coercive YCo₅-based nanograined powders with composition Y_xCo_{100-x} (x = 16.8-20) have been synthesized by mechanical milling of as-cast alloys and subsequently annealing them. The optimum magnetic properties have been obtained in Y_{19.5}Co_{80.5} powders milled for 4 h and annealed at 950 degrees C for 1 min with a coercivity of 16.0 kOe, a high M-t/M-s ratio of 0.67 and a medium-strength maximum energy product (BH)(max) of 7.7 MG Oe. Microstructure studies reveal that the Y_{19.5}Co_{80.5} powders have a nearly single YCo₅ structure with a grain size of about 30-40 nm. The high coercivity is attributed to the high anisotropy field of the YCo₅ phase and to its nanoscale grain size.

[21] NANOCOMPOSITE PRCo5/Pr2Co17 MAGNETS WITH ENHANCED MAXIMUM ENERGY PRODUCT

Chen ZM. Zhang Y. Hadjipanayis GC. - Journal of Magnetism & Magnetic Materials. 219(2):178-182, 2000
Nanocomposite PrCo₅/Pr₂Co₁₇ powders, with different volume fraction of the Pr₂Co₁₇ phase, were synthesized by mechanical milling mixtures of PrCo₅ and Pr₂Co₁₇ alloy powders with the aim of enhancing the maximum energy product of PrCo₅-based powders. It is found that the saturation magnetization increases monotonously with the volume fraction of the Pr₂Co₁₇ phase while the coercivity decreases. As a result, the maximum energy product first increases with the Pr₂Co₁₇ phase, going through a broad peak, and then decreases with further increase of the Pr₂Co₁₇ phase. The highest maximum energy product of 11.8 MG Oe is obtained in a mixture consisting of 70% PrCo₅ and 30% Pr₂Co₁₇ phase. Microstructural studies reveal that a uniform nanoscale PrCo₅/Pr₂Co₁₇ microstructure with an average grain size of about 20 nm is developed in these PrCo₅/Pr₂Co₁₇ powders. Evidence of intergranular exchange coupling is found in the PrCo₅/Pr₂Co₁₇ powders, suggesting that the enhanced energy product is due to exchange coupling between the magnetically hard PrCo₅ and soft Pr₂Co₁₇ nanograins.

[20] HIGH COERCIVITY IN MECHANICALLY ALLOYED BAFE10AL2O19

Wang S. Ding J. Shi Y. Chen YJ. - Journal of Magnetism & Magnetic Materials. 219(2):206-212, 2000
Al-substituted Ba-ferrite in the form of BaFe₁₀Al₂O₁₉ was prepared by mechanical alloying and subsequent heat treatment. Their structure and magnetic properties were investigated in comparison with Ba-ferrite without Al substitution. After annealing at 1100 degrees C, a coercivity as high as 9.3 kOe was measured, while the coercivity values of the Ba-ferrite samples without Al substitution with a similar particle size were observed in the range of 5-6 kOe. A significant reduction of saturation magnetization was observed as compared to pure barium ferrite.

[19] EFFECT OF PAN-MILLING ON RHEOLOGICAL PROPERTIES

Huang H. - Chinese Journal of Polymer Science. 18(5):397-403, 2000
The effect of pan-milling on the rheological properties of high density polyethylene (HDPE) was studied. An innovative milling apparatus, viz. an inlaid pan-mill, was used. Melt indexer, capillary rheometer, Haake Rheocord 90 single-screw extruder and Brabender rheometer were used to evaluate the rheological properties of HDPE. HDPE with higher initial molecular weight and larger particle size was easier to degrade under pan-milling stress, as indicated by the melt index. Pressure oscillation in capillary flow occurred at significantly higher shear stress and shear rate for milled HDPE than for unmilled HDPE. The apparent shear viscosity of HDPE decreased with increasing times of milling. After milling, the flow activation energy decreased and thus the sensitivity of viscosity to temperature was reduced. Die pressure and torque during single screw extrusion were reduced significantly after milling. Plasticizing time as measured in a Brabender mixer decreased markedly with increasing milling times.

[18] SYNTHESIS OF CR2O3 NANOPARTICLES BY MECHANOCHEMICAL PROCESSING

Tsuzuki T. McCormick PG. - Acta Materialia. 48(11):2795-2801, 2000
The synthesis of chromium oxide (Cr₂O₃) nanoparticles by mechanochemical reaction and subsequent heat treatment was investigated. A solid-state displacement reaction Na₂Cr₂O₇ + S → Cr₂O₃ + Na₂SO₄ was induced during mechanical milling of Na₂Cr₂O₇ + S powder mixture, forming amorphous Cr₂O₃ nanoparticles. Annealing the as-

milled powder under vacuum above 520 degrees C resulted in the formation of crystalline Cr₂O₃ nanoparticles separated from each other in a salt matrix. A simple washing process to remove the matrix yielded Cr₂O₃ particles of 10-80 nm in size, having a plate-like morphology.

[17] MICROSTRUCTURAL CHANGES IN EQUAL CHANNEL ANGULAR PRESSED LOW CARBON STEEL BY STATIC ANNEALING

Shin DH. Kim BC. Park KT. Choo WY. - Acta Materialia. 48(12):3245-3252, 2000

The thermal stability of ultrafine grained low carbon steel manufactured by the equal channel angular pressing technique was examined by imposing the static annealing treatment for 1h at various temperatures of 693-873 K. The initial grain size of the ferrite phase of similar to 30 μ m was refined to similar to 0.2 μ m by applying four passes of the equal channel angular pressing in which a single passage yielded an effective strain of 0 similar to 1. At annealing temperatures of 693-783 K, ultrafine ferrite grains were relatively stable with little grain growth but microstructural examination revealed that a recovery process was active, showing the decrement of dislocation density, the restoration of well-defined grain boundary and the existence of a dislocation cell. Above 783 K, the ferrite phase consisted of coarse recrystallized grains which were observable with optical microscopy and ultrafine unrecrystallized grains. The microstructural change of ultrafine ferrite with annealing was examined by estimating the activation energy for grain growth and by comparing it with the activation energies for processes associated with ferrite grain growth. Under the present annealing conditions, microstructure of pearlite phase was characterized by the enhanced spheroidization of cementite compared with the unpressed sample. The enhanced spheroidization behavior of the present pearlite phase was discussed in terms of easy carbon dissolution from cementite into pearlitic ferrite due to intensive plastic deformation of cementite.

[16] IMPROVEMENT OF THE WEAR BEHAVIOUR OF AL-PB ALLOYS BY MECHANICAL ALLOYING

Zhu M. Gao Y. Chung CY. Che ZX. Luo KC. Li BL. - Wear. 242(1-2):47-53, 2000

In the present work, the effect of mechanical alloying (MA) on the improvement of wear properties of Al-Pb binary alloys is reported. The alloys with Pb ranging from 10 to 18 wt.% were prepared by vacuum sintering mechanically alloyed Al-Pb powder. Optical microscope (Oh?), scanning electron microscope, X-ray diffractometer and Vickers hardness indentation were used to characterize the microstructure and mechanical properties of Al-Pb alloys prepared. Wear properties of the alloys were characterized by measuring the bulk wear, the wear rate and the wear coefficient under both dry and oil-lubricated test conditions. And the influence of Pb content was evaluated. The obtained results of wear properties of mechanically alloyed Al-Pb alloys were compared with those of similar alloys prepared by powder metallurgy and casting. The present work shows that MA is an effective way of improving microstructure and consequently the wear properties of Al-Pb alloys.

[15] HIGH-TEMPERATURE EROSION RATES OF FE-CR-C ALLOYS PRODUCED BY MECHANICAL ALLOYING AND SINTERING PROCESS

Hayashi N. Hasezaki K. Takaki S. - Wear. 242(1-2):54-59, 2000

In order to develop a material having high erosive wear resistance at elevated temperature, the alloys of the ternary Fe-Cr-C system were produced by mechanical alloying (MA) and sintering process. Three kinds of alloys which have different contents of M₂₃C₆ carbide were made, and observation of the microstructure, measurement of the hardness and erosive wear test were carried out on each alloy. As a result the Fe-Cr-C alloys made by MA and sintering process have fine microstructure. The Vickers hardness of the MA-Fe-50% Cr-4.8% C alloy is more than 6 GPa at 973 K, and the erosive wear resistance of this alloy at 973 K is almost the same as that of sintered Cr₃C₂/Ni cermet, which is the commercially available material with high wear resistance.

[14] PRODUCTION OF TITANIUM PARTICULATE METAL MATRIX COMPOSITE BY MECHANICAL MILLING

Godfrey TMT. Goodwin PS. Ward-Close CM. - Materials Science & Technology. 16(7-8):753-758, 2000

Mechanical milling is an established production method for aluminium particulate metal matrix composites (MMCs). There are examples of its use for high performance automotive applications and within the aerospace industry. The production of a titanium particulate MMC is still in the developmental stage. However, compared to conventional titanium alloys such materials offer improvements in stiffness, strength, fatigue and creep properties, high temperature capability, and wear resistance. This paper describes the use of mechanical milling for the production of titanium particulate MMCs with the addition of 10 vol.-% TiB. Gas atomised titanium powders with additions of either boron or TiB₂ were milled in a high purity argon atmosphere to avoid contamination of the powders by oxygen or nitrogen. The distribution of the boron or TiB₂ with increasing milling time is discussed along with the effect of the alloy composition. Gas atomised, hydride dehydride, and sponge, fine powder blends are also compared. The powders were subsequently hot isostatically pressed at 500 degrees C for 2 h at 150 MPa followed by 900 degrees C for 2 h at 150 MPa. During this consolidation process TiB was formed by an in situ reaction between either the TiB₂ or boron and the titanium matrix. MST/4541.

[13] CHARACTERIZATION AND SINTERABILITY OF OXIDE-DISPERSION STRENGTHENED NICKEL POWDER PRODUCED BY MECHANICAL ALLOYING

Mohamed KE. Buchkremer HP. Stover D. - Journal of Materials Engineering & Performance. 9(4):370-378, 2000

Among the main requirements for the Ni/8% yttria stabilized zirconia (Ni/8YSZ) material, currently used for manufacturing solid oxide fuel cell (SOFC) anodes, fine homogeneous microstructure, considerable structural and mechanical stability, and sufficient gas permeability are of primary concern. In the present investigation, oxide-dispersion strengthened composite Ni powders containing 2, 5, and 10 vol. % 8YSZ were produced by mechanical alloying (MA) in air using a planetary milling machine and ZrO₂ milling media. The progress of the MA process was followed by particle size analysis, optical metallography, and x-ray diffraction (XRD) techniques. Results showed that dispersion of the oxide particles and structural refinement reached a significant point after milling for 180 h. The crystallite size and lattice distortion showed considerable dependence on the processing parameters. The mechanically alloyed powders were sintered at 1100 degrees to 1350 degrees C. The mechanically alloyed powder containing 10 vol. % 8YSZ exhibited maximum densification. The minimum sintered density was observed for the composite powder containing 2 vol. % 8YSZ.

[12] HYDROPHOBIC DRAWINGS ON HYDROPHILIC SURFACES OF SINGLE CRYSTALLINE TITANIUM DIOXIDE: SURFACE WETTABILITY CONTROL BY MECHANOCHEMICAL TREATMENT

Kamei M. Mitsuhashi T. - Surface Science. 463(1):L609-L612, 2000

The surface wettability control at arbitrary positions of solid surfaces is extremely interesting from the point of view of both science and technology. Recently, we found that a position-controlled high-speed hydrophilic to hydrophobic transition was possible on single crystalline anatase-TiO₂(001) surfaces applying a new 'wet rubbing' method. This new kind of mechanochemical surface treatment realized switching of the hydrophilic surface with water-contact angle 3 degrees to a hydrophobic surface with 80 degrees angle within 1 min at arbitrary positions on the surface. Consequently, hydrophobic drawings could be made by a paintbrush on hydrophilic surfaces.

[11] EFFECT OF MECHANOCHEMICAL ACTIVATION ON SYNTHESIS OF METALLOORGANOSILOXANES

Shapkin NP. Kapustina AA. Talashkevich EA. - Russian Journal of Inorganic Chemistry. 45(4):601-604, 2000

Mechanochemical interaction of monosodium phenylsilanetriol salts with MCl₃ where M = Fe or Cr leads to the formation of ferrophenyl- or chromophenylsiloxanes. The influence of conditions of mechanochemical treatment and of the nature of reagents on the course of the process was studied. The reaction products were studied by IR spectroscopy, electron microscopy, and X-ray powder diffraction. The specific surface area of the samples was determined.

[10] SPECIFIC FEATURES OF SYNTHESIS OF FULLERIDES MNC₆₀ (M = NA, K, RB) IN AROMATIC HYDROCARBONS AS PROBED BY C-13, NA-23, AND H-1 NMR

Bulychev BM. Privalov VI. Dityat'ev AA. - Russian Journal of Inorganic Chemistry. 45(6):931-937, 2000

The interaction of metallic sodium, potassium, and rubidium with C-60 combined in the ratios M/C-60 = 3-11 is studied by C-13, Na-23, and H-1 NMR. Mechanochemical activation of a mixture in an aromatic hydrocarbon medium at 390-400 K leads to the exhaustive formation of M₃C₆₀ and M₆C₆₀ in three to ten days. The influence of the solvent and high mobility of metal atoms in the cavities of the fulleride lattice on the spectral characteristics of intercalation compounds is discussed. At the ratios M/C-60 greater than or equal to 7 (M = Kt Rb), fullerene molecules polymerize.

[9] STRUCTURE TRANSFORMATIONS DURING MECHANICAL GRINDING OF A FE-TiH₂ MIXTURE

Novakova AA. Agladze OV. Tarasov BP. - Russian Journal of Inorganic Chemistry. 45(8):1168-1172, 2000

The nanostructured compound FeTiH was obtained by high-energy mechanical grinding of a Fe-TiH₂ mixture (at a 1 : 1 ratio) in an argon atmosphere. The structure and phase state of the mixture at various instants of grinding were determined by X-ray powder diffraction and Mossbauer spectroscopy. As a result of mechanical action on the mixture of iron with titanium hydride, hydrogen is evolved from the structure of titanium hydride and is actively involved in phase formation by contributing to grinding and mutual diffusion of the elements. This leads to the formation of a fine-dispersed heterogeneous mixture whose ordering is most likely similar to that in the FeTiH phase. The mixture contains also a disordered solid solution TiH₂-x(Fe) formed on the basis of the initial TiH₂.

[8] THERMODYNAMIC FUNDAMENTALS OF MECHANOCHEMISTRY

Rusanov AI. - Russian Journal of General Chemistry. 70(3):329-356, 2000

The definitions of the affinity tensor and the tensor of chemical potential of an immobile component of a solid are given. The mechanochemistry of a liquid is formulated. Mechanically anisotropic states of a solid and their influence on affinity are analyzed. Thermodynamic equations are deduced relating the chemical potential tensor to the stress and strain tensors. The mechanochemistry of an ideally elastic solid and of a solid with mobile components, as well as the mechanochemistry of an interface, are formulated. As an example, the mechanochemical effect of dissolution (evaporation) is considered including its dependence on the deformation sign.

[7] EFFECT OF MECHANICAL ACTIVATION OF RAW MATERIALS ON CLINKER FORMATION AND CEMENT PROPERTIES

Sulimenko LM. Krivoborodov YR. - Russian Journal of Applied Chemistry. 73(5):757-759, 2000

[6] DEVELOPING A LEAD-FREE SOLDER ALLOY SN-BI-AG-CU BY MECHANICAL ALLOYING

Wu CML. Huang ML. Lai JKL. Chan YC. - Journal of Electronic Materials. 29(8):1015-1020, 2000

A new lead free alloy, Sn-6Bi-2Ag-0.5Cu, has been developed by mechanical alloying and has great potential as a lead-free solder system. Initial trials on the manufacture of solder joints with this alloy revealed that a high quality bond with copper could be formed. Its melting range of 193.87 degrees C to 209.88 degrees C is slightly higher than that of eutectic tin-lead solder. Examination of the microstructure of the as-soldered joints revealed that it mainly consists of small bismuth (1 μm to 2 μm) and Ag₃Sn (1 μm) particles finely dispersed in a nearly pure tin matrix with a small amount of eta-Cu₆Sn₅ particles. The Cu-Sn intermetallic compound (IMC) layer formed at solder-copper interface is the eta-Cu₆Sn₅ phase with grain size of 2 μm. The shear strength of the solder joint is higher than that of Sn-37Pb or Sn-3.5Ag. Under shear loading, fracture occurred at IMC layer-solder interface as well as in the bulk of solder.

[5] MICROSTRUCTURAL EVOLUTION OF A LEAD-FREE SOLDER ALLOY SN-BI-AG-CU PREPARED BY MECHANICAL ALLOYING DURING THERMAL SHOCK AND AGING

Huang ML. Wu CML. Lai JKL. Chan YC. - Journal of Electronic Materials. 29(8):1021-1026, 2000

In a previous study, a lead-free solder, Sn-6Bi-2Ag-0.5Cu, was developed by mechanical alloying. The alloy shows great potential as a lead-free solder system. In the present work, the microstructural evolution during thermal shock and aging was examined. In the as-soldered joints small bismuth (1 μm to 2 μm) and Ag₃Sn (1 μm) particles were finely dispersed in a nearly pure tin matrix with a small amount of eta-Cu₆Sn₅ phase in the bulk of solder. During thermal shock and aging microstructural evolution occurred with Cu-Sn intermetallic compound (IMC) layer growth at interface, bismuth phase coarsening and Ag₃Sn phase coarsening. The microstructure of the solder appeared to be stable at high temperature. The shear strength of the present solder joint is higher than that of Sn-37Pb and Sn-3.5Ag solders. Shear failure occurred Cu-Sn IMC layer-solder interface and in the bulk of solder.

[4] GENERATION OF CURVED OR CLOSED-SHELL CARBON NANOSTRUCTURES BY BALL-MILLING OF GRAPHITE

Chen XH. Yang HS. Wu GT. Wang M. Deng FM. Zhang XB. Peng JC. Li WZ. - Journal of Crystal Growth. 218(1):57-61, 2000

Curved or closed-shell carbon nanostructures were produced by ball-milling of graphite. A high resolution indicates that the ball-milling not only produces bend of graphite sheets, forming carbon nanoarches, but also produces closed-shell carbon nanostructures, nearly carbon 'onions'. The possible formation mechanism is proposed.

[3] HEATING OF SUPERPARAMAGNETIC COLLOID IN HIGH-FREQUENCY MAGNETIC FIELD: IMPLICATIONS FOR ELECTROMAGNETIC HYPERTHERMIA

Babincova M. Sustekova E. Babinec P. Cicmanec P. Craciun V. Leszczynska D. - Czechoslovak Journal of Physics. 50(8):979-982, 2000

We have prepared a superparamagnetic colloid by milling magnetite particles and evaluated its heating capabilities in an alternating magnetic field with frequency 3.5 MHz. As has been found relaxation losses are able to heat superparamagnetic suspension to approximate to 80 degrees C in about 3 min. This result may be of an importance for the design of a new efficient hyperthermic material for cancer treatment.

[2] ENHANCED SATURATION LITHIUM COMPOSITION IN BALL-MILLED SINGLE-WALLED CARBON NANOTUBES

Gao B. Bower C. Lorentzen JD. Fleming L. Kleinhammes A. Tang XP. McNeil LE. Wu Y. Zhou O. - Chemical Physics Letters. 327(1-2):69-75, 2000

The effects of processing on the structure and morphology of single-walled carbon nanotubes (SWNT) and their electrochemical intercalation with lithium were investigated. Purified SWNTs were processed by impact ball-milling and were electrochemically intercalated with lithium. The reversible saturation Li composition increased from Li_{1.7}C₆ in purified SWNTs to Li_{2.7}C₆ after 10 min of milling. The irreversible capacity decreased from Li_{3.2}C₆ to Li_{1.3}C₆. Electron microscopy, Raman and X-ray diffraction measurements indicated that ball-milling induced disorder within the bundles and fractured the nanotubes.

[1] THE FULLERENE DIMER C-120 AND RELATED CARBON ALLOTROPES

Komatsu K. Fujiwara K. Tanaka T. Murata Y. - Carbon. 38(11-12):1529-1534, 2000.

Dimerization of C-60 under the solid-state mechanochemical reaction conditions to give C-120 was found to occur in the presence of potassium salts such as KCN, KOH, and KOAc, or of a small amount of alkali metals, or even of organic solid amines such as 4-aminopyridine. The reaction is presumed to involve the formation of the C-60 radical anion, and an equilibrium state is attained between C-60 and C-120. When the solid-state reaction was conducted under the catalysis of 4-aminopyridine, the formation of a small amount (similar to 4% yield) of fullerene trimer C-180 was also observed. The trimer C-180 was confirmed as its cyanated derivative by APCI MS spectroscopy, and was characterized by IR and UV-Vis spectroscopies. Based on the results of HPLC analyses, there are at least four isomers of C-180. The solid-state reaction of C-60 with C-70 in the presence of 4-aminopyridine afforded the cross-dimer C-130 in a low yield (similar to 2%) in addition to C-120 (6%). The dimer C-130 was also confirmed as the cyanated derivative by APCI MS spectroscopy, and was characterized by UV-vis and C-13 NMR spectroscopies.

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