



**RESEAU FRANÇAIS DE
MECANOSYNTHESE**

Lettre N°90

Septembre 2002

**188 Groupes de Recherche
(dont 114) à l'étranger / 34 Pays)**

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Eric GAFFET

CNRS UMR5060 « Métallurgies et Cultures »

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

Chèque ci joint / Check enclosed in the amount of **20 Euros (20€)**

The check has to be to the order to : Réseau Français de Mécanosynthèse

Le site web du RFM est :

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

Rubrique Pages Sciences et Techniques pour l'Ingénieur (Rubrique Sciences)

⇒ vous y trouverez les anciennes lettres du RFM (accessible par Adobe Acrobat), les statuts du RFM ainsi que les annonces concernant les JRFM'2001 et quelques éléments mis à jour régulièrement concernant les derniers résultats dans ce domaine.

Press release

GTM-System - for determining grinding parameters in laboratory mills

The GTM gas pressure and temperature measuring system - a common new development between the Fraunhofer Institute for Applied Material Research (IFAM) in Dresden and the FRITSCH company - enables the determination of gas pressure and temperature data during grinding process in the grinding bowls.

Using this system, it is possible to convert a normal planetary ball mill into an analytical measuring system. By continually measuring gas pressure and temperature, it is possible to monitor thermal effects and gas reactions. Without changing the mill itself, a grinding bowl with an integrated radio transmitter is inserted in the lid. A receiver transfers the data to a computer where a WINDOWS™ programme presents the readings in the form of tables and graphics. The system can be used to check and optimise grinding processes. For the first time it is possible to observe processes during mechanical alloying and, for example, to investigate the grinding behaviour of ductile material. During the event, a Ti+C ---> TiC conversion reaction was made clearly visible.

We are convinced, that this revolutionary new development is a very important improvement for many process and research laboratories.

GAS PRESSURE AND TEMPERATURE MEASURING SYSTEM (GTM System) for Planetary Mills

Measuring the gas pressure and temperature in the grinding bowl while grinding.

Up to date, most of the physical and chemical processes which take place while grinding powders are unknown. If information about the course of the process is necessary, intermediate tests are still required to describe the progress of the comminution, mixing, activation, amorphization or phase transformation processes. These tests are conducted outside the grinding vessel on samples which are rarely identical in condition to the powder during the grinding process.

It was therefore necessary to develop a measuring system which makes it possible to acquire informative process data during grinding.

Economic efficiency and scientific benefitThe GTM system was developed for scientific studies in the mechanical alloying sector to show new amorphous and nanocrystalline materials.

Due to the precise determination of reaction times, it is possible, for example, to prepare new materials by selectively adding coreactants.

Above and beyond this, it makes it possible to monitor and optimize grinding operations in industry. For the first time, the user is able to measure and meaningfully assess process data during grinding operations in grinding vessels of a planetary mill executing complex movements.

Due to the multitude of grinding parameters which exist, combinations develop which could not be investigated at a technically or economically acceptable expense without the GTM system.

Now two very important and meaningful process data items (pressure and temperature) are available to describe the processes being executed. They can be employed for systematic and efficient analyses (optimization). For example, it was possible to demonstrate the influence which grinding parameters speed, ratio between ball and material to be ground and duration of grinding exert on the formation of a few hard materials during intensive grinding, with no need for time-consuming and expensive abortive tests.

A further possible application is the manufacture of powder mixes with special mechanochemical properties (catalytic effects).

Please visit us at MATÉRIAUX 2002 • 21. - 25. Octobre 2002

Vinci – Centre International de Congrès • Tours • France

contact: Fritsch GmbH Manufacturers of Laboratory Instruments

Andrea Köhler - Industriestrasse 8 - D-55743 Idar-Oberstein, Germany

Phone: (0) 67 84/70-146 • Fax: (0) 67 84/70-11

E-Mail: Koehler@fritsch.de • Internet: <http://www.fritsch.de>

Internet: <http://www.fritsch.de>



Congress and School Announcements

8th ICCPS

8th International Conference on Ceramic Processing Science

Hamburg - Sept. 2nd - 5, 2002.

The conference will focus on novel processing of advanced structural and functional ceramics and ceramic composites. The program will favor the most recent developments in this presented in only 10 topical sessions:

1. New Concepts for Economic Production of Powders of High Purity, Reactivity and Ease of Handling
2. Novel Powder Processing and Non-Conventional Shaping (Nanoprocessing, Cellular Structures, etc.)
3. Solution Processing (Thin Film Deposition, Soft Solution, Polymer-Derived, etc.)
4. Biomimetic Structuring (Biotemplates, Biomineralization, etc.)
5. Novel Reaction Forming (Controlled SHS, Reactive Casting, in situ Processing, etc.)
6. Computer-Controlled Shaping and Structuring (Rapid Prototyping, Solid Free-Forming, Controlled Heterogeneities, etc.)
7. Tailoring of Synergy Ceramic Microstructures (LTCC, Self-Sensing Devices, Smart Structures, MEMS, etc.)
8. Grain Boundary Engineering (Grain-Boundary-Free Microstructures, Directed Eutectics, Advanced Electroceramics, etc.)
9. Micromechanics of Composite Synthesis (Transient and Residual Stresses, Constrained Sintering, etc.)
10. COST 528: Chemical Solution Deposition of Thin Films

website : <http://www.tu-harburg.de/gk/8th-ICCPS>

ISMANAM-2002

International Symposium on
Metastable, Mechanically Alloyed and Nanocrystalline Materials
Seoul, Korea, 8-12 September, 2002.

Web site : <http://anu.andong.ac.kr/~ismanam/>

L. A. C. A. M. E – 2. 0. 0. 2

EIGHTH LATIN AMERICAN CONFERENCE
ON APPLICATIONS OF THE MÖSSBAUER EFFECT
PANAMA, 22-27, SEPTEMBER, 2002.

E-mail: <mailto:lacame2000@fisica.ciens.ucv.ve>
<http://www.up.ac.pa/Eventos/lacame2002/inicio.htm>

Matériaux 2002

Tours - France
21- 25 Octobre 2002

Website : <http://www.materiaux2002.net>
E_mail : materiaux@materiaux2002.net

Les JRFM'2002 seront intégrées dans le cadre du Congrès
Matériaux 2002 (Tours – France, du 21 au 25 Octobre 2002)

Poudres et Matériaux Nanostructurés, du fondamental aux applications industrielles

Symposium 1 :

Website : <http://www.materiaux2002.net> : E_mail : materiaux@materiaux2002.net

ICAMP 2002

2nd International Conference on Advanced Materials Processing -
2nd to 4th December 2002 in Singapore.

You are invited to submit papers to the conference secretariat at
Denis Lam - ICAMP 2002 Secretariat
Integrated Meetings Specialist Pte Ltd
114 Middle Road - #05-02 Lee Kai House
Singapore 188971

E-mail: icamp@inmeet.com

Tel: (65) 6226 3069 - Fax: (65) 6226 3016

More detailed information can be found in ICAMP web site

<http://www.eng.nus.edu.sg/PACentre/icamp>

**Fourth INTERNATIONAL CONFERENCE
ON MECHANOCHEMISTRY AND MECHANICAL ALLOYING
4th INCOME 2003**

Technical University of Braunschweig, Braunschweig, Germany
September 7-11, 2003

Website : <http://www.tu-bs.de/INCOME2003>



XV. International Symposium on Reactivity of Solids

**Nov. 09-13 2003
KYOTO, Japan
Sekisui Technical Center**



*Unique, process-oriented symposium
with half a century tradition.*

*To be held in Asia for the first time
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Paris.*

*All about particulate materials from
basic solid state chemistry to advanced
materials.*

First circular will soon be released.

URL will soon be opened

*at: [http://www.physik.uni-
augsburg.de/chemie/ISRS/homepage.html](http://www.physik.uni-augsburg.de/chemie/ISRS/homepage.html)*

Please @contact::

[Deadlines \(tentative\)](#)

Abstract due 2003.2.28

Manuscript due: 2003.11.9

Lettre RFM N°90 - Septembre 2002
Corresp. : <mailto:Eric.Gaffet@utbm.fr>



Thesis Announcement

Preparation of nanocrystalline metal nitrides and hydrides and study of their basic properties.

Thesis by **Marisa Bab**, Universidad Nacional de La Plata (**Argentina**), 2002.

Jury:

A. Fernández Guillermet (Bariloche), Graciela Punte (La Plata), A. Pasqueyich (La Plata);
L. Mendoza Zélis (Directeur de Thèse), F. Sánchez (Codir. de Thèse)

Abstract

The main purpose of this work was the preparation by mechanical grinding and further characterization of nanocrystalline refractory metal nitrides and hydrides and fine dispersions of these ceramic materials in a crystalline or amorphous metallic matrix. Since the short range order strongly affects the properties of the studied systems, hyperfine techniques like Mössbauer Spectroscopy and Perturbed Angular Correlations were particularly useful in our work. They were complemented by X-ray diffraction, electronic microscopy and differential calorimetry.

The preparation method, mechanical grinding in a gaseous ambient, based in the severe plastic deformation introduced in the material when it is trapped between the grinding tools, induce the solid gas reaction assisting the absorption and diffusion of gas atoms and providing mechanical energy. In order to produce the reaction in a controlled manner a system was developed that allows milling operations at constant volume of Ar, N₂ or H₂, monitoring the gas pressure changes and the milling frequency.

The microstructure, essential to nanocrystalline materials properties, is closely related to the preparation method. Then, a careful study of the process was conducted on Zr and Hf, characterizing the dependence of the absorption kinetics on the milling parameters and showing that the absorption degree is determined by the specific energy dose supplied to the powders and is independent of the gas pressure. In this context, a model is proposed to analyze the reaction kinetics by means of an analogy between thermal energy in isothermal processes and the collision energy involved in the impacts in the present mechanical method. A universal correlation was found among the reaction rate constant and the specific milling intensity.

The relation between the absorption kinetics and the structural transformations was studied in both cases. It was found that the solid-gas reactions to form nitrides and hydrides were accompanied by a structural transformation mechanism given by a mechanically assisted atomic plane sliding. For nitrogen, the kinetics is controlled by the occupation of octahedral interstices by N atoms and their grain boundary and bulk diffusion. For hydrogen, on his hand, the reaction is controlled by the interface between hydrided and non hydrided regions.

The influence of composition and structure was studied by milling in N₂, several samples of the Zr-Fe system and Hf₂Fe. It was found that regardless the initial composition or structure, the final product after prolonged milling was a mixture of ZrN (HfN) and almost pure Fe. Among the observed intermediate states we highlight the formation of delta-Zr_{1-x}Fe_xN that may be described as a solid solution of delta-ZrN and gamma-FeN.

Finally the preparation method was applied to amorphous multi component alloys from the ZrAlCuNi family. It was found that the absence of grain boundaries delays the nitrogen absorption evidencing the role of microstructure in the whole process. The method appears as an adequate route to produce nanocrystalline ceramic precipitates in amorphous matrix, possibly improving its remarkable properties.



Cooperative Research on Related Areas

France (12/04/2001)

Le portail Internet "France Contact" a été lancé: ce portail s'adresse aux chercheurs étrangers séjournant ou ayant séjourné en France et permettra le suivi et l'animation du réseau que constituent les milliers de chercheurs étrangers ayant effectué un séjour scientifique au sein des établissements et des organismes de recherche français:

Website : <http://www.francecontact.net>

Europe (6/03/2001)

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

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

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

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



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

From Ch. Gras
(On the 19/08/2002)

POST-DOCTORAL POSITION IN POWDER DIFFRACTION AT IPNS

Argonne National Laboratory, one of the nation's premier scientific research and development organizations, located 20 miles southwest of Chicago, is now looking to fill a post-doctoral position in the Intense Pulsed Neutron Source (IPNS) Division, a facility dedicated to materials science research using neutron scattering techniques.

The successful applicant will join the General Purpose Powder Diffractometer (GPPD) instrument team at IPNS, participate in user-initiated as well as independent scientific programs, and join in commissioning the upgraded GPPD (to be completed in 2003). Ongoing scientific activities include: (1) crystal chemistry and structure-property relationships in catalytic materials; (2) crystallographic and dynamics studies of occluded zeolites - particularly directed at guest-framework interactions; and (3) residual strain/crystallographic texture measurements in alloys and composites, including strain and orientation distribution function determinations. A PhD degree awarded within the last three years in a discipline such as chemistry, materials science or physics is required. Highly desirable is a motivated scientist with a strong background in diffraction and crystallography, including familiarity with x-ray and neutron scattering, powder diffraction and structure/property relationships.

We welcome applications from candidates who can contribute to our EEO/Affirmative Action goals. Interested candidates should submit a curriculum vitae, three letters of recommendation, and a statement of research interests.

Susan M. Walker
Employment and Placement
Box No. IPNS-JWR
Argonne National Laboratory
9700 S. Cass Avenue, Argonne, IL 60439.
Fax: 630-252-9388, Email: employment@anl.gov.

Technical questions concerning this position should be addressed to J. W. Richardson (jwrichardson@anl.gov)

**POSTDOCTORAL RESEARCH ASSISTANT IN MODELLING OF PHASE-CHANGE MATERIALS
Research Staff Grade RAIA / Salary: £ 17,626 - £ 26,491 / Job Ref: DJ02/033**

Applications are invited for a postdoctoral position, available for up to three years, to model electron transport in phase-change materials. The project is funded by the Hewlett-Packard Laboratory (HPL) in Palo Alto as part of ongoing research into advanced data storage devices. The research will involve the extension of a highly-successful Monte Carlo model for film growth to ternary systems and the development of an in-house Tight-Binding code for electron transport to phase-change materials of interest to HPL. The research programme will be led by Professor David Pettifor FRS.

The successful applicant will be expected to interact closely with experimentalists at HPL, visiting Palo Alto at least every six months. Candidates should have a good first degree and completed a doctorate (by the time of appointment) in physics, materials or a related physical science subject, and should show evidence of the required modelling skills, together with knowledge of their fundamental concepts. Excellent verbal and written communication skills in English (the project language), and the ability to work to agreed time-scales, both independently and in a team, are essential.

Before submitting an application, candidates should obtain further particulars available from The Deputy Administrator (Teaching), Department of Materials, University of Oxford, Parks Road, Oxford OX1 3PH (email: posts@materials.ox.ac.uk), or telephone 01865 273750 quoting reference: DJ02/033. The closing date for applications is 9 August 2002 and interviews are planned for 30 August 2002. Further information on the Department may be found on the web-site: <http://www.materials.ox.ac.uk>

**POSTDOCTORAL RESEARCH ASSISTANT IN MODELLING OF CARBON NANOSTRUCTURES
Research Staff Grade RAIA / Salary: £ 17,626 - £ 26,491 / Job Ref: DJ02/029**

Oxford and Cambridge Universities are working together with Hitachi Europe Ltd. to produce radically new devices for future computing, in a project jointly funded by a Foresight LINK Award from the Department of Trade and Industry and Hitachi Europe Ltd. The project brings together research in physics, chemistry, materials science and electronics engineering to make prototype structures for advance conventional computing and for the new field of quantum computing. See www.nanotech.org. Applications are invited for a postdoctoral position in the first-principles modelling of the atomic and electronic properties of endohedral fullerenes within single walled carbon nanotubes. This position is funded until 30 September 2004 and will be supervised by Professor David Pettifor FRS.

The successful applicant will be expected to interact closely with experimentalists performing HREM, STM, EELS and Raman characterization within this LINK programme. Candidates should have a good first degree and completed a doctorate (by the time of appointment) in physics, chemistry or materials, and should show evidence of the required first principles modelling skills. Excellent verbal and written communication skills in English, and the ability to work independently and in a team within an agreed time-scale are essential.



Before submitting an application, candidates should obtain further particulars available from The Deputy Administrator (Teaching), Department of Materials, University of Oxford, Parks Road, Oxford OX1 3PH (email: posts@materials.ox.ac.uk), or telephone 01865 273750 quoting reference: DJ02/029. The closing date for applications is 02 August 2002 and interviews are currently planned for the 29 August 2002. Further information on the Department may be found on the web-site: <http://www.materials.ox.ac.uk>

**POSTDOCTORAL RESEARCH ASSISTANT IN ATOMISTIC MODELLING
RESEARCH STAFF RAIA GRADE / Salary £ 17,626 - £ 26,491 pa / Ref. DJ02/031**

Atomistic Modelling: an immediate vacancy exists for a postdoctoral research appointment funded by the EU for the study of nanoscale amorphous layers in structural and functional ceramic materials. The project is part of an international collaboration of nine research institutions in Europe and the US, in which substantial intergroup communication and exchanges are expected, and is funded until January 2005.

This post will involve Grand Canonical Monte Carlo simulations of the equilibrium structure and composition of nanometre scale grain boundary films in silicon oxy-nitride, building on a very successful network model of non-stoichiometric glasses we have recently published in PRL. Ab initio simulations will be used to refine the structures and predict local electronic structures for comparison with experiment. This project will be led by Professors Adrian Sutton and David Pettifor.

The successful applicant will have a good first degree and have completed a doctorate (by the time of appointment) in materials, physics, or a related physical science subject. The post requires the ability to work both independently and collaboratively as part of a team. Candidates should show evidence of the required skills, and a considered interest in the particular field of research.

Before submitting an application, candidates should obtain further particulars from The Deputy Administrator (Teaching), Department of Materials, University of Oxford, Parks Road, Oxford OX1 3PH (email: posts@materials.ox.ac.uk), or telephone 01865 273750 quoting reference: DJ02/031. The closing date for applications is 9 August 2002 and interviews are planned for 29 August 2002. Further information on the Department may be found on the web-site: <http://www.materials.ox.ac.uk>.

**MICROSTRUCTURAL CHARACTERISATION XRD & SEM SPECIALIST
Research Staff grade RAIA / Salary £ 17,626 - £ 22,522 pa / Ref: DJ02/012**

Applications are invited from experienced scientists in microstructural characterisation. The Materials Department Services to Industry Characterisation and Analysis Service provides a problem solving and advisory service based on microanalytical techniques to internal research units and external commercial customers. The post holder will provide a high quality, fast turnaround X-ray diffraction (XRD) and scanning electron microscope (SEM) advisory and analytical service. He/she will assist with maintenance and servicing of the Department's analytical facilities, advise on the use of these techniques and in the interpretation of data, and assist in the training of students and other researchers in SEM and XRD techniques. The post is available for three years in the first instance.

Before submitting an application, candidates should obtain further particulars available from The Deputy Administrator (Teaching), Department of Materials, University of Oxford, Parks Road, Oxford OX1 3PH (email: posts@materials.ox.ac.uk), or telephone 01865 273750 quoting reference: DJ02/012. The closing date for applications is 19 July 2002 and interviews are planned for the week beginning 29 July 2002. Further information on the Department may be found on the web-site: <http://www.materials.ox.ac.uk>

**MICROSTRUCTURAL CHARACTERISATION EPMA & SEM SPECIALIST
Research Staff grade RAIA / Salary £ 17,626 - £ 26,491 pa / Ref: DJ02/013**

The post of Microstructural Characterisation EPMA & SEM Specialist in the Department of Materials is available for three years in the first instance, to start as soon as possible. Working as part of a small team, the post holder will be involved in providing a high quality, fast turnaround optical microscopy, EPMA & SEM advisory and analytical service to both internal and external customers, assisting with maintenance and servicing of the Department's analytical facilities and advising on the use of these techniques and in the interpretation of data, and participating in the training of students and other researchers in SEM, optical microscopy and EPMA techniques.

Applicants should hold a Materials Science degree and have a detailed understanding of crystallography and a proven, high-level competence in EPMA, with at least five years of sophisticated/advanced analytical expertise. They should be well-organised, have good inter-personal verbal and written communications skills, and an awareness of the financial implications of working with industry, be able to liaise with academic users and industrial customers, and be willing, on occasions, to travel within the UK.

Before submitting an application, candidates should obtain further particulars available from The Deputy Administrator (Teaching), Department of Materials, University of Oxford, Parks Road, Oxford OX1 3PH (email: posts@materials.ox.ac.uk), or telephone 01865 273750, quoting reference: DJ02/013. The closing date for applications is 19 July 2002 and interviews are planned for the week beginning 29 July 2002. Further information on the Department may be found on the web-site: <http://www.materials.ox.ac.uk>



From Assoc. Prof. Gerardo F. Goya
(on the 7th June 2002)

A postdoctoral position is available at the Physics Department, University of São Paulo, Brazil.

The position is for one year (with renewal up to three years), and the salary is about R\$ 34,400.00/year (13,600.00 USD). Candidates must be interested in developing a research project focused on Mechanosynthesis of Magnetic Materials and magnetic characterization.

Applications including a CV, publication list, and names of three references should be sent by e-mail, before August 30, 2002 to:

Assoc. Prof. Gerardo F. Goya,
Departamento de Física dos Materiais
Instituto de Física
Universidade de São Paulo
e-mail: goya@if.usp.br
fax +55 11 3091 6984
tel +55 11 3091 6885

From Dr.-Ing. Adrian JIANU (Rostock University, Physics Dept.)
On 7th June 2002

The Chair of Physics of New Materials of the University of Rostock is seeking outstanding young (35 years old or less) scientists to work on a new project of advanced materials synthesis under extreme pressure and temperature conditions.

The two fellowships (24 months each) are offered in the frame of the Marie Curie Development Host scheme of the 5th European Community Framework Programme.

A Ph.D. in Material Science or related sciences (Solid State or Applied Physics, Chemistry, etc) or at least 4 years of full-time research experience at a post-graduate level is required.

Eligible candidates should be nationals or residents of an European Community Member or Associated States other than Germany.

For further details please visit the website :
<http://www.physik1.uni-rostock.de/user/agburkel/jobs.html>
or please contact for :

Dr. A. Jianu,
phone: 0049-381-4981731,
e-mail: jianu@physik1.uni-rostock.de

Please send applications with C.V. and list of publications to: _

Prof. Eberhard Burkel
Rostock University, August-Bebel-Str., 55,
018055 Rostock, Germany,
tel: 0049-381-4981727,
fax:0049-381-4981726,
e-mail: burkel@physik1.uni-rostock.de

Proposal on 4 June 2002



MATERIALS SCIENTIST

Crown Cork & Seal is the world's leading packaging company. It consists of the best-established packaging companies in the UK, USA, France, Germany, and many other countries, successfully merged into a dynamic family of packaging professionals. In Europe we may be more familiar as CarnaudMetalbox, the largest manufacturer of metal and plastics domestic and retail packaging, such as food and beverage cans and PET bottles. Worldwide, the Company has a turnover of \$7 billion, with 36,000 employees and operations in 51 countries.

Corporate Technologies, based in Wantage UK, and Chicago USA, is the research, development and engineering arm of Crown Cork & Seal, providing technical support to our Businesses and Project Teams.

Our Materials Group, based in Wantage, South Oxfordshire, has a vacancy within the packaging performance and corrosion failure analysis team, for a Materials Scientist with suitable experience in electrochemistry and corrosion. An integral part of the role will involve the integration of electrochemical approaches to corrosion problem solving, together with advanced imaging and analytical techniques (S.E.M, AFM, ESCA etc).

Candidates should have a good first degree, or PhD, in the appropriate discipline with either some relevant industrial experience or an interest in packaging. They will be reliable team players who can communicate at all levels, be self-



motivated and demonstrate an ability to translate a sound, scientific knowledge base into practical advantage in a commercially driven environment.

Applications (full cv or SAF) should be sent to:
Graduate Recruitment & Training Manager,
Crown Cork & Seal,
Downsview Road,
Wantage, Oxon: OX12 9BP
e-mail: grad.careers@eur.crowncork.com



Périodiques / Congrès

[36] EFFECT OF MA ON MICROSTRUCTURE AND SYNTHESIS PATH OF IN-SITU TiC REINFORCED Fe-28at.% AL INTERMETALLIC COMPOSITES

Ko SH. Park BG. Hashimoto H. Abe T. Park YH. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):78-83,

An in-situ composite consisting of titanium carbide and iron aluminide was synthesized by mechanical alloying of elemental powders and pulsed discharge sintering. The microstructure and synthesis path of in-situ TiC reinforced Fe-28at.% Al composite were examined as a function of milling time and heat treatment temperature. Mechanical alloying of the elemental powders promoted bcc solid solution formation, and the solid solution completed at milling of 400 h. During sintering Fe₃Al and TiC precipitated from the supersaturated Fe solid solution containing Al, Ti and C. Microstructure of the sintered body made of powder milled for 200 h consists of three regions, that is, large TiC particles of about 5 μm in size, Fe₃Al matrix with TiC particles of submicron size and particle-free Fe₃Al region. For the sintered body after milling of 400 h. however, the large TiC particles disappeared due to the complete solid solution during mechanical alloying. Sintering of the powders milled for the period shorter than 50 h formed intermediate phases, such as Al₁₅Fe₂, Al₃Ti and Fe₃AlC_x, by heat treatment up to 1273 K, while that of the powder milled for 400 h showed direct precipitation of Fe₃Al and TiC from the Fe solid solution.

[35] FABRICATION OF TiB₂ REINFORCED Al₃Ti COMPOSITE LAYER ON Ti SUBSTRATE BY REACTIVE-PULSED ELECTRIC CURRENT SINTERING

Matsubara T. Shibutani T. Uenishi K. Kobayashi KF. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):84-91, 2002

A TiB₂ reinforced intermetallic compound Al₃Ti composite coating layer was formed by reactive-pulsed electric current sintering of mechanically alloyed Al-Ti-B or Al-Ti-TiB₂ powders, and was simultaneously bonded to a Ti substrate to improve its wear and oxidation properties. The sintering behavior was investigated to obtain a fully dense and homogeneous Al₃Ti/TiB₂ coating. Bonding to substrate was achieved by the formation of reaction layers at the bonding interface and the reaction kinetics were investigated. Although the wear properties of monolithic Al₃Ti coating could be improved by the reinforcement of TiB₂, the oxidation properties at high temperature (1273 K) were degraded due to the decomposition of TiB₂ to elemental Ti and B.

[34] SUPERPOSITION OF GRAIN SIZE AND DISPERSION STRENGTHENING IN ODS L1(2)-(Al,Cr)(3)/Ti

Heilmaier M. Saage H. Mirpuri KJ. Eckert J. Schultz L. Singh P. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):106-111, 2002

The preparation of oxide dispersion strengthened (ODS) Al₆₇Cr₈Ti₂₅-type intermetallic compounds with L1(2)-structure was carried out by mechanical alloying and ball milling. Subsequent powder consolidation by hot uniaxial pressing yielded fully dense samples with nano-scaled dispersions of 1-3 vol.% Y₂O₃, Al₂O₃ and CeO₂ embedded in the single-phase matrix revealing a sub-pin grain size. As a single-phase reference, samples without oxide dispersions were also prepared. While retaining the mean dispersoid size, additional thermal and thermo-mechanical treatment yielded normal and abnormal grain growth of the matrix, respectively, to produce grain sizes ranging from several microns to close to 1 mm. Constant compression tests were carried out at ambient temperature to reveal the contribution to the yield strength stemming from the dispersoid/dislocation interaction as well as from dislocation pile-up at grain boundaries. The results are discussed in terms of actual microstructurally based concepts for room temperature yielding.

[33] SYNTHESIS AND THERMAL STABILITY OF NANO-RuAl BY MECHANICAL ALLOYING

Liu KW. Mucklich F. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):112-117, 2002

Single phase RuAl has been synthesized by mechanical alloying (MA). The structural evolution during MA and thermal stability of as-milled powders at elevated temperatures have been analyzed by XRD, thermal analysis and isothermal annealing. The results indicate that there are two stages of reaction between Ru and Al in MA before single phase RuAl is obtained, and that the as-milled RuAl undergoes reordering, strain relaxation and grain growth at high temperatures. All structural evolutions show signs of stagnation upon high temperature annealing. The isothermal grain growth kinetics has been analyzed by considering the influence of impurities.

[32] MECHANICAL PROPERTIES OF NANOCRYSTALLINE Ti-Al-X ALLOYS

Authors Calderon HA. Garibay-Feblés V. Umemoto M. Yamaguchi M. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):196-205, 2002

Nanocrystalline alloys have been produced by means of mechanical milling and spark plasma sintering. Two types of materials have been obtained, TiAl-X and Al₃Ti-X alloys, X represents Cr, Mn or Fe. Sintered TiAl-X alloys have a two-phase microstructure consisting of the gamma-TiAl phase and the alpha phase, this last one with a globular morphology. Their average grain size varies between 100 and 150 nm. The Al₃Ti-X alloys are constituted by a single phase with an L1(2) structure and all average grain size of about 30 nm. Compression tests are used to evaluate the mechanical properties of these materials at temperatures ranging from 298 to 773 K. Very high flow stresses are found for the TiAl-X alloys, with maximum values of approximately 3 GPa. Surface traces develop during deformation at room temperature of these materials. Microscopic observation reveals dislocation activity in the larger grains. Thenanocrystalline Al₃Ti-X alloys show no ductility.



at room temperature and a rather high fracture strength of about 2.5 GPa. Deformation of heat-treated Al₃Ti-X alloys (larger grain sizes) produces plastic deformation with dislocation activity and lower flow stresses (similar to 1 GPa)

[31] COLD-WORK INDUCED PHENOMENA IN B2FEAL INTERMETALLICS

Authors Varin R.A. Czujko T. Bystrzycki J. Calka A. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):213-221, 2002

For the last several years we have been conducting systematic studies of microstructural changes and mechanical behavior of B2 FeAl alloys, cold-worked by ball-milling and shock-wave loading. Fundamental physical phenomena induced in iron aluminides such as an accelerated chemical disordering, increase in the lattice parameter, non-magnetic/magnetic transformation and formation of nanocrystals in ball-milled powder particles are presented and discussed

[30] APPLICATION OF FLAKE METAL AS A SURFACE MODIFIER FOR THE HYDROGEN ABSORBING INTERMETALLIC ELECTRODE OF AN NI-MH RECHARGEABLE BATTERY

Lee S.M. Yu J.S. Lee P.S. Lee J.Y. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):339-345, 2002

In order to improve the electrochemical cyclic durability of the Ti-based hydrogen storage alloy electrode, a ball-milling process is applied to the Ti-based alloy using the Ni flake as a surface modifier. Ni flake powder is a very useful material to modify the surface of metal hydrides. While the as-cast Ti-base alloy electrode was completely degraded within ten cycles, the ball-milled Ti-base alloy electrode using Ni flakes as a surface modifier showed only 8% of capacity decay even after 180 cycles. It is also noticeable that the ball-milled alloy electrode shows just a little decreased discharge capacity (429 mAh g⁻¹) by modifying with Ni flake powders. These results are closely related with the higher strain and higher surface area of Ni flake powder. The residual strain of Ni flake powder can promote the diffusion reaction in the impact event of ball-milling. Consequently, the Ni flakes as a new surface modifier can modify the alloy surface without changing the bulk properties of the alloy, resulting in an effective surface coating within a shorter ball-milling time.

[29] MICROSTRUCTURAL EVOLUTION OF AN AL67MN8TI24NB1 ALLOY DURING MECHANICAL MILLING AND SUBSEQUENT ANNEALING PROCESS

Sun J. Zhang J.X. Fu Y.Y. Hu G.X. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):703-707, 2002

Microstructural evolution of the ordered L1(2) + DO₂₂ multiphase Al₆₇Mn₈Ti₂₄Nb₁ alloy during mechanical milling and subsequent annealing were investigated by X-ray diffractometer (XRD), transmission electron microscope (TEM) and hot-stage TEM. The transitions induced by severe plastic deformation during mechanical milling with increase of milling time were as follows: L1(2) + DO₂₂ → disordered fcc supersaturated solid solution → amorphous structure. The amorphization of the Al₆₇Mn₈Ti₂₄Nb₁ alloy resulted from the increase of the free energy by introducing high density nano-crystalline grain boundaries and the large internal lattice strain caused by the super-saturated dissolving of the Al-3(TiNb) second phase in fcc solid solution. Transitions during subsequent annealing of the as-milled powders were amorphous-fcc crystalline transition at 250 degrees C, disorder fcc transforming into the L1(2) ordered structure at 300 degrees C and DO₂₂ structured second phase precipitating in the L1(2) matrix around 500-650 degrees C, meanwhile grains growing up to the sub-micron.

[28] HIGH TEMPERATURE OXIDATION OF MECHANICALLY ALLOYED NiAl-Fe-AlN-Al₂O₃

Lee D.B. Kim G.Y. Park S.W. Ur S.C. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 329(Special Issue SI):718-724, 2002

A new NiAl-Fe alloy containing uniformly distributed ultra-fine AlN and Al₂O₃ dispersoids was produced by mechanical alloying in a controlled atmosphere and by subsequent hot extrusion process. The new NiAl-Fe-AlN-Al₂O₃ alloy was oxidized in the temperature range between 1073 and 1473 K in air. The alloy displayed similar oxidation behavior with conventional NiAl alloys. As the oxidation temperature increased, the oxidation rate, the scale thickness and scale spallation increased. The scales formed during isothermal and cyclic oxidation consisted primarily of alpha-Al₂O₃. No transient, metastable aluminas were found. The presence of not nitrogen but iron and nickel within the alumina scales was observed.

[27] (1-x)PNZ-xBT CERAMICS DERIVED FROM MECHANOCHEMICALLY SYNTHESIZED POWDERS

Authors Kong L.B. Ma J. Huang H. Zhang R.F. - Materials Research Bulletin. 37(6):1085-1092, 2002

Nanosized (1 - x)Pb(Zn_{1/3}Nb_{2/3})O-3-xBaTiO₃ (PZN-BT, x = 0.05, 0.10, 0.15, 0.20, 0.25, and 0.30) powders were synthesized directly from their corresponding oxide mixture via a high-energy ball milling process. Almost single phase was achieved in the composition range of PZN-BT. The grain size estimated from SEM observation was about 50 nm, being in good agreement with that (20 nm) calculated from XRD patterns. PZN-BT ceramics were also obtained by sintering the synthesized powders at 1050 degrees C for 1 h. The grain size of the final ceramics decreases from 4.5 to 1.2 μm as BT content increases from 0.05 to 0.30. The properties, such as microstructure, lattice constant, phase composition, dielectric constant as a function of composition of the PZN-BT ceramics, were investigated and discussed.

[26] THERMAL AND MECHANICAL PROPERTIES OF SINTERED MACHINABLE LAPO₄-ZRO₂ COMPOSITES

Authors Min W. Daimon K. Matsubara T. Hikichi Y. - Materials Research Bulletin. 37(6):1107-1115, 2002

Monazite-type LaPO₄ was synthesized using the wet precipitation and mechanochemical reaction methods. Mixtures of xLaPO₄-(1 - x)ZrO₂ (x = 0-1) were dry-pressed to disks or plates and cold isostatically pressed (CIP) at 100 MPa for 10 min and then sintered at temperature between 1500 and 1600 degrees C for 1, 3, and 5 h in air, respectively. Relative densities larger than 96.8% (x less than or equal to 0.4) and 92% (x = 0.5-1) were achieved. It was found that these composites with x greater than or equal to 0.25 and single-phase LaPO₄ were machinable, that is, they could be cut and drilled using conventional tungsten carbide metal-working tools. The drilling rates were measured by applying a fixed load of 49 N to the



drill at 6400 rpm. X-ray diffraction results showed that the LaPO₄ did not react with ZrO₂, at least at 1600 degrees C in air. The linear thermal expansion coefficient, thermal conductivity, bending strength, and Young's modulus of the sintered composites were measured

[25] MAGNETIC PROPERTIES OF Ni₃Fe INTERMETALLIC COMPOUND OBTAINED BY MECHANICAL ALLOYING

Chicinas I. Pop V. Isnard O. - Journal of Magnetism & Magnetic Materials. 242(Part 2):885-887, 2002

Nanocrystalline Ni₃Fe intermetallic compound was obtained by mechanical alloying in argon atmosphere. The nanocrystallites size (12.5 +/- 2.0 nm) was determined by X-ray diffraction performed on an annealed sample. The Curie temperature measurements prove the presence of the Ni₃Fe phase. From magnetisation curves was evidenced the dependence of the susceptibility and spontaneous magnetisation at 4 and 302 K on the milling time

[24] NANOCRYSTALLINE HIGH PERFORMANCE PERMANENT MAGNETS

Authors Gutfleisch O. Bollero A. Handstein A. Hinz D. Kirchner A. Yan A. Muller KH. Schultz L. - Journal of Magnetism & Magnetic Materials. 242(Part 2):1277-1283, 2002

Recent developments in nanocrystalline rare earth-transition metal magnets are reviewed and emphasis is placed on research work at IFW Dresden. Principal synthesis methods include high energy ball milling, melt spinning and hydrogen assisted methods such as reactive milling and hydrogenation-disproportionation-desorption-recombination. These techniques are applied to NdFeB- PrFeB- and SmCo-type systems with the aim to produce high remanence magnets with high coercivity. Concepts of maximizing the energy density in nanostructured magnets by either inducing a texture via anisotropic HDDR or hot deformation or enhancing the remanence via magnetic exchange coupling are evaluated.

[23] EFFECT OF MAGNETIC INTERACTIONS ON THE MAGNETIC PROPERTIES OF BALL-MILLED SmCo₅+NiO POWDERS

Sort J. Nogues J. Surinach S. Munoz JS. Chouteau G. Baro MD. - Journal of Magnetism & Magnetic Materials. 242(Part 2):1287-1289, 2002

An enhancement of the coercivity, H-C, has been observed in SmCo₅ when ball-milled with antiferromagnetic NiO powders. Moreover, after short-term milling, these composites exhibit very high values of the squareness without need for particle alignment. Classical AM plots show that short-range exchange interactions are predominant for fields H < H-C, while long-range magnetostatic interactions prevail for H > H-C

[22] 1 : 7-TYPE MAGNETS PRODUCED BY MECHANICAL MILLING

Authors Venkatesan M. Jiang C. Coey JMD. - Journal of Magnetism & Magnetic Materials. 242(Part 2):1350-1352, 2002

In a search for magnets that can be used at elevated temperatures, we examined the influence of Ti and Cu substitution on the coercivity of nanocrystalline 1:7 type Sm-Co magnets. Amorphous ball milled powders were annealed to give the TbCu₇ type structure. Coercivity of 1.9 and 2.5 T is observed at room temperature for SmCo_{6.7}Ti_{0.3} and SmCo_{6.4}Cu_{0.3}Ti_{0.3}, respectively the value for both materials at 400 degrees C is 0.8 T.

[21] NDFeB-ALPHA FE NANOCOMPOSITES CONTAINING SMALL ADDITIONS OF Pb

Kaszuwara W. Leonowicz M. - Journal of Magnetism & Magnetic Materials. 242(Part 2):1366-1368, 2002

The effect of lead additions on the basic magnetic properties of Nd₁₀Fe_{84-x}Pb_xB₆ (x = 0.3) magnets, processed by mechanical alloying, are presented. Small additions of Pb increase the coercivity after annealing of the material at 650 degrees C. The maximum coercivity only slightly exceeds the value for the Pb-free magnets. The remanence versus Pb content, for annealing at 650 degrees C, initially decreases, attains a maximum for 1.5 at%. Pb and decreases again for higher lead concentrations.

[20] MAGNETIC AND MAGNETO TRANSPORT PROPERTIES OF NANOCRYSTALLINE (Fe₂B)_{0.20}X-0.80 (X = Ag OR Cu) ALLOYS PREPARED BY MECHANICAL ALLOYING

Passamani EC. Tagarro JRB. Nunes E. Takeuchi AY. - Journal of Magnetism & Magnetic Materials. 247(2):191-199, 2002

The magnetic and magneto transport properties of nanocrystalline (Fe₂B)_{0.20}X-0.80 (X = Ag or Cu) alloys have been studied by Mossbauer, magnetization and magneto resistance (MR) techniques. The samples were prepared by mechanical alloying the nanostructured Fe₂B alloy and Ag or Cu chemical elemental powders in a high-impact mill machine. The Mossbauer spectroscopy and magnetic measurements of as-milled (Fe₂B)_{0.20}Ag-0.80 and annealed (Fe₂B)_{0.20}Cu-0.80 alloys indicate the presence of small Fe and Fe₂B magnetic particles. The magneto resistance curves of (Fe₂B)_{0.20}X-0.80 (X = Ag or Cu) alloys show a non-saturated behavior, an indication of a spin-glass-like state generated by the magnetic coupling between these magnetic particles. The non-saturated effect is more pronounced in the alloy with Ag, where the MR values decrease linearly with the external magnetic field, even at 7 T. The magneto resistance values, at 4.2 K and for a magnetic field of 7 T, are 4.0% and 4.5%, for (Fe₂B)_{0.20}Ag-0.80 and (Fe₂B)_{0.20}Cu-0.80 samples, respectively.

[19] MECHANICALLY INDUCED SOLID-STATE REACTION FOR SYNTHESIZING NEW MULTICOMPONENT Ta₅₅Zr₁₀Ni₁₀Al₁₀Cu₁₅ GLASSY ALLOY POWDERS WITH EXTREMELY WIDE SUPERCOOLED LIQUID

El-Eskandarany MS. Zhang W. Inoue A. - Materials Transactions. 43(6):1422-1424, 2002

New multicomponent Ta-based glassy alloy powder was synthesized by mechanical alloying a mixture of elemental Ta₅₅Zr₁₀Ni₁₀Al₁₀Cu₁₅ powders at room temperature, using a low-energy ball mill. The glassy powders of the final-product (1080 ks) in which its glass transition temperature (T-g) lies at a high temperature (834 K), crystallize through a single sharp exothermic peak at 1004 K (T-x). The total enthalpy change of crystallization (Delta H(x)) is -10.32 kJ/mol. The supercooled liquid region before crystallization (Delta T(x)) of the synthesized glassy powders shows the widest value (170 K) of any reported metallic glassy system



[18] DEVELOPMENT OF CHROMIA FORMING MO-W-CR ALLOYS: SYNTHESIS AND CHARACTERIZATION

Diliberto S. Kessler O. Rapin C. Steinmetz P. Berthod P. - Journal of Materials Science. 37(15):3277-3284, 2002

The sintering process and microstructural characteristics of tungsten-based and molybdenum-based alloys containing chromium and group VIII metals as sintering agents have been investigated. The influences of the alloy composition, the nature of the sintering agent and the synthesis process on the microstructure and microhardness of these materials have been studied. Homogeneous alloys can be obtained with palladium or nickel as the sintering agent. The mechanisms are totally different with these two metals. In the case of nickel, diffusion of the refractory metal through a nickel layer is responsible for the densification of the alloys, whereas with palladium, a CrPd liquid phase at the grain boundaries leads to homogeneous sintering. Formation of the CrPd phase is directly dependent on the chromium content which influences the solubility of palladium in the MoW matrix. Consequently, a low chromium content leads to a high CrPd content, and to an increase in the grain size. On the contrary, with a nickel sintering agent, a high Ni content leads to an increase in thickness of the interdiffusion layer and thus a decrease in the grain size. Stresses generated by uniaxial sintering and mechanical alloying are not released during the annealing sequence and contribute to increase the microhardness of the alloys. Microhardness is also a strong function of the tungsten content.

[17] SUPERCONDUCTIVITY OF MgB₂ AFTER MECHANICAL MILLING

YD. Ding J. Rao GVS. Chowdari BVR. Sun WX. Shen ZX. - Physica Status Solidi A-Applied Research. 191(2):548-554, 2002

A MgB₂ powder was mechanically milled for different times. X-ray diffraction indicated the formation of an intermediate phase with an unknown structure before formation of amorphous phase. The intermediate structure was superconducting below 18 K, while the amorphous phase was non-superconducting till 4.2 K. After heat treatment at 700 degrees C, all the mechanically milled samples formed back into the hexagonal MgB₂ structure with T_c = 39 K. X-ray and Raman investigations suggested that the intermediate structure was metastable with a lattice compression, which was probably associated with the reduction in transition temperature.

[16] IMPROVEMENT IN THE NANOINDENTATION TECHNIQUE FOR INVESTIGATION OF THE TIME-DEPENDENT MATERIAL PROPERTIES

YI. Ivolgin VI. Korenkov VV. Korenkova NV. Farber BY. - Philosophical Magazine A-Physics of Condensed Matter Defects & Mechanical Properties. 82(10):2173-2177, 2002

An improved nanoindentation technique was developed for dynamic investigation of the time-dependent properties of materials under conditions close to real nanocontact interaction during dry friction, abrasive wear, milling, mechanical alloying and so on. For these purposes the duration of the loading-unloading cycle, was reduced to 20 ms and a nanocontact fatigue test was performed with the number of reloading cycles reaching 10(3)-10(5).

[15] SOLVENT-FREE MECHANOCHEMICAL SYNTHESIS OF TWO PT COMPLEXES: CIS-(PH₃P)₂PTCL₂ AND CIS-(PH₃P)₂PTCO₃

Balema VP. Wiench JW. Pruski M. Pecharsky VK. - eChemical Communications. (15):1606-1607, 2002.

Cis-(Ph₃P)₂PtCl₂ and cis-(Ph₃P)₂PtCO₃ were prepared mechanochemically from solid reactants in the absence of a solvent; cis-(Ph₃P)₂PtCl₂ was obtained in 98% yield after ball-milling of polycrystalline PtCl₂ and Ph₃P; the mechanically induced solid-state reaction of cis-(Ph₃P)₂PtCl₂ with an excess of anhydrous K₂CO₃ produced cis-(Ph₃P)₂PtCO₃ in 70% yield; the formation of transition metal complexes as a result of mechanochemical solvent-free reactions has been confirmed by means of solid-state P-31 MAS NMR spectroscopy, X-ray powder diffraction and differential thermal analysis

[14] STUDY ON THE KINETICS OF THERMAL DECOMPOSITION OF MECHANICALLY ACTIVATED PYRITES

Hu HP. Chen QY. Yin ZL. Zhang PM. Zou JP. Che HS. - Thermochemica Acta. 389(1-2):79-83, 2002

The kinetics of the thermal decompositions of mechanically activated pyrite and non-activated pyrite was studied by using Friedman method at different heating rates of 2.5, 5, 7.5 and 15 K min⁻¹ in argon. Results show that the activation energies (E), reaction orders (n) and pre-exponential factors (A) are 268.612 kJ mol⁻¹, 0.42 and 1,094 x 10(15) min⁻¹ for non-activated pyrite, 243.725 kJ mol⁻¹, 0.62 and 2.008 x 10(13) min⁻¹ for pyrite mechanically activated for 20 min (abbreviated as activated pyrite 1, 177.288 kJ mol⁻¹, 0.65 and 5.924 x 10(9) min⁻¹ for pyrite mechanically activated for 40 min (abbreviated as activated pyrite 2, respectively. Comparing the integral width of X-ray diffraction peaks (2θ) and (440) of activated pyrites at different grinding time with that of non-activated pyrite, several values of the deformation (ε) of crystal lattice and the particle size (D) of the crystallite were obtained. It is found that the mechanical activation of the original material brings about a change in surface structure of pyrite, which results in non-activated pyrite's transformation into metastable pyrite in the course of mechanical activation. The metastable pyrite is more liable to thermal decomposition than non-activated pyrite

[13] TRANSFORMATION OF THE DECAGONAL QUASICRYSTALLINE PHASE TO A B₂ CRYSTALLINE PHASE IN THE AL-CU-CO SYSTEM BY HIGH-ENERGY BALL MILLING

Mukhopadhyay NK. Murthy GVS. Murty BS. Weatherly GC. - Philosophical Magazine Letters. 82(7):383-392, 2002

Samples of a decagonal quasicrystalline phase, located in the Al-Cu-Co system and synthesized by a slow cooling technique, have been mechanically milled in a high-energy planetary ball mill for 10, 20 and 30 h. The milled powders, as well as powders that had been annealed (after milling) for times ranging from 30 to 150 min at 600 degrees C, were characterized by X-ray diffraction, scanning electron microscopy and transmission electron microscopy. A phase transformation from the decagonal phase to a B₂ crystalline phase during high-energy ball milling is reported here for the first time. Powders milled for more than 10 h contained predominantly the B₂-type crystalline phase with a lattice parameter of 0.29 nm. This



crystalline phase was found to be quite stable after milling for 30 h and also on subsequent annealing at 600degrees C. These experimental results lend support to an earlier suggestion that the decagonal phase in Al-Cu-Co is actually less stable than the B2 phase at low temperatures

[12] COMPOSITE DEPOSITS BASED ON TITANIUM ALUMINIDE PRODUCED BY PLASMA SPRAYING

Hoshiyama Y. Miyake H. Murakami K. Nakajima H. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 333(1-2):92-97, 2002

A Ti-Al-N composite powder is produced by ball-milling of elemental titanium and aluminum powders in a nitrogen atmosphere, and is plasma-sprayed in an Ar gas atmosphere. yielding titanium aluminide-based deposits. The main constituent of the as-sprayed deposit formed on a directly water cooled substrate is Ti₃Al(alpha(2)), and subsequent heat-treatment of the deposit results in the formation of TiAl (gamma), Ti₂N and Ti₂AlC. There is little difference in hardness between the as-sprayed deposit and the deposits heat-treated at temperatures up to 1473 K. The constituents of the as-sprayed deposit formed on an indirectly water-cooled substrate are alpha(2),gamma and Ti₂N. This as-sprayed deposit is harder than the deposits formed on a directly water-cooled substrate both in the as-sprayed condition and in the heat-treated conditions

[11] MATRIX POOLS IN A PARTIALLY MECHANICALLY ALLOYED TUNGSTEN HEAVY ALLOY FOR LOCALIZED SHEAR DEFORMATION

Hong SH. Ryu HJ. Baek WH. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 333(1-2):187-192, 2002

A fabrication process for a tungsten heavy alloy with matrix pools was suggested in order to increase the susceptibility to localized shear deformation. A partial mechanical alloying process was introduced to form matrix pools intentionally within a tungsten heavy alloy. The partially mechanically alloyed powders were sintered by solid-state sintering, followed by liquid-phase sintering. The volume fraction of matrix pools was decreased with an increase in the secondary liquid-phase sintering time. Penetration test showed that the matrix pools were effective in enhancing the triggering of localized shear deformation.

[10] MECHANOCHEMICAL REDUCTION OF MAGNESIUM FERRITE

Sepelak V. Menzel M. Becker KD. Krumeich F. - - Source Journal of Physical Chemistry B. 106(26):6672-6678, 2002

The changes in magnesium ferrite. MgFe₂O₄, due to high-energy milling in a stainless steel vial have been investigated by Mossbauer spectroscopy, X-ray diffraction, electron microscopy, and thermal analysis. The milling process reduces the average crystallite size of MgFe₂O₄ to the nanometer range. Prolonged mechanical treatment leads to the chemical reduction of MgFe₂O₄ and to the formation of a solid solution of FeO and MgO. In addition to the solid solution, metallic iron has been found as a byproduct. The fraction of the reaction products increases with increasing milling time. The range of thermal stability of the metastable milled reduction products has been determined by studying their response to changes in temperature.

[9] STRUCTURE OF MILLED GALENA (PbS) PARTICLES AS A RESULT OF GRINDING: OBSERVATIONS BY ELECTRON MICROSCOPY

Martinetto P. Castaing J. Walter P. Penhoud P. Veyssiere P. - Journal of Materials Research. 17(7):1601-1611, 2002

We have examined galena powders with the aim of providing information about the preparation mode of such powders from ancient Egyptian burial objects. Two extreme conditions of milling have been used to prepare galena powders in the laboratory, and the resulting products have been examined using scanning electron microscopy and transmission electron microscopy (TEM). The microstructure of hand-crushed coarse particles consists mainly of dislocation tangles. Annealing at 300 degreesC promotes a substantial recovery of the dislocation structure with the formation of subboundaries. Energetic ball milling produces a large variety of particle sizes, from 10 nm to several micrometers, with grains containing very high dislocation densities. Although PbS is a soft plastic compound, its fragmentation occurs down to very small sizes along various fracture regimes like in many brittle materials. Comparisons are made between TEM observations and the data obtained from x-ray diffraction peak profile analysis

[8] COMBUSTION SYNTHESIS OF TIN INDUCED BY HIGH-ENERGY BALL MILLING OF TI UNDER NITROGEN ATMOSPHERE

Gotor FJ. Alcalá MD. Real C. Criado JM. - Journal of Materials Research. 17(7):1655-1663, 2002

A planetary ball-mill device that enables one to perform solid-gas reactions at constant pressure was developed. Titanium powders were ball milled under nitrogen at a spinning rate of 960 rpm. The influence of the nitrogen pressure on the mechanochemical reactivity of titanium was analyzed at 1.5 and 11 bars. A spontaneous combustion took place during the grinding process, leading to a high yield of TiN for short milling times. The conversion of titanium into titanium nitride was facilitated by increasing the nitrogen pressure. At 11 bars, full conversion was reached for grinding times shorter than 5 h. Titanium nitride obtained in this way exhibited a high sintering activity.

[7] MECHANICALLY ALLOYED AMORPHOUS TI-50(CU0.45NI0.55)(44-X)ALXSI4B2 ALLOYS WITH SUPERCOOLED LIQUID REGION

Zhang LC. Xu J. Ma E. - Journal of Materials Research. 17(7):1743-1749, 2002

A high-energy ball milling procedure has been developed to produce amorphous alloys in Ti-50(Cu_{0.45}Ni_{0.55})(44-x)AlSi₄B₂ (X = 0, 4, 8, 12) powder mixtures. The milling products were characterized using x-ray diffraction, differential scanning calorimetry, and transmission electron microscopy. The Ti-based amorphous alloy powders prepared through this solid-state process exhibit a well-defined glass transition and a supercooled liquid region ($\Delta T(x) = 64$ K) close to the largest achieved so far for Ti-based undercooled melts. The substitution of Al for Cu and Ni has beneficial effects on stabilizing the supercooled liquid. Residual nanocrystals of the alpha-Ti structure are uniformly dispersed in the amorphous



matrix. The composite alloy powders offer the potential for consolidation in the supercooled liquid region to bulk lightweight amorphous alloys and the possibility to attain desirable mechanical properties

[6] A STRUCTURAL, MAGNETIC AND MICROWAVE STUDY ON MECHANICALLY MILLED FE-BASED ALLOY POWDERS

Ding J. Shi Y. Chen LF. Deng CR. Fuh SH. Li Y. - Journal of Magnetism & Magnetic Materials. 247(3):249-256, Fe₉₀M₁₀ powders with M = Fe, Co, Ni, Si, Al, Gd, Dy and Nd were prepared by mechanical milling. Their structure and magnetic properties were investigated. Microwave measurements were performed on the mechanically milled Fe₉₀M₁₀ powders. The results were compared with those of carbonyl Fe powders and coarse Fe powder. It has been shown that fine nanocrystalline Fe-based alloy powders prepared by mechanical milling are promising for microwave applications

[5] FE-MN MECHANICALLY ALLOYED POWDERS CHARACTERISED BY LOCAL PROBES

Uhrmacher M. Kulinska A. Baldokhin YV. Tcherdyntsev VV. Kaloshkin SD. Maddalena A. Principi G. - Intermetallics. 10(6):571-578, 2002 Jun.

High-energy ball milling of Fe-Mn elemental powder mixtures has been carried out for Mn atomic concentrations in the range 10-90%. X-ray diffraction (XRD), Mossbauer spectroscopy (MS) and perturbed angular correlations (PAC) have been used to investigate the crystalline structure in the milled samples. It is found that ball milling gives rise to concentration ranges of existence of terminal solid solutions more extended than in the equilibrium phase diagram, Particular attention has been paid to the environment of Fe-57 (MS) and In-111 (PAC) probe atoms: 57Fe atoms are a constituent of the system, while In-111 atoms have been implanted at 400 keV into pills made from the milled powders. The PAC spectra of milled Fe show the ferromagnetic alpha-phase with a high fraction of a single vacancy next to the probe. Accordingly, the Mossbauer spectrum is a sextet with the characteristic splitting of alpha-Fe and a broadening which indicates a certain degree of atomic structure disorder. With an amount of Mn up to 15% PAC probes with one and two Mn next neighbours are identified by their smaller magnetic hyperfine field, corresponding to two distinct magnetic components in the Mossbauer spectra. At 20 and 30% of Mn the PAC magnetic signal of the alpha-phase disappears in favour of a distorted cubic apparently non-magnetic signal, From 40 to 70% of Mn a broad distribution of hyperfine magnetic fields is observed by PAC. Mossbauer spectra in the 20-70% of Mn range can be fitted with an unresolved low field magnetic sextet. Finally, the PAC spectra at 80 and 90% are quite similar to the one which is obtained after milling pure Mn, while the corresponding Mossbauer data can be roughly approximated to those of the alpha-Mn(Fe) solid solution.

[4] REACTIVE MECHANICAL GRINDING APPLIED TO A (TI PLUS NI) MIXTURE AND TO A TINI COMPOUND

Bobet JL. Chevalier B. - Intermetallics. 10(6):597-601, 2002

Reactive mechanical grinding (MG under H-2) was applied to a (Ti + Ni) mixture. After only 1 h, all the titanium is transformed into TiH₂. After 10 h of milling the TiH₂ is nano-structured and it takes approximately 25 h to obtain nano-structured Ni. After 45 h no binary compound is formed between Ti (or TiH₂) and Ni and a very homogeneous nano-structured mixture is formed. The electrochemical capacity is approximately 150 mAh g⁻¹ and almost constant upon cycling, Finally the RMG process of TiNi mixture allows one to obtain a partial conversion of ingot into powder

[3] NUMERICAL SIMULATION OF GAS-FLOW IN BALL MILL

ZY Ren, JZ Lin - PROCEEDINGS OF THE FIFTH INTERNATIONAL CONFERENCE ON FLUID POWER TRANSMISSION AND CONTROL (ICFP'2001), 2001, pp 489-492 - 5TH INTERNATIONAL CONFERENCE ON FLUID POWER TRANSMISSION AND CONTROL (ICFP 2001); HANGZHOU, PEOPLES R CHINA. APRIL 3-5, 2001

The present paper performs the numerical simulation of the gas flow in the coal ball mill with two-way inlet and two-way outlet according to the practical condition of 40.53 type mill. The velocity of inlet gas and the fill ratio of steel balls are studied emphatically. Results obtained provide beneficial reference for milling, drying, choosing and transporting coal powder in the practical product.

[2] MECHANOCHEMICALLY INDUCED SOLID-STATE TRANSFORMATIONS OF COMPLEX ALUMINOHYDRIDES

VK Pecharsky, VP Balema - FUNDAMENTALS OF ADVANCED MATERIALS FOR ENERGY CONVERSION, 2002, pp 95-107 - ANNUAL MEETING OF THE MINERALS-METALS-AND MATERIALS-SOCIETY; SEATTLE, WASHINGTON. FEBRUARY 17-21, 2002

Recent interest in complex aluminohydrides as potential near ambient, ultra-high capacity, solid-state sources of hydrogen (e.g., for fuel cells) calls for an improved understanding of the processes occurring in these hydrogen-containing materials during both the release and the uptake of hydrogen. Lithium aluminohydride (LiAlH₄) rapidly releases 5.2 wt. % of hydrogen (i.e., nearly four times more than LaNi₅-based alloys) during mechanochemical processing at ambient conditions in the presence of transition metal catalysts. Using a variety of solid-state characterization techniques, the mechanochemical transformations in a series of LiAlH₄ - metal catalyst systems have been examined and preliminary insights on the mechanism have been obtained. Surprisingly, the well-known hydrogenating-dehydrogenating catalysts, such as Ni and Pt, are practically inactive in the mechanochemical dehydrogenation of LiAlH₄.

[1] SYNTHESIS OF NANOCRYSTALLINE METAL HYDRIDES BY HIGH TEMPERATURE MILLING

J Huot, R Schulz - FUNDAMENTALS OF ADVANCED MATERIALS FOR ENERGY CONVERSION, 2002, pp 173-181 - ANNUAL MEETING OF THE MINERALS-METALS-AND MATERIALS-SOCIETY; SEATTLE, WASHINGTON. FEBRUARY 17-21, 2002

It has been shown that magnesium-based metal hydrides such as Mg₂Ni could be synthesized by high energy mechanical alloying. This process creates a nanocrystalline, alloy that has enhanced hydrogen sorption proper-ties due to the high density of defects and grain boundaries. Unfortunately, this process also requires a long synthesis time (up to 100 hours in



some cases). In order to reduce processing time and cost of synthesis, we have investigated the effect of milling at elevated temperature under an inert atmosphere. Milling at high temperature improves interdiffusion of the elements and reduces the number of structural defects such as vacancies, dislocations and internal strain. It was found that by milling elemental powders at 200degreesC, a complete synthesis of Mg₂Ni could be achieved in 8 hours. This synthesis time is roughly an order of magnitude lower than that of the process conducted at room temperature. The hydrogen sorption kinetics and capacity of this material are comparable to Mg₂Ni synthesized at room temperature.



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