



**RESEAU FRANÇAIS DE  
MECANOSYNTHESE**

**Lettre N°95**

**Février 2003**

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(dont 115 à l'étranger / 34 Pays)**

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**Bulletin d'adhésion 2003 / Subscription Print**

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**Congress and School Announcements**  
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ISMANAM 2003,  
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Dear Colleagues,

4th International Conference on Mechanochemistry and Mechanical Alloying (INCOME 2003) will be held in Braunschweig, Germany, on 7-11 September 2003 - please mark the date in your diary now!

We cordially invite you to submit your ABSTRACT (deadline: April 15th, 2003) electronically via the website (<http://www.tu-bs.de/INCOME2003>) or by fax or mail.

We also look forward to receive your REGISTRATION. For details, please visit the conference website. All necessary information dealing with the accommodation and payment will be sent to you after your registration.

We do hope that you and your colleagues will be able to attend INCOME 2003 in Braunschweig!

Best regards,

K. D. Becker, V. Sepelak  
Organisers INCOME 2003

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Lettre RFM N°95 - Février 2003  
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## Périodiques / Congrès

### **[32] EFFECTS OF LIFTER BARS ON THE BALL MOTION AND ALUMINUM FOIL MILLING IN TUMBLER BALL MILL**

Hong SH. Kim BK. - Materials Letters. 57(2):275-279, 2002

Effects of lifter bars on the ball motion during ball milling and characteristics of aluminum flake powders prepared by the ball milling of aluminum foil scraps were studied. When rotation speed of milling jar without lifter bar is below 75% of critical revolutions per minute (rpm), balls slide in the jar. As rotation speed of milling jar increases up to 93% and 140%, the mode of balls motion changes to cascading and cataracting type, respectively. By setting even one lifter bar in the jar, balls move as cascading mode and cataracting mode at 37% and 56% of critical rpm, respectively. As number of lifter bars increases, the necessary rotation speeds of milling jar for cascading mode and cataracting mode decrease drastically. The aluminum foils scrap was milled in the milling jar with four lifter bars and without lifter bar under the rotation speeds of jar corresponding to cascading and cataracting modes. That result shows that it is possible to achieve same quality of milled fine powder by using lifter bars even under the significantly lower rotation speeds of jar.

### **[31] THE INFLUENCE OF SULPHUR ON THE PROCESSING OF ZIRCONIA BASED CERAMICS**

Lazar DRR. Menezes CAB. Ussui V. Bressiani AHA. Paschoal JOA. - Journal of the European Ceramic Society. 22(16):2813-2820, 2002

Yttria stabilized zirconia powders were synthesized by the coprecipitation route. Zirconium oxychloride containing Sulphur as contamination and analytical grade yttrium chloride were used as raw materials. Powders were calcined at temperatures between 600 and 1100 degreesC and ground by ball and attrition milling. The ceramic bodies were sintered at 1350 and 1550 degreesC for 1 h and the apparent density was measured. In the present work it is shown that the most deleterious effect of sulphur was observed in 3 mol% yttria stabilized zirconia, especially when the pellets were obtained at high pressures and sintered at 1500 degreesC. The elimination of sulphur at higher calcination temperatures minimizes the effects caused by this contamination, despite the reduction of powder surface area. The best processing condition to obtain high density zirconia ceramics from powders contaminated with Sulphur was established.

### **[30] PROPERTIES OF MECHANICALLY ALLOYED MG-NI-TI TERNARY HYDROGEN STORAGE ALLOYS FOR NI-MH BATTERIES**

Ruggeri S. Roue L. Huot J. Schulz R. Aymard L. Tarascon JM. - Journal of Power Sources. 112(2):547-556, 2002

MgNiTi<sub>x</sub>, Mg<sub>1-x</sub>Ti<sub>x</sub>Ni and MgNi<sub>1-x</sub>Ti<sub>x</sub> (with x varying from 0 to 0.5) alloys have been prepared by high energy ball milling and tested as hydrogen storage electrodes. The initial discharge capacities of the Mg-Ni-Ti ternary alloys are inferior to the MgNi electrode capacity. However, an exception is observed with MgNi<sub>0.95</sub>Ti<sub>0.05</sub>, which has an initial discharge capacity of 575 mAh/g compared to 522 mAh/g for the MgNi electrode. The Mg-Ni-Ti ternary alloys show improved cycle life compared to Mg-Ni binary alloys with the same Mg/Ni atomic ratio. The best cycle life is observed with Mg<sub>0.5</sub>Ti<sub>0.5</sub>Ni electrode which retains 75% of initial capacity after 10 cycles in comparison to 39% for MgNi electrodes, in addition to improved high-rate dischargeability (HRD). According to the XPS analysis, the cycle life improvement of the Mg<sub>0.5</sub>Ti<sub>0.5</sub>Ni electrode can be related to the formation of TiO<sub>2</sub> which limits Mg(OH)<sub>2</sub> formation. The anodic polarization curve of Mg<sub>0.5</sub>Ti<sub>0.5</sub>Ni electrode shows that the current related to the active/passive transition is much less important and that the passive region is more extended than for the MgNi electrode but the corrosion of the electrode is still significant. This suggests that the cycle life improvement would be also associated with a decrease of the particle pulverization upon cycling

### **[29] GRAPHITE-FESI ALLOY COMPOSITES AS ANODE MATERIALS FOR RECHARGEABLE LITHIUM BATTERIES**

Lee HY. Lee SM. - Journal of Power Sources. 112(2):649-654, 2002

Iron-silicon are prepared by annealing elemental mixtures at 1000 degreesC followed by mechanical milling. Graphite-Fe<sub>20</sub>Si<sub>80</sub> alloy composites have been prepared by ball-milling a mixture of Fe<sub>20</sub>Si<sub>80</sub> alloy and graphite powder. The microstructure and electrochemical performance of the composites are characterized by X-ray diffraction and an electrochemical method. The FeSi<sub>2</sub> matrix is stable for extended cycles and acts as a buffer for the active centre, Si. The Fe<sub>20</sub>Si<sub>80</sub> alloy electrode delivers large initial capacity, but the capacity degrades rapidly with cycling. Fe<sub>20</sub>Si<sub>80</sub> alloy-graphite composite electrodes, however, show good cycleability and a high reversible capacity of about 600 mAh g<sup>-1</sup>. These composites appear to be promising candidates for negative electrodes in lithium rechargeable batteries.

### **[28] STUDY OF THE SOLID-STATE 'AMORPHIZATION' REACTION IN FE50RE50 BY MEANS OF MOSSBAUER SPECTROMETRY AND DIFFRACTION MEASUREMENTS**

Randrianantoandro N. Cooper RJ. Greneche JM. Cowlam N. - Journal of Physics-Condensed Matter. 14(41):9713-9724, 2002

The solid-state 'amorphization' reaction produced by the mechanical alloying (MA) of the equiatomic alloy Fe<sub>50</sub>Re<sub>50</sub> has been studied using 57 Fe Mossbauer spectrometry plus x-ray and neutron diffraction. The percentages of iron atoms in the magnetic phases present in the reaction have been obtained from the Mossbauer spectra and the consumption of the parent elements derived from the reduction in intensity of their Bragg peaks in the diffraction patterns. The reaction in the Fe<sub>50</sub>Re<sub>50</sub> alloy appears to be 2-3 times slower than the reaction in the related Fe<sub>58</sub>Ta<sub>42</sub> alloy studied by us previously. A possible reason for this is the presence of an intermediate phase in the reaction revealed by the hyperfine structure at Fe-57. This is identified as an iron-rich solid solution by the absence of any new Bragg peaks in the diffraction patterns. Although a small fraction of the rhenium remains unconsumed at the end of the reaction, the FeRe alloy obtained after 24 h of MA has a genuine amorphous structure, whose reduced radial distribution function G(r) is sensitive to the topological order present

Author e-mail Address shuzhi@ee.uwa.edu.au



**[27] MECHANOCHEMICAL SYNTHESIS AND CHARACTERIZATION OF GAN NANOCRYSTALS**

Cai S. Tsuzuki T. Fisher TA. Nener BD. Dell JM. McCormick PG. - Journal of Nanoparticle Research. 4(4):367-371, 2002

A solid-state displacement reaction of Ga<sub>2</sub>O<sub>3</sub> with Mg<sub>3</sub>N<sub>2</sub> has been used to synthesize GaN nanocrystals by mechanochemical processing. X-ray diffraction, transmission electron microscopy (TEM) and selected area electron diffraction (SAED) measurements indicated that the nanocrystals had a hexagonal structure and sizes ranging from 4 to 20 nm. Optical absorption and transmission measurement showed the bandgap of the nanocrystals was consistent with that of bulk GaN samples (3.43 eV). This study demonstrates that mechanochemical processing has significant potential for the synthesis of GaN nanocrystals in a simple and efficient way.

**[26] PREPARATION OF W-AL ALLOYS BY MECHANICAL ALLOYING**

Tang HG. Ma XF. Zhao W. Yan XW. Hong RJ. - Journal of Alloys & Compounds. 347(1-2):228-230, 2002

W<sub>1-x</sub>Al<sub>x</sub> (x=0-0.86) alloys were synthesized by mechanically alloying the pure metal powder mixtures at designated compositions by conventional high-energy ball milling. The W-Al alloys were stable under high pressure and high temperature. The alloys were lighter than W. The hardness and oxidation resistance of the alloys was greatly improved compared to both W and Al.

**[25] HIGH-PRESSURE HYDROGEN LOADING IN Ti45Zr38Ni17 AMORPHOUS AND QUASICRYSTAL POWDERS SYNTHESIZED BY MECHANICAL ALLOYING**

Takasaki A. Kelton KF. - Journal of Alloys & Compounds. 347(1-2):295-300, 2002

Amorphous and icosahedral phase (i-phase) powders, synthesized directly by mechanical alloying (MA) and after subsequent annealing, respectively, are hydrogenated at a temperature of 573 K and an initial pressure of 3.8 MPa. The i-phase powder contains a Ti<sub>2</sub>Ni-type phase (fcc structure, lattice parameter, a=1.23 nm) as a minor phase. Hydrogen cycling for the i-phase powder decreases the coherence length and enhances the formation of an fcc hydride phase, namely (Ti, Zr)H<sub>2</sub>. The amorphous powder, which transforms to the fcc hydride after hydrogenation, is transformed primarily into a Ti<sub>2</sub>Ni-type crystal phase and a small amount of the i-phase after hydrogen desorption. Hydrogen cycling and mechanical alloying in a hydrogen gas atmosphere dramatically reduces the loading time of hydrogen for both the i-phase and the amorphous powders

**[24] ZINC NIOBATE DERIVED FROM MECHANOCHEMICALLY ACTIVATED OXIDES**

Kong LB. Ma J. Huang H. Zhang RF. Zhang TS. - Journal of Alloys & Compounds. 347(1-2):308-313, 2002

ZnO and Nb<sub>2</sub>O<sub>5</sub> mixtures partially reacted to form ZnNb<sub>2</sub>O<sub>6</sub> during a high-energy ball milling process after milling for 5-15 h. The milled powders were extremely active and almost single phase ZnNb<sub>2</sub>O<sub>3</sub> could be achieved at a temperature as low as 500 degreesC. The effect of post-annealing on the grain growth and microstructure of the milled powders was investigated and discussed. Fully dense ZnNb<sub>2</sub>O<sub>6</sub> ceramics with an average grain size of 5, 3.5 and 2.4 μm can be obtained at 1100 degreesC from the powders milled for 5, 10 and 15 h, respectively.

**[23] CYCLING AND THERMAL STABILITY OF NANOSTRUCTURED MgH<sub>2</sub>-Cr<sub>2</sub>O<sub>3</sub> COMPOSITE FOR HYDROGEN STORAGE**

Dehouche Z. Klassen T. Oelerich W. Goyette J. Bose TK. Schulz R. - Journal of Alloys & Compounds. 347(1-2):319-323, 2002

This paper presents investigations on the long-term cycling stability as well as the thermal stability of the hydriding-dehydriding properties of nanostructured MgH<sub>2</sub> with 0.2 mol.% Cr<sub>2</sub>O<sub>3</sub> catalyst additions synthesized by ball milling. The hydrogen charge and discharge stability of the nanocomposite hydride has been tested at 300 degreesC for up to 1000 cycles. Between the first and the 500 or 1000 cycle, an increase of hydrogen storage capacity by about 8% is observed in dynamic and pCT measurements. This is attributed to structural relaxations and crystallite growth. While absorption kinetics remain almost as fast as in the first cycle, the kinetics curves show a significant and systematic slow-down of the desorption rates by about a factor of four. Evaluation of X-ray patterns before and after 1000 cycles reveals crystallite growth from initially 21 nm to 84 nm after 1000 cycles. This microstructural coarsening during cycling may explain the decreasing desorption rate of the nanocrystalline magnesium based composite. Annealing experiments of the as-milled material show, that the microstructural coarsening is rather slow at temperatures up to 350 degreesC, while exposure to 400 degreesC over 55 h leads to coarsening of the crystallite size and concomitant loss of the excellent kinetic properties.

**[22] ELECTROCHEMICAL LITHIUM EXTRACTION FROM BETA-LITHIUM NITRIDE**

Prosini PP. Cardellini F. - Electrochemistry Communications. 4(11):853-856, 2002

In this paper we report the electrochemical characterization of mixtures of ball-milled lithium nitride and iron metal. Several samples were prepared with different lithium nitride to iron molar ratios. X-ray diffraction (XRD) spectra showed the presence of iron metal in all the samples and beta-lithium nitride in the samples with higher Li<sub>3</sub>N/Fe ratio. No evidence of other phases was detected. The milled powders were used to prepare composite cathodes for the electrochemical characterization. It was found that lithium can be extracted from the materials at a flat potential of 1.2 V vs. Li. The sample with Li<sub>3</sub>N/Fe molar ratio 8:1 showed the highest specific capacity (1125 mAh g<sup>-1</sup>) corresponding to the extraction of 1.8 Li equivalents per mole of lithium nitride. Only a fraction of the lithium extracted was re-inserted in the following discharge cycle. A drastic reduction of the capacity was observed for all the samples on further cycling. An enhancement of the cyclability was obtained by lowering the end-charge voltage that resulted in a reduction of the lithium extracted. The lithium extraction/insertion process was characterized by a large voltage difference indicating that the reaction is largely irreversible

**[21] BALL-MILLING: THE BEHAVIOR OF GRAPHITE AS A FUNCTION OF THE DISPERSAL MEDIA**

Janot R. Guerard D. - Carbon. 40(15):2887-2896, 2002.



The ball-milling in liquid media leads to well organized, thin and highly anisometric graphite (HAG) crystals. The presence in the milling container of a liquid, which acts as a lubricant and decreases the violence of the shocks, is relevant. Two liquids are used: n-dodecane and water. With dodecane, inert towards graphite and the metal of the milling tools, the powder consists of pure graphite whereas with water, the graphite particles are covered with nanocrystallites (15 nm) of a magnetic compound: the maghemite ( $\gamma\text{Fe}_2\text{O}_3$ ). The electrochemical properties of those powders are interesting. The highly anisometric graphite leads to an irreversible capacity around half of that for the initial graphite powder, in contradiction with previous results claiming that higher the surface area, the higher the irreversible capacity. In fact, milling in the presence of dodecane provokes essentially a cleavage, which increases the global area, but does not drastically change the number of edge carbon atoms, responsible for the increase of the large irreversible capacity. The graphite-maghemite composites present a high capacity, partly reversible by oxidation-reduction between iron and wustite ( $\text{FeO}$ ). This reaction is made possible by the nanometric size of the particles, and therefore their high reactivity

**[20] THE STRUCTURE AND THERMAL STABILITY OF MECHANICALLY ALLOYED NI-NB-ZR AMORPHOUS ALLOYS**  
Enayati MH. Schumacher P. Cantor B. - Journal of Materials Science. 37(24):5255-5259, 2002

Ni<sub>80</sub>Nb<sub>20</sub>, Ni<sub>60</sub>Nb<sub>40</sub>, Ni<sub>40</sub>Nb<sub>60</sub>, Ni<sub>60</sub>Nb<sub>20</sub>Zr<sub>20</sub> and Ni<sub>60</sub>Zr<sub>40</sub> amorphous alloys were prepared by mechanical alloying. The structure and thermal behaviour of the amorphous alloys were studied by X-ray diffractometry and differential scanning calorimetry and were compared to corresponding melt spun materials. In Ni-Nb amorphous alloys the mean nearest-neighbour distance and the thermal stability both increase with increasing Nb content. Substitution of Nb by Zr in Ni<sub>60</sub>Nb<sub>40</sub> amorphous alloy also increases the mean nearest-neighbour distance, but reduces the thermal stability

**[19] AN INVESTIGATION OF THE MICROSTRUCTURE OF A CRYOGENICALLY MECHANICALLY ALLOYED POLYCARBONATE-POLY(ARYL ETHER ETHER KETONE) SYSTEM**

Martin JP. McCartney SR. Kander RG. - Journal of Materials Science. 38(2):195-200, 2003

This work investigates processing-microstructure relationships of a model cryogenically mechanically alloyed polymer-polymer system consisting of polycarbonate (PC) and poly(aryl ether ether ketone) (PEEK). Powders mechanically alloyed for 10 hours were imaged via transmission electron microscopy (TEM) and were shown to have a two-phase microstructure physically mixed on a sub-micron level. These powders were processed into coupons using a laboratory scale ram-injection molder, and the resulting microstructure of the coupons was investigated as a function of mechanical alloying and injection molding parameters. Atomic force microscopy, TEM, and scanning transmission X-ray microscopy all revealed that the intimate blending achieved during the mechanical alloying process was not retained upon post-processing using this conventional polymer processing technique

**[18] ELECTROCATALYTIC PROPERTIES OF MECHANICALLY ALLOYED CO-20WT%NI-10WT%MO AND CO-70WT%NI-10WT%MO ALLOY POWDERS**

Arce-Estrada EM. Lopez-Hirata VM. Martinez-Lopez L. Dorantes-Rosales HJ. Saucedo-Munoz ML. Hernandez-Santiago F. - Journal of Materials Science. 38(2):275-278, 2003

Mechanically alloyed Co-20wt%Ni-10wt%Mo and Co-70wt%Ni-10wt%Mo (nominal compositions) alloy powders were produced by milling of pure elemental powders. Mechanically alloyed powders were characterized by X-ray diffraction, scanning electron microscopy and transmission electron microscopy. MA powder specimens were tested electrochemically in a 30% KOH aqueous solution at 298 K. X-ray diffraction analysis and transmission electron microscopy of milled powders showed the presence of two phases, an fcc solid solution and intermetallic compounds of Ni or Co with Mo. These phases showed a nanometric size. The linear sweep voltammograms confirmed also the presence of two phases in both mechanically alloyed alloy powders. The Co-20wt%Ni-10wt%Mo alloy powders showed the best electrocatalytic activity for hydrogen evolution reaction

**[17] THE EFFECT OF MECHANICAL MILLING ON THE SOLID STATE REACTIONS IN THE BARIUM OXALATE-IRON(III) OXIDE SYSTEM**

Berbenni V. Marini A. Welham NJ. Galinetto P. Mozzati MC. - Journal of the European Ceramic Society. 23(1):179-187, 2003

The formation of barium hexaferrite, BaFe<sub>12</sub>O<sub>19</sub>, from a 1:6 molar ratio mixture of barium oxalate and iron oxide has been investigated. Thermogravimetry (TGA), high temperature X-ray powder diffraction (HT-XRPD), differential scanning calorimetry (DSC) and micro-Raman spectroscopy have been used to determine the effect of mechanical activation on the solid state reactions occurring during heating. The resulting magnetic properties were investigated measuring hysteresis loops. For the activated mixtures, the mass loss is over at approximate to 600 degreesC i.e. well below the temperature where BaCO<sub>3</sub> spontaneous decomposition is complete (T>850 degreesC). Such a noticeable temperature lowering is a consequence of the high energy milling enhancing the formation of BaFe<sub>2</sub>O<sub>4</sub>. After heating the milled mixture to 850 degreesC, BaFe<sub>12</sub>O<sub>19</sub> was rapidly formed from the BaFe<sub>2</sub>O<sub>4</sub> and residual Fe<sub>2</sub>O<sub>3</sub>. Starting from an unmilled mixture, only minor amounts of BaFe<sub>12</sub>O<sub>19</sub> were formed by heating to 850 degreesC. The favourable formation of barium hexaferrite, when starting from milled powders, has been confirmed by micro-Raman spectroscopy. The powder from the activated sample was shown to have far better magnetic properties than the unactivated sample

**[16] FORMATION OF TITANIUM CARBIDE/ALUMINUM OXIDE NANOCOMPOSITE POWDER BY HIGH-ENERGY BALL MILLING AND SUBSEQUENT HEAT TREATMENT**

Li JL. Li F. Hu K. - Journal of the American Ceramic Society. 85(11):2843-2845, 2002

The preparation of titanium carbide/aluminum oxide (TiC/Al<sub>2</sub>O<sub>3</sub>) nanocomposite powders from a mixture of titanium, carbon, and Al<sub>2</sub>O<sub>3</sub> powders via a high-energy ball milling process and subsequent heat treatment was investigated. The



microstructure development of the powder mixtures was monitored by X-ray diffraction and transmission electron microscopy. The ball milling of an elemental carbon, titanium, and Al<sub>2</sub>O<sub>3</sub> powder mixture at ambient temperature resulted in the formation of TiC within 15 h of milling. With further milling of up to 25 h, the resulting powder mixture was composed of nanosized TiC particles and nanocrystalline carbon, titanium, and Al<sub>2</sub>O<sub>3</sub>. The nanocrystalline titanium and carbon were transformed into nanosized TiC particles after subsequent heat treatment. The final product was composed of nanosized TiC and microcrystalline Al<sub>2</sub>O<sub>3</sub>. Most of the nanosized TiC particles were located within Al<sub>2</sub>O<sub>3</sub> grains

**[15] SLATER-PAULING CURVE OF FE-CU SOLID SOLUTION ALLOYS**

Mashimo T. Huang XS. Fan X. Koyama K. Motokawa M. - Physical Review B. 6613(13):2407, 2002

Magnetization measurement was performed on bulk samples of metastable solid solution alloys with bcc and fcc structures in the iron (Fe)-copper (Cu) system, which were prepared by mechanical alloying and shock compression. The saturation magnetic-moment (M-S) curve versus number of electrons per atom at 0 K was found to be reasonably similar to the Slater-Pauling curve of other transition-metal binary systems. The M-S curve shows a local maximum at about 26.2 electrons per atom similar to the cases of Fe-Co and Fe-Ni systems, and approaches zero at about 28.6 electrons per atom. Negative curvature is seen around the boundary between the mixed phase region (bcc and fcc) and the fcc phase in a Cu content of about 35 mol % (about 27.1 electrons per atom).

**[14] SELF-PROPAGATING REACTION INDUCED BY BALL MILLING IN A MIXTURE OF CU<sub>2</sub>O AND AL POWDERS**

Bakhshai A. Pragani R. Takacs L. - Metallurgical & Materials Transactions A-Physical Metallurgy & Materials Science. 33(11):3521-3526, 2002

The mechanochemical reduction of Cu<sub>2</sub>O with Al was induced via ball milling. A self-propagating reaction took place in two distinctly different ways. If the mass of the reactant powder mixture was large enough, ignition happened within a few seconds after starting the mill. Neither the activation of the reactants nor the formation of a powder layer covering the surfaces of the milling tools were necessary. If the mass of the charge is smaller than a critical value, the self-propagating reaction is ignited only after several minutes of mechanical activation. A slight excess of Al promoted an immediate reaction. The mechanism of the process is determined by the balance of the reaction heat, the heat transfer within the powder, and the heat loss to the environment. Local melting plays an important role, especially by promoting the formation of partially molten aggregates from free particles

**[13] MECHANICAL, INTERGRANULAR CORROSION, AND WEAR BEHAVIOR OF ALUMINUM-MATRIX COMPOSITE MATERIALS REINFORCED WITH NICKEL ALUMINIDES**

Da Costa CE. Velasco F. Torralba JM. - Metallurgical & Materials Transactions A-Physical Metallurgy & Materials Science. 33(11):3541-3553, 2002

This article presents experimental results of important properties of aluminum-matrix (AA 2014) composite materials reinforced with different intermetallics of the Ni-Al system. For the present study, the intermetallics: are prepared either by mechanical alloying (MA) or by gas atomization (GA). The reinforced composite materials were manufactured by mixing the constituents,, followed by uniaxial compacting of a preform and subsequent extrusion without canning or degassing. The present study considered the materials in the extruded state and after T6 heat treatment. Assessments were made from the viewpoint of microstructure (by means of optical and scanning electron microscopy (SEM)) and thermal characteristics (by differential scanning calorimetry (DSC), with special emphasis on studying the reactions that take place between the matrix and the reinforcement and which produce a highly copper-enriched interphase. A study was also made of the effect of this reactivity on the mechanical properties and wear behavior of the composite materials, as well as the intergranular corrosion resistance of the materials in the extruded state.

**[12] STRUCTURE AND PROPERTIES OF AMORPHOUS AND NANOCRYSTALLINE NITITI PREPARED BY SEVERE PLASTIC DEFORMATION AND ANNEALING**

Sergueeva AV. Song C. Valiev RZ. Mukherjee AK. - Materials Science & Engineering A-Structural Materials Properties Microstructure & Processing. 339(1-2):159-165, 2003

The formation of homogeneous nanocrystalline structure by nanocrystallization of amorphous NiTi subjected to high pressure torsion is demonstrated. Structural evolution during annealing was investigated and homogeneous nanocrystalline structures with different grain sizes have been obtained by controlled annealing. Nanocrystallization results in the record value of room temperature strength for this material equal to 2650 MPa with an elongation to failure of about 5%. At elevated temperatures of (0.4...0.5) T-m nanocrystalline nitinol showed a high ultimate strength with sufficient elongation (up to 200%). The observation that the shape and the size of grains after deformation remain close to that of the initial state suggests that in nanocrystalline NiTi such mechanism as grain boundary sliding and grain rotation are active and the generation and motion of dislocations play the role of accommodation of stress concentration

**[11] FORMATION OF TITANIUM CARBIDE/ALUMINUM OXIDE NANOCOMPOSITE POWDER BY HIGH-ENERGY BALL MILLING AND SUBSEQUENT HEAT TREATMENT**

Li JL. Li F. Hu K. - Journal of the American Ceramic Society. 85(11):2843-2845, 2002

The preparation of titanium carbide/aluminum oxide (TiC/Al<sub>2</sub>O<sub>3</sub>) nanocomposite powders from a mixture of titanium, carbon, and Al<sub>2</sub>O<sub>3</sub> powders via a high-energy ball milling process and subsequent heat treatment was investigated. The microstructure development of the powder mixtures was monitored by X-ray diffraction and transmission electron microscopy. The ball milling of an elemental carbon, titanium, and Al<sub>2</sub>O<sub>3</sub> powder mixture at ambient temperature resulted in the formation of TiC within 15 h of milling. With further milling of up to 25 h, the resulting powder mixture was composed of nanosized TiC particles and nanocrystalline carbon, titanium, and Al<sub>2</sub>O<sub>3</sub>. The nanocrystalline titanium and



carbon were transformed into nanosized TiC particles after subsequent heat treatment. The final product was composed of nanosized TiC and microcrystalline Al<sub>2</sub>O<sub>3</sub>. Most of the nanosized TiC particles were located within Al<sub>2</sub>O<sub>3</sub> grains

**[10] A SIMPLE METHOD FOR THE SYNTHESIS OF SILICON CARBIDE NANORODS**

Kholmanov IN. Kharlamov A. Barborini E. Lenardi C. Li Bassi A. Bottani CE. Ducati C. Maffi S. Kirillova NV. Milani P. - Journal of Nanoscience & Nanotechnology. 2(5):453-456, 2002

SiC nanorods were synthesized by a reaction at a temperature of 1200 degreesC, under an argon gas atmosphere, from silicon and amorphous carbon powders mixed by ball milling. The reaction product, which contain SiC nanorods and nanoparticles, has been characterized by high-resolution transmission electron microscopy, X-ray diffraction, and micro-Raman spectroscopy. The synthesized nanorods are more than 1 µm long with a mean diameter of about 10-30 nm. The nanorods possess a well-defined crystalline structure with a thin layer of amorphous SiO<sub>2</sub> on the surface. Raman shifts of SiC nanorods and the role of structural defects are discussed.

**[9] EVOLUTION OF THE MOSSBAUER RECOILLESS FRACTION DURING MECHANOCHEMICAL ACTIVATION OF IRON OXIDES**

Sorescu M. - Journal of Materials Science Letters. 21(22):1759-1761, 2002

**[8] BALL TEMPERATURES DURING MECHANICAL ALLOYING IN PLANETARY MILLS**

Kwon YS. Gerasimov KB. Yoon SK. - Journal of Alloys & Compounds. 346(1-2):276-281, 2002

A simple calorimetric technique was used to estimate the temperature of balls during mechanical alloying (MA) in an AGO-2 planetary ball mill. Temperatures up to 600 degreesC were realized for balls in the case that compact layers of milled powder are formed on the surface of the balls and the wall of the vial. Though free powders in the vial would decrease the temperature of the balls, it was found that a difference in temperature between the balls and the vial still exists. This should be taken into account in the analysis of temperature effects during MA. An influence of the temperature of the balls on the MA process of Mg<sub>67</sub>Ni<sub>33</sub> and Ni<sub>50</sub>Al<sub>50</sub> powder blends was demonstrated.

**[7] ELECTROCHEMICAL BEHAVIOUR OF HIGH-ENERGY BALL-MILLED TIFE ALLOY**

Jankowska E. Jurczyk M. - Journal of Alloys & Compounds. 346(1-2):L1-L3, 2002

The effect of high-energy ball-milling (HEBM) on the electrochemical properties of TiFe electrode material has been investigated. The discharge capacity of HEBM TiFe material increased from 0 to 64 mA h g<sup>-1</sup> (at 4 mA g<sup>-1</sup> discharge current). HEBM is effective for the improvement in activation behaviour of TiFe electrode material, due to the reduction in the particle size and to the creation of new clean surfaces.

**[6] THE EFFECT OF MECHANICAL TREATMENT ON COLLOIDAL AND CHEMICAL PROPERTIES AND REACTIVITY OF POWDERED CELLULOSE**

Prusov AN. Zheleznov KN. Alekseeva OV. Padokhin VA. Rozhkova V. - Colloid Journal. 64(5):601-604, 2002

The effect of mechanical activation on colloidal and chemical properties of aqueous dispersions of powdered cellulose (particle size, electrokinetic parameters, surface electrical properties, adsorption, etc.) and its solubility in a methylmorpholine N-oxide monohydrate-dimethyl sulfoxide mixture is studied. A rise in the number of mechanical treatment cycles increases the surface charge density, adsorbability, and solubility of cellulose, but decreases particle size and electrophoretic mobility, as well as the viscosity of cellulose solutions due to a reduction in the degree of cellulose polymerization, development of microporosity, and a rise in the internal surface area of polymer particles as a result of their disintegration.

**[5] SULPHIDIZATION OF METAL OXIDES BY MEANS OF MECHANOCHEMICAL SOLID REACTION**

Zhang QW. Wang J. Saito F. Okura T. Nakamura I. - Chemistry Letters. (11):1094-1095, 2002

Co-grinding nonferrous metal oxides and sulphur together with iron/aluminium metal stimulates a solid-state reaction to form the nonferrous metal sulphides and iron/aluminium oxide, allowing the use of the current mineral processing technologies to recover metals from various kinds of wastes

**[4] ELECTRON MICROSCOPY NANOSCALE CHARACTERIZATION OF BALL-MILLED CU-AG POWDERS. PART I: SOLID SOLUTION SYNTHESIZED BY CRYO-MILLING**

Zghal S. Hytch MJ. Chevalier JP. Twesten R. Wu F. Bellon P. - Acta Materialia. 50(19):4695-4709, 2002

We present a study of nanostructured Cu-Ag material obtained by low temperature ball milling. The microstructural characterization is carried out using a wide variety of transmission electron microscopy (TEM) techniques from conventional dark-field imaging, selected area diffraction and energy dispersive X-ray spectrometry (EDS) to more modern techniques of scanning TEM high-angle dark-field imaging (HAADF), nanodiffraction and high resolution imaging (HREM). A novel method of HREM image analysis is also presented which consists of calculating geometric phase images by Fourier filtering. Real-space maps of lattice spacings and lattice rotations are thus obtained. The analysis addresses the following essential points of nanostructural characterization: dislocation densities, grain sizes and morphologies, grain boundaries and local lattice rotations, local textures, local variations in lattice parameters. A new description of the microstructure emerges from the observations, quite different to that expected. Analytical modeling suggests that large lattice rotations can be expected in nanomaterials produced by intense deformation.

**[3] ELECTRON MICROSCOPY NANOSCALE CHARACTERIZATION OF BALL MILLED CU-AG POWDERS. PART II: NANOCOMPOSITES SYNTHESIZED BY ELEVATED TEMPERATURE MILLING OR ANNEALING**

Zghal S. Twesten R. Wu F. Bellon P. - Acta Materialia. 50(19):4711-4726, 2002

Microstructures and phases stabilized at steady state by variable temperature ball milling of Cu<sub>50</sub>Ag<sub>50</sub> powders are characterized using transmission and scanning transmission electron microscopy. Starting from chemically mixed and cold-



worked powders obtained by room temperature milling, it is shown that, upon increasing the milling temperature, the material first decomposes into Cu-rich and Ag-rich solid solutions, and then recrystallizes. A similar sequence is observed during the static annealing of the solid solution precursor. In both cases, Cu-Ag nanocomposites are synthesized, at a scale of a few nanometers in the unrecrystallized state, and at a scale ranging from 30 nm after dynamic recrystallization to 75 nm after static recrystallization. These nanocomposites exhibit high hardness values, approaching 6 GPa. Interestingly enough, recrystallization leads to an increase in the hardness of these materials

**[2] MECHANO-CHEMICAL FUNCTIONALIZATION OF CARBON NANOTUBES**

K Niesz, Z Konya, I Vesselenyi, A Fonseca, JB Nagy, I Kiricsi - STRUCTURAL AND ELECTRONIC PROPERTIES OF MOLECULAR NANOSTRUCTURES (Series: AIP CONFERENCE PROCEEDINGS), 2002, Vol 633, pp 82-85 - 16TH INTERNATIONAL WINTERSCHOOL ON ELECTRONIC PROPERTIES OF NOVEL MATERIALS; KIRCHBERG, AUSTRIA. MARCH 2-9, 2002

Short, functionalized multiwall carbon nanotubes were prepared by a simple mechano-chemical way. The fundamental idea of our method is breaking of the nanotubes under reactive gas atmosphere such as CO, COCl<sub>2</sub>, Cl<sub>2</sub>, NH<sub>3</sub>, CH<sub>3</sub>SH in a ball mill. During this ball milling procedure the tube length decreased to 200-300 run, while the specific surface area increased by about 20% and the inner pore of the nanotubes became accessible.

**[1] MECHANICAL CUT OF CARBON NANOTUBES**

K Niesz, Z Konya, I Vesselenyi, A Fonseca, JB Nagy, I Kiricsi - STRUCTURAL AND ELECTRONIC PROPERTIES OF MOLECULAR NANOSTRUCTURES (Series: AIP CONFERENCE PROCEEDINGS), 2002, Vol 633, pp 100-102 - 16TH INTERNATIONAL WINTERSCHOOL ON ELECTRONIC PROPERTIES OF NOVEL MATERIALS; KIRCHBERG, AUSTRIA. MARCH 2-9, 2002

Ball milling technique is a very efficient way of breaking carbon nanotubes. After 100 hour grinding the length of the tubes decrease to 200-300 run although the final material contains high-density particles, thus further purification method is necessary. We present a purification method using KMnO<sub>4</sub> to destruct the particles and form well separated nanotubes.

