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MINISTRY OF EDUCATION, YOUTH AND SPORTS
OP Education for Competitiveness
INVESTMENTS IN EDUCATION DEVELOPMENT

Nanoteam VSB – TU Ostrava

CZ.1.07/2.3.00/20.0038

COMTES FHT®
Complete Technological Service - Forming, Heat Treatment

NOTICE

WORKSHOP

„What I have to offer“

2nd – 4th February 2012

Hotel Raztoka Trojanovice, Trojanovice, Czech Republic

Location: Hotel Raztoka Trojanovice

The project: Creation of an international team of scientists and participation in scientific networks in the sphere of nanotechnology and unconventional forming material

Registration number: CZ.1.07/2.3.00/20.0038, ref. 25619/2010-461

Term of realization: from 1. 6. 2011 to 31. 5. 2014

Preliminary topic:

- Methods of nano- and ultra-fine grain refinements and their characterization
- Development of UFG and nano-materials for the needs of industrial practice
- Simulation of technological processes

INVESTMENTS IN EDUCATION DEVELOPMENT

GENERAL INFORMATION

Dates: 2nd – 4th February 2012

Location: Hotel Raztoka Trojanovice, Trojanovice, Czech Republic

Language: English

REGISTRATION OF LECTURES

Abstracts (extent 200 - 250 words) with keywords in English have to be sent at the latest on the 15th January 2012 by e – mail to the address **stanislav.rusz@vsb.cz**. The paper without an abstract it can not be included into the workshop program.

FORMAT OF PAPERS

Papers for workshop proceedings must be sent at the latest on 31st March 2012 by e – mail to the address **stanislav.rusz@vsb.cz**. Extent of papers is max. 6 pages including images, text format - according to the attached template.

INSTRUCTIONS FOR PRESENTATION

Duration of the presentation is 20 min + 5 min for discussion. Format of presentation - according to the attached template.

IMPORTANT DATES AND DEADLINES

Deadline for sending of abstracts **15th January 2012**

Deadline for sending of papers **31st March 2012**

I hope that you will accept my invitation to the workshop.

prof. Ing. Stanislav Rusz, CSc.

CONTACT PERSON

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This project is financed by the European Social Fund and state budget of the Czech Republic.


VŠB–Technical University of Ostrava
Creation of an international team of scientists and participation in scientific networks in the sphere of nanotechnology and unconventional forming materials
Registration number : CZ.1.07/2.3.00/20.0038
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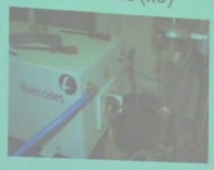
CZ.1.07/2.3.00/20.0038
Presentation of
ICMPE-Institute of chemistry and Materials science of Paris-East
CNRS-National Research Center for Science, France
University of Paris-East, Créteil
Director, Dr. Michel Latroche, CNRS Research Director
Dr. HDR Patrick OCHIN, CNRS Research Engineer
Dr. HDR Yannick Champion, CNRS Research Director
Group Microstructure Metallugy and ceramics
2 February 2012

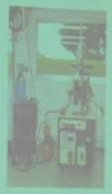
Alloys preparation and processing

Cold crucible (x6)

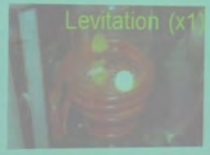


Ball Milling (x4)

Electric arc furnace(x2)



Levitation (x1)



Melt Spinning (x1)

Twin Roll Casting (x1)

10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OF THE POLISH ACADEMY OF SCIENCES
The Institute is one of the leading research centres in Poland in the field of fundamental and applied materials science. The research activities correspond to the priorities of Ministry of Science, Polish Academy of Sciences, 6th and 7th Frame-work Programs of the European Community. The research is performed based of long-term co-operation with large number of scientific institutions in Poland and such countries as: Austria, Canada, France, Germany,, Hungary, Israel, Japan, Russia, Spain, Slovakia, USA, Japan and Korea. The Institute employs 90 persons, including 36 scientific staff: 8 professors with tenure, 7 associate professors (with D.Sc.), 18 assistant professors (with Ph.D.), 3 research assistant (stand for 2011). The Institute is authorized to confer Ph.D. and D.Sc. degrees in the field of metallurgy and materials science. PhD studies in materials science are are carried out together with Jagiellonian University
CZ.1.07/2.3.00/20.0038


Prof. Dr. Gerhard Wilde
Dr. Patrick Ochin


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Creation of an international scientific team and incorporation to scientific networks in the area of nanotechnology and unconventional forming material.
CZ.1.07/2.3.00/20.0038
Presentation of COMTES FHT a.s. and WBCMM
Dr. Michal Zemko
2 February 2012


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Towards multifunctional bulk nanostructures: grain boundary structur
and grain boundary diffusivity of severe
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CZ.1.07/2.3.00/20.0038
Production of nanosized
metallic powders
at ICMPE
Patrick OCHIN


STROJ-SPORT
Trutnov
POČET KOL
HODY
START
STOP
Dr. Yannick Champion
prof. Ing. Jozef Zrnik, CSc.


Outlines


VŠB-Technical University of Ostrava
Creation of an international team of scientists and participation in scientific networks in the sphere of nanotechnology and unconventional forming materials


VŠB-Technical University of Ostrava

INVESTMENTS IN EDUCATION DEVELOPMENT

Workshop „What I have to offer“

2nd – 4th February 2012

Project name: Creation of an international team of scientists and participation in scientific networks in the sphere of nanotechnology and unconventional forming material.

Registration number: CZ.1.07/2.3.00/20.0038

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Workshop „Co můžu nabídnout“

2. – 4. Únor 2012

Název projektu: Tvorba mezinárodního vědeckého týmu a zapojování do vědeckých sítí v oblasti nanotechnologií a nekonvenčního tváření materiálu

Číslo projektu: CZ.1.07/2.3.00/20.0038

1. WORKSHOP

What I have to offer

Obr. 1 Přední strana Sborníku abstraktů z 1. Workshopu na téma What I have to offer.

Obr. 2 Zadní strana Sborníku abstraktů z 1. Workshopu na téma What I have to offer.

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INVESTMENTS IN EDUCATION DEVELOPMENT

International Nanoteam of VŠB – TU Ostrava

CZ.1.07/2.3.00/20.0038

WORKSHOP

„What I have to offer“

2nd – 4th February 2012

ABSTRACT PROCEEDINGS

Hotel Raztoka *, Trojanovice, Czech Republic**

Project name:	Creation of an international team of scientists and participation in scientific networks in the sphere of nanotechnology and unconventional forming material.
Program:	Operational Programme Education for Competitiveness
Priority Programme:	2 - Tertiary Education, Research and Development
Support area:	2.3 - Human resources in research and development
Registration number:	CZ.1.07/2.3.00/20.0038
Project start date:	1. June 2011
Project closing date:	31. May 2014
Project applicant:	VŠB - TU Ostrava
Project partner:	COMTES FHT a.s.
Administrative team:	The main project manager – prof. Ing. Stanislav Rusz, CSc. Material manager (Project coordinator) – Ing. Jan Kedroň Finance manager – Ing. Stanislav Tylšar

Nanoteam VSB – TU Ostrava
CZ.1.07/2.3.00/20.0038

WORKSHOP

„What I have to offer“

Collection of abstracts

2nd – 4th February 2012
Hotel Raztoka Trojanovice
Trojanovice, Czech Republic

This publication is in its original form without editorial and stylistic correction.

Programme

Thursday 02. 02. 2012

10.^{00} – 13.^{00} **Registration**

12.^{00} – 13.^{15} **Lunch**

13.^{15} – 16.^{30} **Accompanying program, visit of the mountain site "Pustevny"**

16.^{30} – 17.^{00} **Refreshment**

17.^{00} – 18.^{40} Introduction of the participants to the project and basic elements of solution

- presentation of the VŠB – Technical University of Ostrava (prof. Rusz)
- presentation of the Münster University (prof. Wilde)
- presentation of the ICMPE-CNRS Institut de Chimie et des Matériaux Paris Est (prof. Champion, prof. Ochin)
- presentation of the Institute of Metallurgy and Materials Science of the Polish Academy of Sciences Kraków (prof. Dutkiewicz)
- presentation of the Czestochowa - Technical University (prof. Dyja)
- presentation of the Technical University of Žilina (doc. Donič)
- presentation of the COMTES FHT. (Dr. Zemko)
- presentation of the SVUM a.s. Prague (prof. Očenášek)

18.^{40} – 19.^{00} **Discussion**

19.^{30} – 23.^{00} **Social evening**, an exchange of experience with development of production technology for UFG materials

Friday 03. 02. 2012

Section: „Methods of nano- and ultra-fine grain refinements and their characterization“

Chairmen: prof. Dutkiewicz, doc. Donič

(20 min presentation + 5 min discussion)

09.^{30} – 09.^{55}	***Towards multifunctional bulk nanostructures: grain boundary structure and grain boundary diffusivity of severely strained alloys***, prof. Gerhard Wilde, University of Münster, Germany
09.^{55} – 10.^{20}	***Effect of grain refinement in magnetocaloric Huesler alloys,*** Dr. Wojciech Maziarz, Institute of Metallurgy and Materials Science of the Polish Academy of Sciences Kraków, Poland
10.^{20} – 10.^{45}	***Production of nano-sized metallic powders,*** prof. Patrick Ochin, ICMPE-CNRS Institut de Chimie et des Matériaux Paris Est, France#
10.^{45} – 11.^{10}	***Processing and characterization of nano-sized metallic powders and fine grained metals,*** prof. Yannick CHampion, ICMPE-CNRS Institut de Chimie et des Matériaux Paris Est, France
11.^{10} – 11.^{25}	**Coffee break**
11.^{25} – 11.^{50}	***Aluminum alloy and silver base nanocomposites obtained using powder metallurgy methods,*** prof. Jan Dutkiewicz, Institute of Metallurgy and Materials Science of the Polish Academy of Sciences Kraków, Poland
11.^{50} – 12.^{15}	***Development of new materials on demand: example on Heusler compounds***, Dr. Jaroslav Hamrle, VŠB – Technical University of Ostrava, Czech Repulic
12.^{15} – 12.^{40}	***Understanding fundamental physics and design of materials from ab initio calculations***, Dr. Dominik Legut, VŠB – Technical University of Ostrava, Czech Repulic
12.^{45} - 14.^{00}	**Lunch**
	Free time

Section: „Development of technological processes"

Chairmen: prof. Wilde, prof. Ochin

(20 min presentation + 5 min discussion)

16.^{00} - 16.^{25}	***The Rotary Die Equal Channel Angular Pressing System***, prof. Tibor Donič, University of Žilina, Slovak Republic
16.^{25} – 16.^{50}	***Numerical modelling of the SPD processes*****,** prof. Henryk Dyja (Dr. M. Knapinski), Czestochowa – Technical University, Poland
16.^{50} – 17.^{15}	***Development of equipment for production UFG materials at the Department of Mechanical Technology VSB - Technical University of Ostrava***, prof. Stanislav Rusz, VŠB – Technical University of Ostrava, Czech Republic
17.^{15} – 17.^{40}	***Strength and ductility improvement of ECAP processed aluminium alloy 7075*****,** prof. Jozef Zrník, COMTES FHT Inc., Czech Republic
17.^{40} – 18.^{00}	**Coffee break**
18.^{00} – 18.^{25}	***Characterization of magnesium nanocomposites****,* prof. Pavel Lukáč, Charles University, Czech Republic
18.^{25} – 18.^{40}	***Joining Technology for UFG Materials***, Ing. Vladislav Ochodek, VŠB – Technical University of Ostrava, Czech Republic
18.^{40} – 18.^{55}	***Influence of Clay Particles Size on Properties of Vitreous Enamel Coating****,* doc. Jitka Podjuklová, VŠB – Technical University of Ostrava, Czech Republic
19.^{00} – 20.^{00}	**Dinner**
20.^{00} – 23.^{00}	**Evening program**

Saturday 04. 02. 2012

Section: „Development of UFG and nano-materials for the needs of industrial practice“

Chairmen: prof. Lukáč, prof. Zrník

(20 min presentation + 5 min discussion)

09.^{00} – 09.^{25}	***Experimental possibilities of SPD investigation of aluminium alloys***, Dr. Vladivoj Očenášek, SVUM a.s., Czech Republic
09.^{25} – 09.^{45}	***Method of determining a relationship between a grain size, surface topography and material strengthening,*** doc. Jan Valíček, VŠB – Technical University of Ostrava, Czech Republic
09.^{45} – 10.^{10}	***Experience with the project proposal evaluation of European Community programmes for research and technological development***, Dr. Karel Malaník, Research and Development Dobra, Czech Republic
10.^{10} – 10.^{35}	***New trends of materials in the automotive industries***, Dr. Marcel Klos, Visteon, Czech Republic
10.^{35} – 11.^{00}	***Summary of Research and Development Activities in The range of steel strip and examples of results***, Dr. Josef Bořuta, Materials and Metallurgical Research Ostrava – Vitkovice, Czech Republic
11.^{00} – 11.^{15}	**Coffee break**
11.^{15} – 12.^{00}	Discussion on the theme: ***Recent trends in the submission projects within the 7th and 8th EU Framework Programmers.***
12.^{00} – 13.^{00}	**Lunch**
13.^{00} –	***The implementation team meeting to conclusions of the workshop.***

INVESTMENTS IN EDUCATION DEVELOPMENT

Towards multifunctional bulk nanostructures: grain boundary structure and grain boundary diffusivity of severely strained alloys

Gerhard WILDE

Institute of Materials Physics, University of Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany

Abstract

Bulk nanocrystalline materials offer unique and new functional properties and property combinations that render them ideally suitable for a large spectrum of applications, ranging form the biomedical area to materials for off-shore industries or the aerospace sector, to mention only a few examples. Out of the few options for producing sizeable amounts of dense nanocrystalline materials, severe plastic deformation processing offers the most versatile and also the most promising route, as shown by combinations of high strength and high ductility or high mechanical strength and high electrical conductivity. Underlying the dramatic property enhancement is a modification of the atomic structure and volume density of the grain boundaries. In fact, strain distributions around - and atomic transport along these internal interfaces determine largely the resulting property combination of the product material.

The present contribution summarizes recent experimental results based on microstructure analyses (SEM-EBSD, TEM including Cs-corrected HRTEM and local strain analyses with atomic-scale spatial resolution by Geometric Phase Analysis) together with detailed grain boundary diffusion analyses on different pure metals and binary alloys using the radiotracer method. Basic issues concerning the existence and evolution of so-called “non-equilibrium” grain boundaries, their property characteristics and their relation with the performance of SPD-processed materials are addressed. In addition to the creation of grain boundaries with specific properties, the formation of a distinct hierarchy of internal boundaries with significantly different atomic mobilities along the boundary planes has been identified. Additionally, stabilization mechanisms of bulk nanocrystalline materials obtained by severe plastic deformation against coarsening is critically discussed.

Keywords

Bulk Nanocrystalline Materials, Severe Plastic Deformation, Diffusion, High resolution Transmission Electron Microscopy, Calorimetry, Defect Analysis, Strain Field Determination.

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Effect of grain refinement in magnetocaloric Huesler alloys

Wojciech MAZIARZ

Institute of Metallurgy and Materials Science, Polish Academy of Scinces, Reymonta 25, 30-059 Krakow, Poland, nmmaziar@imim-pan.krakow.pl

Abstract

The effect of rapid solidification and vacuum hot pressing on the transformation behavior, microstructure and mechanical properties of Ni-Mn-Z (*Z*=*In*, *Sn*) Huesler alloys doped by Co and Fe has been studied by X-ray diffraction, scanning and transmission electron microscopy, differential scanning calorimetry and compression test. The rapid solidification process allowed to obtain the flaky form ribbons with the two phase structure $L2_1$ and modulated martensite. The modulations depend on chemical composition of martensite determined by TEM investigations. The ribbons were mechanically fragile and very brittle what limits their applications. The ball milling process conducted in argon atmosphere was applied for pulverizations of ribbons and then vacuum hot pressing of powders at 650°C under 350MPa allowed to obtain a single phase martensite compacts with densification of about 98% of theoretical density. The average grain size of compacts was about of 500 nm. One step martensitic transformation in the vicinity of room temperature has been detected both in the ribbons as well as in the hot pressed compacts. The significant improve of plasticity was observed in the hot pressed samples. This effect was confirmed in the compression tests performed for hot pressed as well as hot pressed and solution treated samples. The selected magnetic properties of melt spun ribbons also are presented.

Keywords

Magneto-caloric effect, Huesler alloys, rapid solidification, vacum hot pressing, martensitic transformation, microstructure, mechanical properties.

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Production of nano-sized metallic powders

Patrick OCHIN, Yannick CHAMPION

ICMPE-CNRS Institut de Chimie et des Matériaux Paris Est, 2 rue Henri Dunant, 94320 Thiais, F, ochin@icmpe.cnrs.fr

Abstract

Nanometric metallic powders have been synthesized based on the evaporation-condension principle since the middle of 70‘. Another process, cryomelting also based on the gas condensation technique, has been developped since 1983 at CECM-CNRS. It consists in overheating a molten metal in contact with a cryogenic fluid (nitrogen or argon). Fusion by induction in electromagnetic levitation avoids any potential chemical reaction with a container and permits the overheating of the melt and a subsequent improved evaporation rate. Nanocrystalline powders of pure metals (Fe, Co, Cu, Cr, Al) and alloys (Fe-Ni) have been produced. A moderate rate of production (about 50g per hour) is obtained which allowed to produce macroscopic compacts (through pressing and subsequent sintering).

We present in this article, after a brief survey of different methods, a detailed description of this process and barriers which have been encountered. We focused on a summary of our results on copper (using liquid nitrogen) and aluminium (using liquid argon). Different conceptual models have been proposed to explain the formation of each of the two nanocrystalline metal particles. We shall finish with the presentation of our future project based on the same principle mixed with atomization of a precursor, using a induction coupled plasma torch which permits to reach much higher temperatures.

Keywords

Induction melting in levitation, evaporation-condensation, nanosized powders, cryomelting, induction coupled plasma.

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Processing and characterization of nano-sized metallic powders and fine grained metals

Yannick CHAMPION

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Abstract

Nanopowders of metals and some metallic alloys have been produced mainly by the cryomelting process for strudying their formation and properties as well as their transformation into bulk fine grained materials. The nanoparticles (Cu, Al, Sn, Fe, Cu (Ag) FeNi) were characterized at a structural and chemical point of view using transmission electron microscopy. In particular, these investigations led to the observation, for the first time, of vortex structure of magnetic fields localised within FeNi nanoparticles. Then, the powder metallurgy processing of nanopowders was the subject of intensive researches with investigations on compaction, reduction and sintering with the control of grain size as well as densification under isostatic differential extrusion. Today, densification of nanopowders is studied using the spark plasma sintering method.

Multifunctional and improving specific properties of materials have been the aims for studiying bulk fine grained metals, in particular the search for combination of high strength, ductility and magnetic or electric properties for the fields of microelectronics, electrotechnics, micromechanics. Experimental works on the mechanical behaviour were conducted on pure copper and effect of chemistry approached with copper-sylver. They were followed by the modelisation of the micromechanims of deformation to understand, control and tend to optimization of the structure for properties improvement.

Keywords

Nanosized powders, fine grained metals, prowder metallurgy, mechanical properties.

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Aluminum alloy and silver base nanocomposites obtained using powder metallurgy methods

Jan DUTKIEWICZ

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Abstract

Aluminium alloys 6061 or 7475 powders were ball milled together with ceramic ZrO_2 or Al_2O_3 nanopowders in order to obtain nanosize aluminium solid solution crystals with incorporated ceramic particles. The powders were consolidated using uniaxial hot pressing in vacuum at temperature of 380^{o}C, what prevented grain growth together with the addtion of 1.5% of Zr (raising recrystallization temperature). The composites consisted of aluminium solid solution grains of size between 100 – 200 nm, intermetallic particles due to Zr, Mg. Zn, Si and Cu additions of similar size and from ceramic nanoparticles. These components were identified using TEM studies. The compression strength of composites based on the 7475 alloy with ceramic nanoparticles attained 1000 MPa, while those based on 6061 alloy attained strength near 800 MPa. The plasticity of composites was rather low. It was explained by formation of magnesium containing oxide layer at the aluminium-ceramic interface initiating crack formation during deformation. Indeed, composites based on pure aluminium have shown very high plastic deformation during compression test due to lack of such interface oxide layer like in magnesium containing aluminium alloys

Another type of nanocomposites, based on silver were intended for applications as electric contact materials. Nanocrystralline silver matrix was strengthened with either nickel or zirconium base amorphous powders obtained by mechanical alloying. It appeared that such composites have shown higher strength and similar mass loss during 50000 switching operations as silver tungsten conventional contact materials.

Keywords

Aluminium alloy base nanocomposites, ball milling, hot pressing, silver base composites, electric contact materials.

INVESTMENTS IN EDUCATION DEVELOPMENT

Development of new materials on demand: example on Heusler compounds

Jaroslav HAMRLE, Dominik LEGUT, Jaromír PIŠTORA

VŠB – Technical University of Ostrava, 17. listopadu 15, 708 33 Ostrava – Poruba, CZ, jaroslav.hamrle@vsb.cz

Abstract

The development of new materials is an important part of today's solid state physics. A powerful way to develop new materials is to include *ab-initio* calculation (called also first principle calculations), calculations providing electronic structure and allowing to calculate most of the material's properties, for example, transport (e.g. conductivity), optical, thermodynamical, magnetic properties, temperature dependences, stable phases and corresponding phase transitions, dependences on crystallographic disorder etc. This theoretically designed and optimized material is then fabricated as a bulk or thin film. Consequently, such a sample is investigated by various crystallographic and spectroscopic tools, in order to probe the crystallographic structure and electronic structure. The results are then compared with *ab-initio* calculations. This investigation chain is ideally employed in an iterative way, as each stage (theory-fabrication-characterization) provides feedback to other stages.

Keywords

New materials, *ab-initio* calculations, Heusler compounds.

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Understanding fundamental physics and design of materials from ab initio calculations

Dominik LEGUT

VŠB – Technical University of Ostrava, 17. listopadu 15, 708 33 Ostrava – Poruba, CZ, legut@ipm.cz

Abstract

The materials properties and their response to a wide variety of external conditions might be traced back to the behavior of electrons and their interactions with atomic nuclei at the atomic scale. Quantum-mechanical (so-called ab initio) calculations based on the density functional theory[1] (DFT), which was awarded by a Nobel Price (W. Kohn 1998), reached a considerable reliability in predicting physical and chemical properties of solids. DFT[2] does not only determine precisely the ground-state properties, but in many cases also far-from-equilibrium states with unprecedented accuracy. The success of the ab-initio approach will be demonstrated by a few following examples:

a) Mechanical properties: The determination of single crystal elastic constants, bulk and shear moduli, Young modulus, Poisson ratio, etc. The anisotropic shear resistivity of crystals to external loads, as obtained from the calculated materials stress-strain response, is related to some extent to their ideal strength. Subsequently, the ductility/brittle behavior may be considered according to a number of phenomenological criteria and materials with tailored elastic properties may be designed.

b) Lattice vibrations. To account for the temperature effects, T>0K, the free energy contribution due to lattice vibrations (phonons) is calculated. Phonons determine the thermodynamic stability of solids as well as many other thermodynamic properties such as specific heat or thermal expansion coefficients.

c) Magneto-optical (MO) phenomena: Using the x-ray magnetic circular dichroism one can determine the spin and orbital moments in ferromagnetic materials on an element-selective basis and employing linear light one can investigate antiferromagnetic materials. Well-known Kerr, Faraday, Voigt and other MO effects have been calculated in last two decades and their origin is now well understood from the electronic structure analysis.

References:

1. P. Hohenberg, W. Kohn: Phys. Rev. 13 (1964) B864.
2. W. Kohn, L. J. Sham: Phys. Rev. 140 (1965) A1133.

Keywords:

Ab - initio, first-principles calculations, thermal expansion, mechanical properties, magneto-optics.

INVESTMENTS IN EDUCATION DEVELOPMENT

The Rotary Die Equal Channel Angular Pressing System

Tibor DONIČ

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Abstract

For the purpose of creating nanostructures in metallic materials, especially in powder preparations based on aluminum was designed a special experimental system. This system has a very simple way to ensure repeat deformation group procedure that functional part of the system is able to rotate. For this reason, created a computer model of the functional parts of the ECAP, which was then used for deformation group of the design drawings. Blanks for the experimental work was 99.9% aluminum powder, which was compressed pressure of 600 MPa, then the forward extruded and that the sample was then used in ECAP system. Universal deformation system Rotary Die ECAP was used in the process of static deforming - hydraulic press, but also at higher speeds on Cam plastometer and also for high-speed deformation - HILTI system. Metallographic analysis of products derived from these types of deformation were analyzed in detail. Because the samples before the actual process of ECAP - Rotary Die, were not individual particles and sintered aluminum powder were substantially covered with oxide layer and the operation of forward extrusion the oxide layer is not perfect destructed and consequently the process selfdiffusion pure aluminum material is very limited. This shortcoming could not be eliminated by the operation nor ECAP Rotary Die as demonstrably proven by metallographic analysis. Upgrade of Rotary Die ECAP with the possibility of heating the functional parts would be a promising procedure for the procedure diffusion activation between aluminum particles which would result in a homogeneous ultra fine metal aluminum structure.

Keywords

Aluminum powder, forward extrusion, ultra-fine aluminum microstructure ECAP, metallographic analysis, cam plastometer, high strain rate.

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Numerical modeling of the SPD processes

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Abstract

In the work the results of numerical simulation obtained by commercial program Forge 2009 for thermo-mechanical analysis of metal forming processes were presented. The presented results concerning plate rolling process (ARB), equal channel angular extrusion and new process which is combined of backward extrusion and multiaxial compression processes. The proposed method of alternate backward extrusion and multiaxial compression is charracterized by appearing states of strains in deformed material very similar to states which are characteristic for such processes as equal channel angular extrusion and cyclic extrusion compression.

Keywords

Accumulative roll-bonding – ARB, equal channel angular extrusion ECAE, alternate backward extrusion and multiaxial compression, severe plastic deformation, nanomaterials.

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Development of equipment for production of UFG materials

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Abstract

Department of Mechanical Technology at VSB – Technical University of Ostrava conducts research and development of technology for production of UFG metallic materials for more than 7 years. In the first years of development influence of construction solution of ECAP tools with geometry of connecting channel (90°) and sample of the size of 8×8×34 mm, 10×10×42 mm and 15×15×60 mm (final stage) was tested. The actual geometry of the channel is gradually changing. Angle of connection of channels ϕ = 90° (a constant), but design of horizontal channel was changed. New design was proposed - deflection of the channel around the vertical axis - by 10° and 20°. In the final stage a helix with pitch angle of 30° was built into the channel. This design solution created back pressure in the channel. A substantial increase efficiency of the process of grain refinement was achieved. The experiments were performed on hydraulic press of the type DP 1600 kN. Grain refinement was examined on Al and Mg alloys. The experimental results clearly confirmed achievement of the largest grain refinement and mechanical properties and high efficiency process for the ECAP channel with built-in helix. Mean values of grain size reached 250 to 350 nm in Al alloys after 5 passes through the ECAP tool. In the next stage of development work two prototype devices for semi-finished sheet metal and wire were developed. The device works on the principle of the SPD and it is similar to the device C2S2 (DCAP) and CONFORM. Extrusion of strip sheet of aluminium, copper, brass and low carbon steel was performed on the prototype machinery DRECE (Dual Rolls Extrusion Equal Channel). Remarkable results were achieved in brass and steel. Mechanical properties were increased (100% of R_e and R_m) already after 4 passes through DRECE machinery. The ductility values were reduced. In future development we want to modify the design of tools of DRECE machinery and propose the appropriate heat treatment to maintain the required elongation, while achieving high mechanical properties.

Keywords

Severe plastic deformation, grain refinement, extrusion process, mechanical properties, formability, forming equipment, new design of forming tool, strip of sheet.

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Strength and ductility improvement of ECAP processed aluminium alloy 7075

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Abstract

Strength of materials subjected to severe plastic deformation can be significantly improved due to ultrafine grain structure formation. The impact of various strain levels ε_{ef} on structure refinement and proportions different portions of grains with high angle boundaries and subgrains having low angle boundaries is present. Any severe plastic deformation procedure (ECAP, HPT, ARB, CGP) refines grains to size below 1000 nm and is usually accompanied by strength increase and reduction in ductility.

In order to improve the deformation behaviour of SPD prepared aluminium alloy AA7075 microstructure modification by ageing due to various holds at precipitation temperature prior to ECAP processing and post-deformation treatment were carried out. Over-aging process carried out prior severe deformation modified the characteristics of precipitates (intermetallic phases) present in alloy. The microstructure refined by intensive deformation was then altered by various annealing procedures. Ageing prior to ECAP contributed to a small increase in strength, as hardness results, as shown by results of hardness measurement and observation of microstructure. On the other hand, podt-deformation annealing of the ECAP-ed samples at various temperatures markedly modified the deformation response of the alloy as regards ductility. Evaluating the mechanical properties a small increase in strength was achieved at lower temperature of at lower temperatures of annealing (250°C, 300°C), whereas the highest temperature of annealing (350°C) preserved the strength at the same level as in samples without any additional post-deformation annealing. The microstructure analyses (TEM and EBSD) provided evidence about the ultrafine grain structure transformation towards bimodal structure. These preliminary results of purposeful structure modification will be further examined in regard to strength.

Keywords

Al alloy, microstructure, precipitation, ECAP deformation, annealing, EBSD, strength, ductility.

INVESTMENTS IN EDUCATION DEVELOPMENT

Characterization of magnesium nanocomposites

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Abstract

Aluminium and magnesium alloys reinforced with ceramic particles are used in different applications. The reinforcement of magnesium (magnesium alloys) with ceramic nanosize particles has given rise a new class of composite materials – nanocomposites. The addition of nanosize particles increases the strength (yield strength, ultimate tensile strength, maximum flow stress), stiffness and hardness. The shape of reinforcements plays an important role in the mechanical properties. The type and amount (volume fraction) of reinforcements influence the yield strength. Recently, some studies have shown that the addition of nanosize particles can also increase ductility of composites at room temperature. The authors investigated the deformation behavior of magnesium reinforced with Al_2O_3 and ZrO_2 at different temperatures between room temperature and 300°C. It was shown that the test temperature significantly influences the deformation behavior of composites including the yield strength.

The results obtained show that the deformation behavior characterized by a high strength at room temperature and low strain hardening at elevated temperatures may be explained both by the interaction of moving dislocations with nanosize particles and by the effect of the matrix and particles properties as well as the interfaces between the matrix and the particles. The effect of the microstructural factors is discussed.

Keywords

Particle reinforced magnesium, yield strength, volume fraction of reinforcements.

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Method of determining a relationship between a grain size, surface topography and material strengthening

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Abstract

Over the last years, attention is focused on the research of nanostructured materials allowing to obtain high mechanical and physical properties of structural materials. It is based on the idea of the Hall-Petch relationship of dependencies of strength properties of polycrystalline materials on a grain size (of crystals) to the grain sizes of 10-100 nm. Research in the field of preparation of ultra - fine grained and nanostructured materials is focused in particular on metals and their alloys. Currently, most attention is being paid to aluminium and copper alloys. There is also the research in the field of preparing fine-grained and nanostructured materials with high strength. A great challenge lies in the preparation of massive, structural, nanostructured materials. There is put emphasis on structure homogeneity, product size, strength and plastic properties of nanomaterials. On this basis, it is necessary to predict and control the grain size of all types of materials, its strengthening depending on technological conditions of material structure formation and created surface topography. This paper deals with a newly derived method to determine the relationship between the grain size of materials after extrusion, surface topography and its strengthening.

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Influence of Clay Particles Size on Properties of Vitreous Enamel Coating

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Abstract

Corrosive process depreciate of the products which are in contact with corrosive environment. Vitreous enamel coating is surface treatment, which ensure not only perfect protection of materials against corrosion, but also give for surface of basic material the exceptional properties.Vitreous enamels are glazes formed on a metallic undercoat by burning at temperature exceeding 800°C. This coating can be used in various fields of engineering. Forming of a compact enamel coating (with no defects or cracks penetrating up to ground metal) is a fundamental prerequisite for utilization of its functional features. Properties of the coating are dependent on its structure, texture and chemical composition. The most important inorganic components during production of this coating are clay and fritted glass. Usage of various sizes of these components influences final quality of the coating. The main goal of this thesis is to compare properties of vitreous enamel coatings made by using commonly-dimensioned inorganic particles and of inorganic particles in nano-dimensions. Contribution also studies effect of clay component like input raw material which is add in different time sequence on mechanical properties of vitreous enamel coatings.

Keywords

Vitreous enamel coating, corrosion, clay, nanodimension, properties.

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Experimental possibilities of SPD investigation of aluminium alloys.

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Abstract

Aluminium and its alloys belong to materials in which the SPD (Severe Plastic deformation) effect on the microstructure and properties is often studied. The most usual deformation methods are ECAP (Equal Channel Angular Pressing), HPT (High Pressure Torsion), ARB (Accumulative Roll Bonding); a special equipment Conform can be also used. These methods are relatively difficult from the experimental point of view and, consequently, only small amount of SPD in bulk material is realized. At the present time, ECAP and Conform methods seem to be the most suitable for the industrial applications. Further, the aim of deformation experiment influences substantially its performance. It is important for the choice of alloy and its initial state, whether the severe plastically deformed material is used for different following investigations (e.g. creep resistance, superplasticity, structural stability) or the resulting material structure and properties are considered as the final ones. In aluminium alloys, the hardenable or nonhardenable alloy type influences also the way of deformation experiments. For SPD investigation, the both alloy types are used. In the present paper, the attention is paid particularly to the choice of deformation parameters in the dependence on the alloy type and initial microstructure conditions. Typical examples of alloys deformed mostly by ECAP method are shown.

Keywords

Severe plastic deformation, ECAP, aluminium alloys, heat treatment, microstructure.

INVESTMENTS IN EDUCATION DEVELOPMENT

Joining Technology for UFG Materials

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Abstract

The ultrafine grain sized material (UFG- ultra fine grain sized material) have due to special manufacturing processes using extreme plastic deformation (SPD-Severe Plastic Deformation) significantly higher mechanical properties them materials with similar alloying produced by conventional methods. In the event that the technology can not directly produce the final product should be considered on the choice of subsequent production technology and its influence on the material and final product properties respectively. The paper presents the review and characterization suitable joining technology with a focus on the welding, brazing and adhesive bonding. For attainment required properties of the final product is necessary optimal choice of materials, joining technology and structural design.

Keywords

UFG materials, welding, brazing, adhesive bonding.

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Experience with the project proposal evaluation of European Community programmes for research and technological development

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Abstract

The presentation deals with the project proposal evaluation of the European Community R&D programmes. The experience with procedures of evaluation is performed within the programmes „Research Fund for Coal and Steel" and FP7.

There are mentioned particular steps of proposal evaluation for research, pilot and demonstration projects – evaluation (justification of marking, resubmitted proposals, outcome of the individual evaluation, thresholds), consensus (consensus meeting, marking, outcome of the consensus meeting), ranking list.

The main attention is dedicated to the individual evaluation process of proposals, especially to the evaluation criteria - that means scientific and technical approach, innovative content, consistency of resources and quality of partnership, industrial interest and scientific / technical prospects, added value for the European Union and contribution to EU policies.

Good knowledge of the evaluated criteria and evaluation procedures is very useful and essential for high-quality preparing, processing and management of project proposals and so the presented information should help to improve the probability of the support obtaining from the EU funds.

Keywords

EU funds, R&D projects, proposal, evaluation process, evaluation criteria.

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New materials trends in the automotive industries

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Abstract

The develop aspects automotive industries repose in the time new on used materials.

Company which are in Czech Republic Visteon Inc., Global producer of air condition system of the care and other company is Ejot Gmh. connected material producer. Customers of these companies are Global care producer for example Ford, Mercedes, PSA, Fiat, Bentley.

Companies occurring in automotive industries represented by these branches industries have new requirements on materials in term of high corrosive immunity, stability of size, increasing formability and high mechanical properties.

In individuals requirement is increasing pressure on changes of conventional material for example steel and stainless steel for used as material connection two components. In time is an existing new requirement for material on base aluminium and titanium. Global automotive industry given of emphasis on decreasing total price of components in the last three years. An imported factor for global care producer is minimal price of used components. These reasons are imported factors for applications nano-materials in serial productions.

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Summary of research and development activities in the range of steel strip and examples of results

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Abstract

History and traditions of steel forming research in Vítkovice will be presented. In the institute MATERIAL AND METALURGICAL RESEARCH Ltd. originaly creating a part of the company VÍTKOVICE and now independent, a branch of forming research has already been existing for almost 60 years. Part of the author team has worked in forming research more then 40 years.

Technological methods of testing hot formability of steel, such as the impact of bending and upsetting tests, developed and used during the sixties, enabled a study of the effects of base deformation conditions, such as temperature, heating, degree and rate of deformation and stress condition, on formability and sensitivity to hot shortness. Tensile and torsion testing of hot formability was introduced at the end of the sixties. In those days it was possible to perform even interrupted torsion tests with longer between individual deformations. Enhancement of the quality of testing hot formed steel deformation characteristics occurred in 1981. In 1985 the installation of an up-to-date torsion SETARAM plastometer, provided with a control computer, followed. At the present time the plastometer SETARAM have the second generatin of control computer. Possibilities of plastometric tests will be demonstrated on the simulation of hot rolling steel strip for to achieve a very fine microstructure.

The main part of this article is based on complete processing of 25 grades of carbon and low-alloyed steel strip by cold rolling to the limit options determined by cold formability. Also will be described methodology of evaluation of formability of cold formed steels. In the field of cold formability of steel testing the conventional tensile test is mostly used in normal practice. Other aspects of changes of mechanical properties of strain hardened steel and also classification and charakteristics of tested strip steels according to their cold formability will be shown.

Keywords

Material and metallurgical research, forming research, steel strip, cold strip, microstructure, mechanical properties, cold deformation, cold formability.

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Project applicant

Project partner

Cooperating organizations from the Czech Republic

Foreing cooperating organizations

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