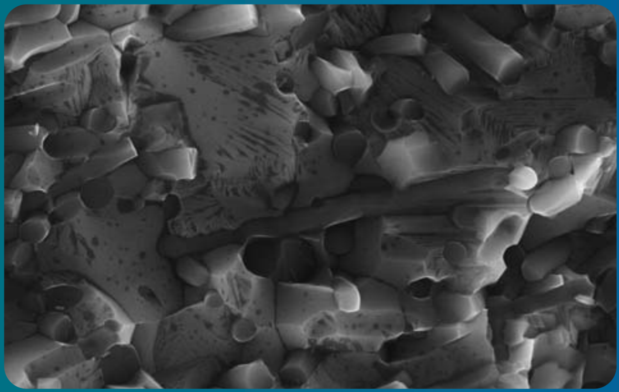
Research papers

Materials

Selected materialographical photo



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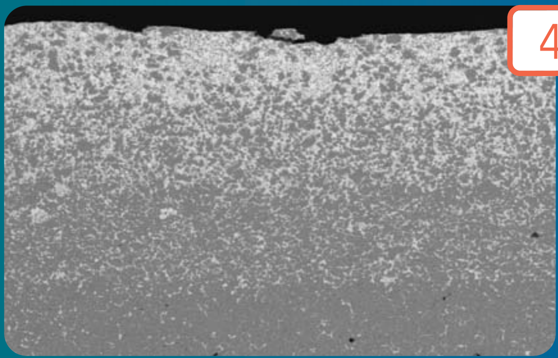
Authors: L.A. Dobrzański, L. Wosińska, J. Mikuła, K. Gołombek and T. Gawarecki in the paper entitled "Investigation of hard gradient PVD (Ti,Al,Si)N coating" on a **page 59** present the investigation of gradient coating of (Ti,Al,Si)N deposited on the Al2O3+SiC(w) oxide ceramics substrate by cathodic arc evaporation CAE-PVD method. Gradient structure and main properties of the investigated materials were introduced. It has been stated that properties of the oxide tool ceramic with gradient (Ti,Al,Si)N coating increase in comparison with uncoated material. Depositing the wear resistant gradient coating onto the Al2O3+SiC(w) oxide tool ceramic results in a significant increase of the surface layer microhardness, contributing most probably in this way in machining to the decrease of the wear intensity of cutting tools' flanks made from the Al2O3+SiC(w) oxide tool ceramic.



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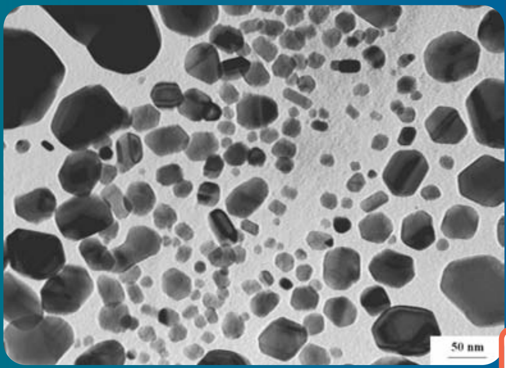
The paper entitled "Structure and properties of gradient tool materials with the high-speed steel matrix" by L.A. Dobrzański, A. Kloc-Ptaszna, G. Matula and J.M. Torralba on a **page 47** shows the research on the structure and properties of gradient tool materials with the HS6-5-2 high-speed steel matrix reinforced by the tungsten carbide. The material presented in this paper has layers consisting of the carbide-steel with growing hardness on one side, and on the other side the high-speed steel, characterised by high ductility. The density of the compacted and sintered test pieces grows along with the sintering temperature increase. The porosity grows along with the WC content growth in the particular layers. It was observed that the sintering time has an effect on the porosity growth. The longer the sintering time is, the higher the porosity is. The HRA hardness of the compacted and sintered test pieces grows along with the sintering temperature increase. It was noted that application of longer sintering time results in slight hardness lowering. Now developed material is tested for turning tools.



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The paper written by J.P. Stobrawa, Z.M. Rdzawski and W. Głuchowski on "Microstructure and properties of nanocrystalline copper – yttria microcomposites" on a **page 83** investigates changes in structure and properties of Cu – yttria microcomposites which take place in the process of controlled sintering and deformation of materials of nanometric initial structure. Tests were made with the Cu-yttria microcomposites containing up to 3% of a hardening phase. These were obtained by powder metallurgy techniques and further deformation. The analysis of the initial nanocrystalline structure of these materials was made, and its evolution during deformation process was investigated with an account of the changes in the mechanical and electrical properties.

A controlled process of milling compacting, sintering and cold deformation, allow to obtain nanocrystalline copper based materials with improved functional properties. Within this group of materials particular attention is drawn to dispersion hardened microcomposites with nanometric or submicron grain size of a copper matrix, which exhibit higher mechanical properties. A growing trend to use new copper-based functional materials is observed recently world-wide.

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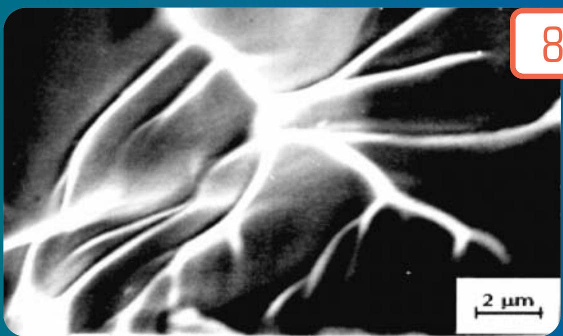
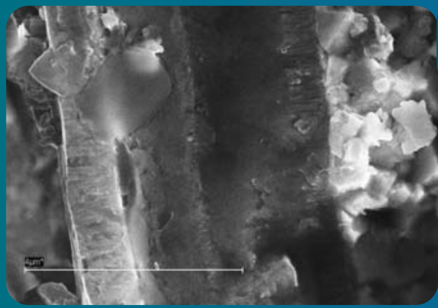


The paper from Amorphous Materials area made by D. Szewieczek, J. Tyrlik-Held and S. Lesz on "Structure and mechanical properties of amorphous Fe84Nb7B9 alloy during crystallisation" on a **page 87** describes the results of crystallisation, in temperature range of 300÷700°C in time 1 h, of amorphous Fe84Nb7B9 alloy. The alloy was obtained in tape form by a planar-flow-casting method. The changes of mechanical properties and fracture morphology being connected with the structure changes involved by crystallisation process have been stated. The measurement of mechanical properties, like: tensile strength Rm, ductility ϵ and cracking energy Ep, were made. It has been stated that heat treatment leads to the crystallisation of two-stage character. The relationship between heat treatments parameters and mechanical properties can be useful for the practical application of these alloys.

Properties

Methodology of research



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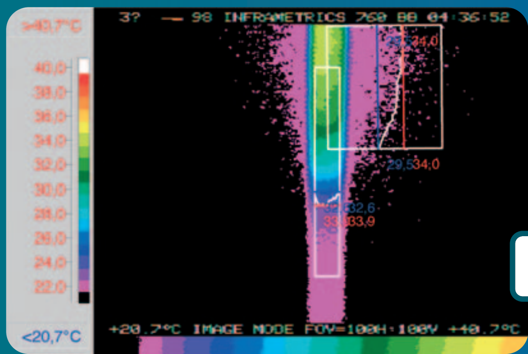
Authors: K. Gołombek and L.A. Dobrzański in the paper entitled "Hard, wear resistance coatings for cutting tools" on a **page 107** present the results of structure and properties of the cemented carbide tips and tool cermets, both uncoated and coated with single and multiple hard surface layers in the physical (PVD) and chemical (CVD) vapour deposition processes. The TiN+gradient or multi (Ti,Al,Si)N+TiN system coatings deposited with the PVD method in the cathodic arc evaporation CAE onto the substrates from cermets and cemented carbides reveal better working properties in comparison to the commercial tool materials with the gradient- or multi-layer and single- and two-component coatings deposited in the PVD or CVD processes. In the paper the research of TiN+gradient or multi(Ti,Al,Si)N+TiN nanocrystalline coatings deposited in the CAE process on cemented carbides and cermets carried out in order to improve the tool cutting properties.



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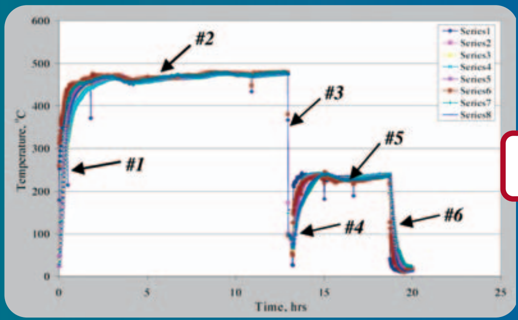
In the research paper entitled "Thermographic diagnosis of fatigue degradation of epoxy-glass composites" by G. Muzia, Z.M. Rdzawski, M. Rojek, J. Stabik and G. Wróbel on a **page 123** the results of thermography application to evaluate the degree of fatigue degradation of epoxy-glass composites is presented. The analysis of achieved results allowed to elaborate relation between a number of fatigue cycles and the degree of fatigue degradation. Such a relation may be applied in diagnostic procedures. Samples of epoxy-glass composite were subjected to fatigue degradation. During a fatigue test, after a defined number of cycles, samples were heated using infra-red heater and at the opposite side temperature increase was evaluated with a thermovision camera. Performed tests were of preliminary character and results will be applied to prepare research programme on thermographic testing of composites. Thermographic methods are applied up till now to non-destructive flaws detection. A method proposed in the paper may be applied to evaluate the degree of thermal and fatigue degradation in composites without any macroscopic flaws. Results of such tests may be applied in the future in diagnostic procedures to non-destructive evaluation of the degree of fatigue degradation of high performance polymer composites.



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The paper written by L. A. Dobrzanski, M. Kasprzak, W. Kasprzak and J. H. Sokolowski on "A novel approach to the design and optimisation of aluminium cast component heat treatment processes using advanced UMSA physical simulations" on a **page 139** presents a new laboratory methodology for simulation of industrial melting, solidification and heat treatment using the patented Universal Metallurgical Simulator and Analyzer (UMSA) Technology Platform. The unique UMSA Platform was used to rapidly physically simulate very complex industrial heat treatment processes using stationary macro test samples and computer controlled heating and cooling source. Two examples to demonstrate UMSA's capabilities are presented for optimised heat treatment processes at the request of the North American automotive industry. The UMSA simulations proved to be very accurate in order to simulate the non-linear temperature/time profile of the solidification process combined with the continuous heat treatment operation. The simulation method that is presented here will greatly improve the ability of laboratory investigators to simulate and assess the effects of the heat treatment variables. The presented methodology is capable of dissecting all processes and linking the cast component's optimised performance with individual production steps. The technical capabilities of the UMSA Platform have been recognised and have already been applied by industrial partners.

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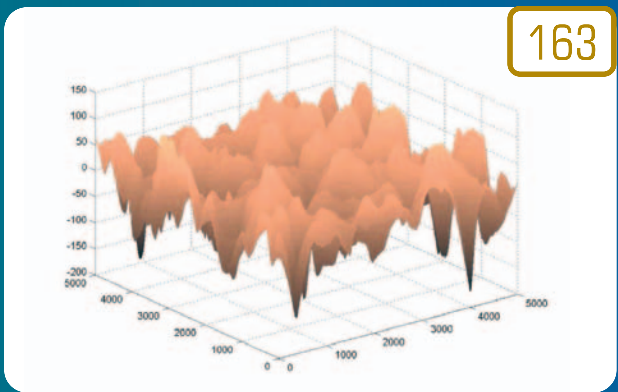
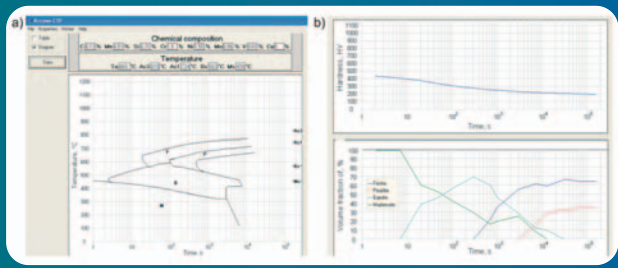


The paper entitled "Modelling of properties of the PVD coatings using neural network" by W. Kwaśny, W. Sitek and L.A. Dobrzański on a **page 163** demonstrates developed neural network models based on the experimental results of multifractal analysis of the examined coatings made basing on measurements obtained from the AFM microscope, using the projective covering method. The goal of this work is to develop the neural network model for prediction of properties Ti+TiN, Ti+Ti(C,N) and Ti+TiC coatings obtained in the PVD process. The presented in the paper research results indicate that neural networks can be applied for modelling the properties of PVD coatings on the base of multifractal parameters. An investigation or a relationship between parameters describing the multifractal spectrum and physical properties of the examined materials calls for further analyses.

Analysis and modelling

Manufacturing and processing



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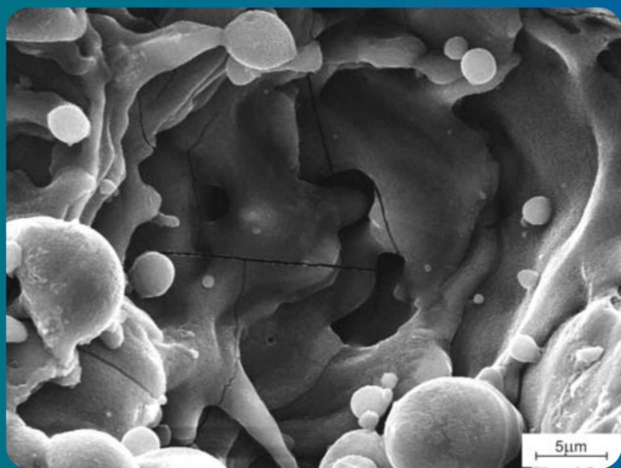
The paper from Analysis and Modelling area made by J. Trzaska, A. Jagiełło and L.A. Dobrzański on "Computer programme for calculating the CCT diagrams" on a **page 171** presents that the computer programme uses the artificial neural networks for prediction steel properties after heat treatment. Input data are chemical composition and austenitising temperature. Results of calculation consist of temperature of the beginning and the end of transformation in the cooling rate function, the volume fraction of structural components and hardness of steel cooled from austenitising temperature with a fixed rate. The created method for designing chemical compositions is limited by ranges of mass concentrations of elements. The methodology demonstrated in the paper makes possibility to add new steels to the system. The presented computer programme can be used for selecting steel with required structure after heat treatment.



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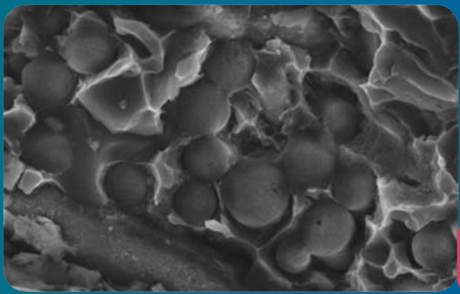
The research paper entitled "Application of laser in multicrystalline silicon surface processing" by L.A. Dobrzański, A. Drygała, P. Panek, M. Lipiński and P. Zięba on a **page 179** describes the method of laser texturisation of multicrystalline silicon for solar cells. The analysis performed in the paper revealed the existence of laser-damaged layer on the textured surface which has to be removed prior to successive technological steps to obtain solar cells of satisfactory performance. Surface texturisation is a common technological process in a solar cell manufacturing aiming at a reduction of the light reflection losses. The standard alkaline texturing of multicrystalline silicon for solar cells is not effective because of random orientation of the grains. In this paper a method of laser texturisation has been proposed to overcome these difficulties. It seems to be a very promising method since it can be applied in industry.



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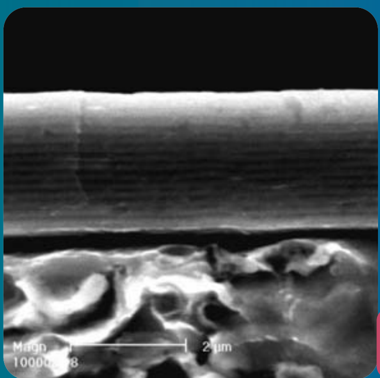
In the research paper entitled "Application of pressure infiltration to the manufacturing of aluminium matrix composite materials with different reinforcement shape" by L.A. Dobrzański, M. Kremzer and A. Nagel on a **page 183** the investigation of influence of reinforcing phase's shape on structure and properties of composite materials with aluminium alloy matrix is presented. The material for studies was produced by a method of pressure infiltration of the porous ceramic framework. In order to investigate the influence of reinforcing phase's shape the comparison was made between the properties of the composite material based on preforms obtained by Al2O3 Alcoa CL 2500 powder sintered with addition of pore forming agent in form of carbon fibres Sigrafil C 10 M250 UNS from Carbon Group company and composite materials based on much more expensive commercial fibrous preforms. The matrix consisted of cast aluminium alloy EN AC – AlSi12. The obtained results show the possibility of manufacturing the composite materials by the method of porous sintered framework pressure infiltration based on the ceramic particles, characterised with the better properties than similar composites reinforced with fibres. The composite materials made by the developed method can find an application as the elements of devices where beside the benefits from utilisable properties the small weight is required (mainly in aircraft and motorisation industries).



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Authors: M. Polok-Rubiniec, K. Lukaszkowicz, L.A. Dobrzański and M. Adamiak in the paper entitled "Comparison of the PVD coatings deposited onto hot work tool steel and brass substrates" on a **page 195** present the investigation of the structure and mechanical properties of monolayers CrN, TiN and multilayers TiN/TiAlN and Ti/TiAlN coatings deposited by PVD techniques onto the substrate from the X37CrMoV5-1 steel and CuZn40Pb2 brass. The monolayer PVD coatings deposited onto hot work steel and brass substrate demonstrate the high hardness, adhesion and wear resistance. It should be stressed that the mechanical properties of the PVD coatings obtained in this work are very encouraging and therefore their application for products manufactured at a mass scale is possible in all cases where reliable, very hard and abrasion resistant coatings, deposited onto tools steel and brass substrate are needed.

Cleaner production

Industrial management and organisation

Education and research trends

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