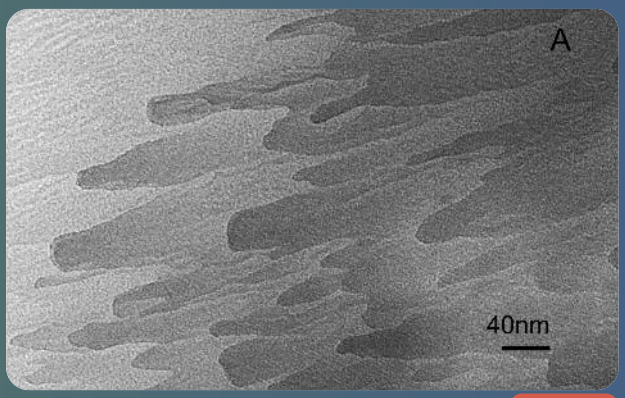
Research Monographs

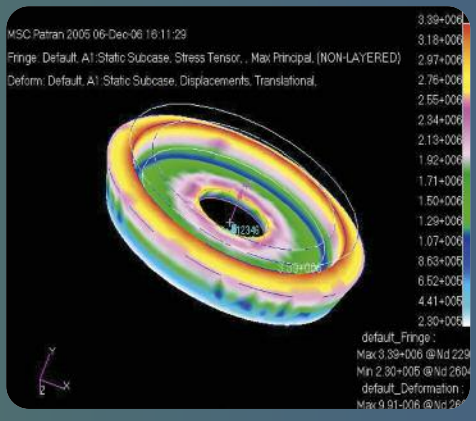
Materials

Selected materialographical photo



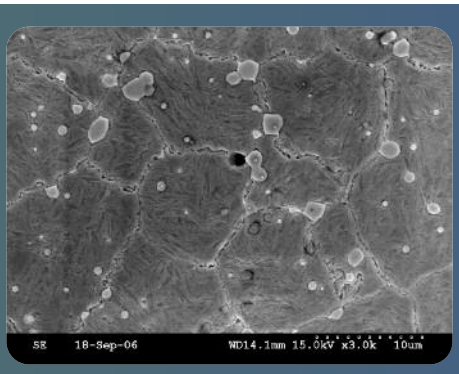
145

The research paper made by M. Richert, A. Mazurkiewicz and J. Smolik on "Chromium carbide coatings obtained by the hybrid PVD methods" on a **page 145** presents information, which could be useful in the industrial practice for the production of wear resistant coatings on different equipments and tools. With the use of the Arc-PVD and Arc-EB PVD hybrid method, the chromium carbide coatings were deposited on steel substrate. Two kinds of coatings were obtained. The nanostructure coatings were formed by deposition of chromium carbide films by Arc PVD evaporation technique. The multilayer coatings were produced by Arc-EB PVD hybrid technology. In the second case the amorphous phase in majority was found in samples, identified by X-ray investigations. The microstructure of deposited coatings differs depending on the used deposition method. The Arc PVD deposition produced nanometric coatings with the Cr_3C_2, $Cr_{23}C_6$, Cr_7C_3 and CrC carbides built from nanometric in size clusters. In the case of the Arc-EB PVD hybrid technology in majority of cases the amorphous microstructure of coatings was found. The hybrid coatings consist of alternating layers of Ni/Cr-Cr_3C_2.



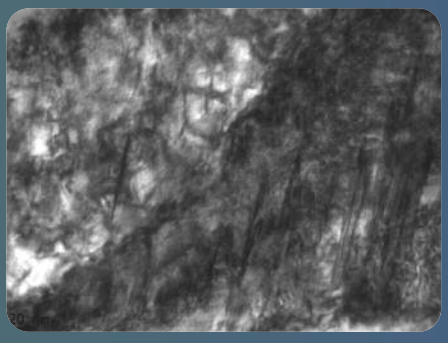
27

The paper entitled "Numerical analysis of small recessed silicon carbide grinding wheels" by M.J. Jackson on a **page 27** demonstrates how stresses and factors of safety are calculated in order to predict the bursting speeds of small recessed SiC grinding wheels. The main used methods include finite element analysis and mechanical testing of abrasive materials. The approach of the paper is to integrate the use of numerical analysis techniques and experimental techniques to predict the safe operating conditions of SiC abrasive products. Calculations were conducted to determine maximum stress in parallel-sided and recessed cup wheels. Relevant factors of safety and bursting speed were also calculated and compared with experimental data. The paper proves the usefulness and applicability of a method developed for taking account of stress concentrations at the recess of small cup-shaped silicon carbide grinding wheels. The originality in the paper is revealed owing to the fact that fracture mechanics principles are applied to the prediction of failure of rotating grinding wheels. The paper is of practical importance to mechanical designers who are responsible for the safe design of grinding wheels.



64

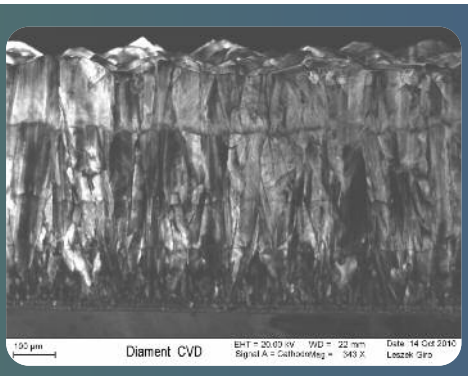
The paper written by P. Bała and J. Pacyna on "The influence of kinetics of phase transformations during tempering on high-speed steels mechanical properties" on a **page 64** presents the determination of the influence of the phase transformation kinetics, at tempering, on the properties of high-speed steels. In order to achieve this aim investigations of the influence of continuous heating and isothermal tempering from the as-quenched state on the investigated steels hardness were performed. The advancement degree change obtained by changing the heating rate and by pre-tempering was applied in strength properties studies. Those results should be of interest to engineers concerned with designing the new technologies of high-speed steels tempering. Changing heating rates for tempering one can influence steel properties. Better results are achieved when steels are heated up to the tempering temperature with the higher rate. The heating rate increased from 15°C/min to 300°C/min improved the investigated steels bending strength by 8%. On the basis of the obtained results it is possible to select the tempering parameters in such a way as to achieve the optimal combination of strength and plastic properties needed for the anticipated application of the given high-speed steel.



80

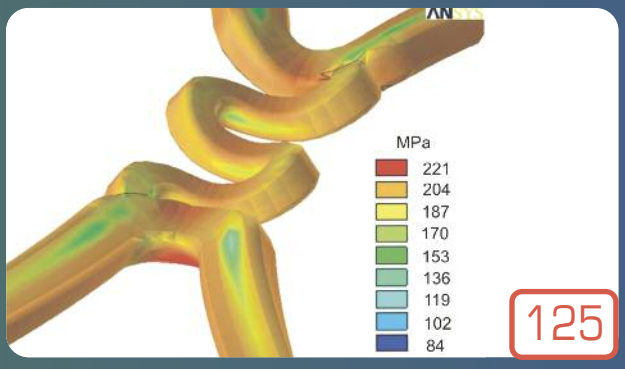
The Materials area represented by J. Jeleńkowski, A. Ciski and T. Babul on "Effect of deep cryogenic treatment on substructure of HS6-5-2 high speed steel" on a **page 80** presents results of the use of transmission electron microscopy (TEM) and differential scanning calorimetry (DSC) in order to reveal the changes in substructure of speed steel made with deep cryogenic treatment (DCT), in comparison with substructure formed by conventional heat treatment for secondary hardness. Observations made with aid of SEM-TEM microscope revealed the presence of high density of globular clusters situated at dislocations, and precipitations of the fine carbide plates, located in twinned crystals of martensite. Thermal analysis (DSC) showed an occurrence of higher exothermic effects in specimens treated with use of DCT, than in specimens heat treated conventionally. In steel samples after quenching and DCT the additional exothermic effect was observed. Electron diffraction in TEM studies of these specimens allowed to observe reflections of which indexing exhibited that the precipitated carbide phase has crystallographic structure of B1 type. Research of HS6-5-2 high speed steel allowed concluding that DCT, besides refinement of martensite grain size, causes an increase of quantity of sites for nucleation of clusters, in which during tempering the B1 carbides are formed. These fine, coherent with matrix and stable carbides are found to be responsible for enhancement of toughness and wear resistance of HSS tools. The issue of DCT is a niche topic in Poland, there are no detailed studies on the changes taking place during this process.

Properties



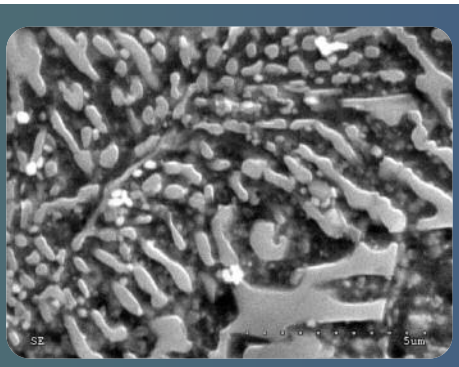
94

The Materials section represented by A.T. Karczemska on "Diamonds in meteorites – Raman mapping and cathodoluminescence studies" on a **page 94** presents the abundance of diamonds existing in the Universe and diamonds diversity among the diversity of other extraterrestrial carbon phases. The main subject of research shown here are example meteorites consisting of diamonds: ureilites DaG 868 and Dho 3013. Results are compared with previous investigations. Diamonds exist in many different meteorites, interplanetary dust particles (IDPs) and in comets dust. The origin of different diamonds is still debated among the scientists, two main possibilities are taken into consideration: CVD process or shock metamorphism. Understanding laboratory techniques of manufacturing diamond helps in understanding the processes taking place in the Space. From the other side, the new findings and discoveries give the new insight to materials science and laboratory techniques. Results show the possibilities of creating the new diamond-based materials similar to those found in meteorites. Diamond polytypes are not well characterised yet and could give some surprises for materials science. For future research it would be interesting to apply more methods such as X-ray diffraction or HRTEM. Diamonds have been found in different samples with different shock stages. It means that not all diamonds in urelites could have shock origin. Diamonds from examined samples show high diversity, they exist in different sizes, from nanodiamonds to micrometer sizes diamonds and in different polytypes. Shifts of Raman diamond peaks indicates this.



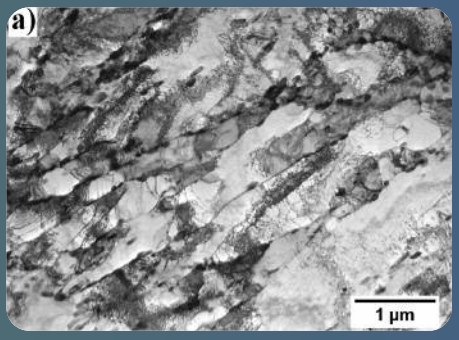
125

An Author: Z. Paszenda in the paper entitled "Use of coronary stents – material and biophysical conditions" on a **page 125** discusses application issues of using the metallic implants for treatment of the cardiovascular diseases. The analysis of the biophysical conditions of the heart – coronary vessels system has been used to distinguish the tissue environment properties which should be compatible with properties of the metal biomaterial and stent's surface. On this basis the author presented results of experiments concerning the usefulness of the passive-carbon layer for surface treatment of vascular stents made of stainless steel. Deposition of the dielectric carbon layer on coronary stents' made of stainless steel is effective method of reducing reactivity of their surface in blood environment and blood clotting in consequence. The need to determine the correct quality and properties of coronary stents was indicated. The properties refer to stents' design, physio-chemical properties of the metallic biomaterial and its surface.



136

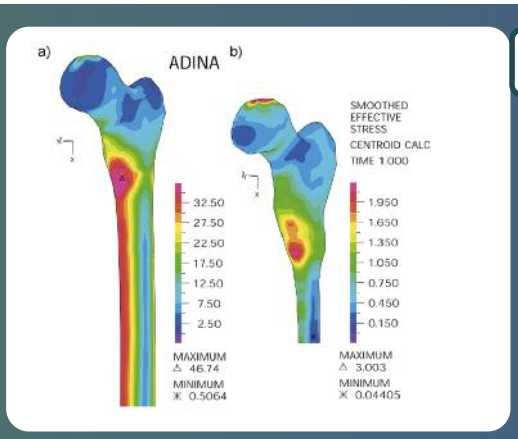
The paper from Materials area made by S. Pietrowski on "High quality casting materials" on a **page 136** describes results of the new developed high quality cast materials. The paper discusses the high quality cast alloy, layer products and presents the high quality casting materials in the point of view principles of materials selection. The following materials are: hypereutectoid cast steel with various microstructure modular graphite obtained in as-cast condition (raw state), ductile cast iron of bainite-martensitic carbides structure obtained in a raw state, aluminum bronzes and silumins with additives of: chromium, molybdenum, wolfram, vanadium. These alloys are characterised primarily by significant mechanical properties and high wear resistance. It was also discussed getting of layer products by combination of steel or cast iron using alphinated layer with silumin. The above problem is shown in the background of "Rules of materials selection" as well as a model of production system in company.



200

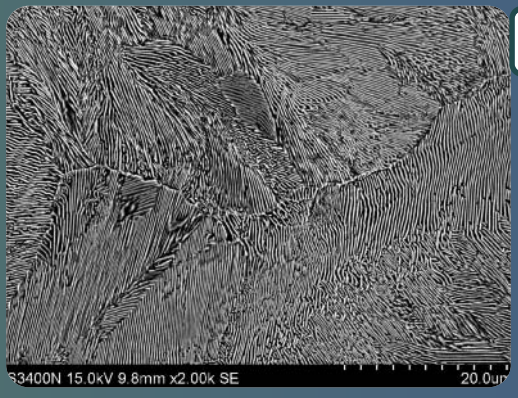
The Materials section represented by A. Zielińska-Lipiec, T. Kozieł and A. Czyrska-Filemonowicz on "Quantitative characterisation of the microstructure high chromium steel with boron for advanced steam power plants" on a **page 200** presents the microstructure of high chromium steel with boron for advanced steam power plants. The present study is focused on the influence of temperature of autenitisation on the microstructure of the VM12 steel with 145ppm boron. The quantitative parameters of the VM12 microstructure were determined. The VM12 steel is a high Cr martensitic steel developed for advanced coal-fired power station operating at temperature higher than 600°C. The microstructure of new 12% chromium steel developed for advanced power stations operated around 625-650°C, has been characterised in order to correlate its structural parameters with steel creep properties. Microstructure of the received condition has a significant influence on creep resistance of 9-12% Cr steels operating at elevated temperatures. Quantitative TEM analyses of steel microstructure were undertaken to determine the dislocation density within the sub-grain, the width of the martensite laths/sub-grains and the particle parameters (shape, size, distribution). Phase identification was performed using electron diffraction and X-ray spectrometry. The influence of the austenitisation temperature (1060-1100°C) on the microstructure of the VM12 steel with 145ppm boron was investigated. The results show that increase of the austenisation temperature caused slight increasing of a sub-grain size and decreasing of dislocation density within sub-grains in the steel tempered at 780°C. The $M_{23}C_6$ and MX particle size was not significantly changed. Quantitative TEM analyses of the VM12 steel microstructure showed that favourable characteristics exhibit the steel which was austenised at 1060°C.

Analysis and modelling



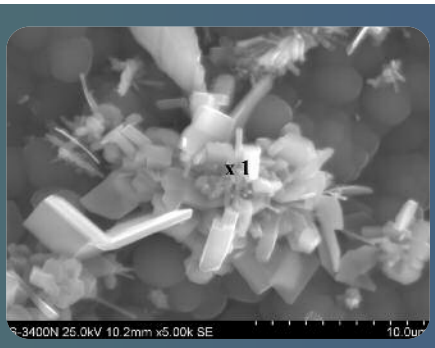
222

The paper entitled "Material and tribological problems occurring during the design and utilisation of hip endoprostheses" by M. Gierzyńska-Dolna, W. Więckowski and H. Wiśniewska-Weinert on a **page 222** demonstrates the influence of frictional pair „endoprosthesis head-acetabular cup" material on frictional resistance and endoprostheses wear, and the stress distribution in the elements of "bone-cement-implant" system. Preservation of geometrical, material and tribological similarity to the natural joints is of great significance in design of hip endoprostheses. Despite significant progress in material engineering not all similarity conditions were achieved. The replacement of a specific bone structure and natural joint with polyurethane insert and metal elements (stem, head of endoprosthesis), i.e. materials with much higher modulus of elasticity, cause the significant increase of the "bone-cement-implant" system rigidity. Frictional and wear processes occurring in the moveable system: "head-acetabular cup" and the resulting low endoprosthesis durability pose a serious problem. Future development of endoprostheses alloplasty is determined by the progress in biotribology, especially frictional and wear tests of endoprostheses. Both the numerical calculations and tests carried out on the hip endoprosthesis simulator gave us many valuable information on frictional resistance value, wear mechanism and durability of new endoprostheses constructions.



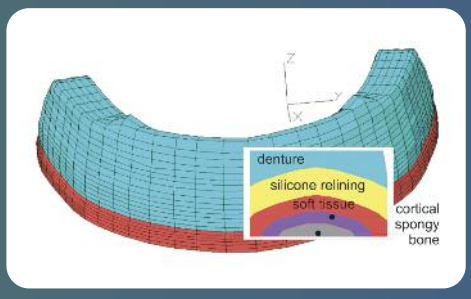
236

In the paper entitled "Abrasive wear of railway sections of steel with a different pearlite morphology in railroad switches" by J. Herian and K. Aniołek on a **page 236** the analyse of pearlite morphology changes as a result of hot rolling process and isothermal annealing is presented. In physical modelling of tests of resistance to abrasive wear for the steel grade R260 after hot rolling and isothermal annealing it has been proved that this feature is a function of the steel structure and properties in the given operation conditions. The resistance to abrasive wear of steel R260 with a pearlitic structure and different pearlite morphology decreases with the increase of load and slide. The obtained test results confirm that these methods can be effectively used in shaping the pearlitic structure and properties of the steel.



252

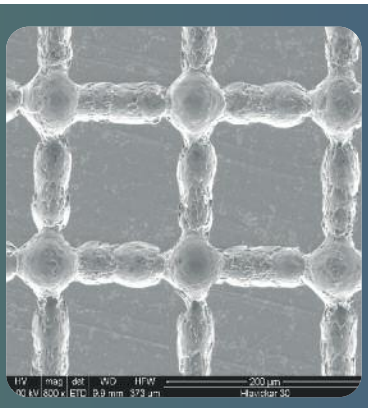
Authors: J. Małecka and W. Grzesik in the paper entitled "High temperature corrosion of Ti-46Al-7Nb-0.7Cr-0.1Si-0.2Ni intermetalics–based alloys in N_2-O_2-SO_2 environments" on a **page 252** presents the test of the intermetalic alloy with improved oxidation and sulfidation resistance to air and a N_2-O_2-SO_2 gas mixture at temperatures higher than 900ºC, typical for working conditions of highly loaded parts of gas turbine. Original value of the paper is the assessing of the oxidation resistance of Ti–46Al–7Nb–0.7Cr–0.1Si–0.2Ni-based intermetallic alloy at the conditions combining high temperature and sulphur-containing atmosphere. The novelty of this research deals with the mechanism of oxidation at such boundary conditions and its quantification. This knowledge can support the design of parts made of the intermetalic alloy. The considered problem is currently important for aeroplane and automotive industry, especially for gas turbine manufacturers. This investigation confirms that oxidation in $9\%O_2+0.3\%SO_2+N_2$ atmosphere causes an increase in the rate of oxidation in comparison to the pure oxidation in air. The main conclusion is that combined oxidation and sulfidation at temperature between 900ºC and 950ºC results in the formation of specific phases at the product-substrate and product-oxide boundaries. One of practical outcomes is to select the thermal conditions and surface preparation technology which guarantee the reduction of oxidation in $9\%O_2+0.3\%SO_2+N_2$ atmosphere. It is recommended to use alloys with higher content of niobium.



324

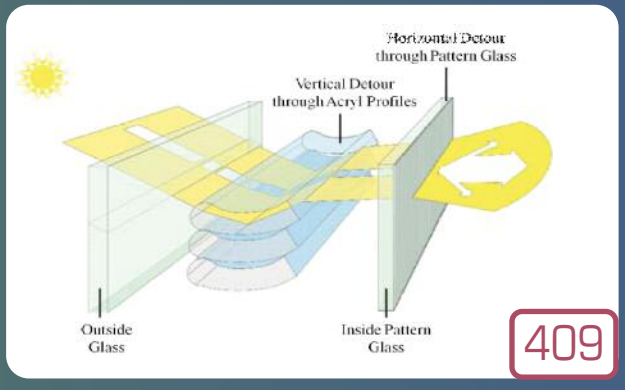
The Analysis and modelling area is shown in the paper on "Denture foundation tissues loading criteria in evaluation of dentures wearing characteristics" by J. Kasperski, J. Żmudzki and G. Chladek on a **page 324**. One of the model simplifying assumptions was the assumption of isotropic linear elasticity of materials mechanical characteristics and denture adherence to its foundation. Maximum shear is observed under mucous surface at bone on the side of process prominence. Soft tissues injuries and pain discomfort might result from exceeding both tolerances of pressure and shear, which maximum values are located in the opposite areas. Maximum pressure values are present in central areas at tips of edentulous ridges. The layers of relining material results in a decrease and balancing of maximum pressure values. It decreases tendencies of slip and frictional injuries occurrence by means of reducing tangential stresses on the mucous interface. Nevertheless, the transfer of a part of loadings on ridges slopes results in increased shear inside of the tissue at the side of the convexity. In a bone tissue at the tips of edentulous ridges decrease of principal stresses and the lack of significant changes of equivalent von Mises stresses are observed. Injuries occurring in the central area of bone convexities are recommended to relining. If, in spite of a proper denture fit, there is still a typical ulceration at the side of the ridges convexity, use of relining increases shear of those area of the tissue, conducing development of a typical deep ulcer located usually from the bone towards the surface of soft tissues.

Manufacturing and processing



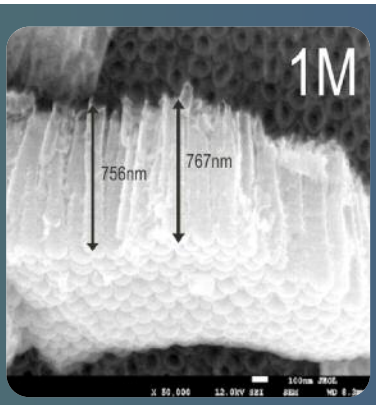
341

The Analysis and modelling section represented by V. Leshchynsky, M. Ignatiev, H. Wiśniewska-Weinert, J. Borowski, T. Rybak and I. Dobrovnik on "Forging tools modification with graphene-like solid lubricant nanoparticles" on a **page 341** presents analysis of failure mechanisms for different forging tools. Working conditions of forging tools have become severer within the years. To increase their wear and heat resistance the surface of the tool is coated by CVD/PVD methods. Relatively high friction coefficient of coatings results in high friction losses and low durability of coating films due to high shear stress at tool–workpiece interface. That is why improved self-lubricating system should be developed. Combination of modern coatings (nanostructured ones, nanolayers, nanocomposites, etc.) with self-lubricating tool design and application of solid lubricant MoS2 and WS2 graphene-like nanoparticles is a very promising and effective way to solve existing forging tool problems. The continuous supply to a sliding area of nanoparticles will be for the first time applied to decrease high shear stress at an interface between forging tool and treated material. The next research step will be the transfer of the developed methods of self-lubrication from samples to real cold forging tools. As a result, increased tool durability and high forging precision could be reached. Analysis of failure mechanisms for different forging tools were carried out. It was found out that one of the important reasons of tool wear is a high friction coefficient between treated material and the tool. Graphene-like nanoparticles of MoS2 solid lubricant were produced by Rolling Cleavage Technology. A paper consists of SEM, TEM and AFM analysis of applied coatings and solid lubricant particles.



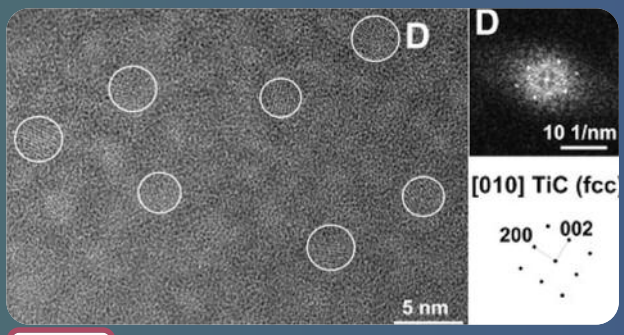
409

In the paper entitled "A brighter place: overview of microstructured sunlight guide" by H. Hocheng, T.Y. Huang, T.H. Chou and W.H. Yang on a **page 409** the overview of the daylighting system using existing and advanced submicron technology for buildings is presented. The approaches of a movable and fixed sunlight guiding system for saving the energy of artificial lighting will be reviewed. The major part is devoted to the sunlight guide panel/film based on a formed prismatic microstructure on transparent substrate by UV-imprint and roll-to-roll process. The reviewed daylighting system with submicron-patterned prismatic sunlight guide panel/film made of inorganic-organic materials is based on the authors' original work of daylighting techniques. It significantly elevates the use of sunlight and saves energy consumption in a building. The analysis reveals the outgoing light above the horizontal level of the transom in a major portion. It indeed provides the adequate indoor daylighting by the proposed sunlight guide panel/film. The authors conclude the proposed prismatic sunlight guide panel/film is a promising approach for guiding daylight into a room.



424

The paper entitled "Tailoring of anodic surface layer properties on titanium and its implant alloys for biomedical purposes" presented by E. Krasicka-Cydzik on a **page 424** shows the different anodizing methods used for formation of thin, thick, gel like covered and nanostructural titania and alloy component oxides. Evaluation of their properties for various biomedical applications in implantology and biosensing. Anodizing of titanium materials in phosphoric acid solutions allowed to obtain surface layers of various morphology and topography. They differ in porosity, thickness and chemical composition and according to their specific properties can be used in various biomedical applications. The development of gel-like layer and formation of nanotube layer was observed while anodizing in higher concentration of electrolyte or anodizing in the presence of fluorides. Both surface layers are much more bioactive than anodic barrier oxide layers on titanium. The primary tests to use nanostructured layer as platform for the third generation biosensors were promising. Phosphate gel-like layer over surface oxide layer on titanium materials and nanostructural surface layer rich in both: phosphates and fluorides, are highly bioactive, which is the desirable property of implant materials. Use of medical implants covered with porous and nanostructural anodic layers tailored to particular biomedical purposes enables new practical applications in implantology and biosensing.



455

In the paper entitled "Hard and superhard nanolaminate and nanocomposite coatings for machine elements based on Ti6Al4V alloy" by B. Wendler, T. Moskalewicz, I. Progalskiy, W. Pawlak, M. Makówka, K. Włodarczyk, P. Nolbrzak, A. Czyrska-Filemonowicz and A. Rylski on a **page 455** verification of a series of hybrid treatments of Ti6Al4V alloy consisting of primary diffusion hardening of the substrate with subsequent deposition of wear resistant coatings is presented. Applicability of the broad spectrum of nanolaminate and nanocomposite coatings as well as different CVD and PVD techniques for an improvement of tribological properties of Ti6Al4V alloy was analyzed in the paper including a newly developed original high density gas pulsed plasma magnetron sputtering technique. Besides an important increase of Ti6Al4V alloy hardness much greater further increase of hardness was obtained due to coatings deposition up to 53 GPa in case of a nanolaminate coating and to 47 GPa in case of a nanocomposite nc-TiN/a-SiN coating. At the same time the volume wear coefficient decreased several orders of magnitude for all the coatings. Simultaneously the friction coefficient decreased to a great extent except for the nc-TiN/a-SiN coating. Greater surface roughness and high resistance to wear of the coatings synthesised using the newly developed gas pulsed plasma magnetron sputtering deposition limited their application to wear protection of cutting tools rather than for friction reduction in tribological couples.

Industrial management and organisation