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ДЕРЖАВНА НАУКОВО-ТЕХНІЧНА БІБЛІОТЕКА УКРАЇНИ

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1. Alcantara-Garcia A. Electrochemical study of the synergic effect of phosphorus and cerium additions on a sol-gel coating for Titanium manufactured by powder metallurgy / Alcantara-Garcia A., Garcia-Casas A., Jimenez-Morales A. // Progress in Organic Coatings. – 2018. – № 124. – P. 267-274. – Mode of access: http://doi.org/10.1016/j.porgcoat.2018.01.026

The goal of this work was to combine the physical barrier properties provided by the sol-gel network with an active-chemistry protection against corrosion provided by corrosion inhibitors and cross-linking agents. Sol-gel coatings, organic–inorganic hybrid materials were prepared by hydrolysis and condensation of (3-glycidyloxypropyl)trimethoxysilane (GPTMS) and tetraethylorthosilane (TEOS) in an ethanol/water solution. This coatings were satisfactorily modified by adding an inhibitor of the corrosion, namely hexahydrate cerium nitrate, and a cross-linking agent, namely tris(trimethylsilyl)phosphite (TMSP). The synergetic effect of these two compounds was evaluated by means of electrochemical characterization. The evolution rate of the hydrolysis-polycondensation reaction was monitored by Fourier-transform infrared spectroscopy and viscosity. Once the hydrolysis-polycondensation rate was reached, sols were deposited on titanium fabricated by powder metallurgy. The morphological characteristics and elemental distribution of the coatings were studied using scanning electrochemical microscopy (SEM). The solid-state of Si-NMR spectroscopy and thermogravimetric analysis (TGA) was employed in order to identify the cross-linking state of the coating by ensuring the creation of enough siloxane bonds. Impedance measurements were carried out to study the effect of cerium and TMSP on the corrosion resistance. It was observed that the coating with additions of cerium presented stable and good barrier features against 5 mM NaCl solution. The synergy between the cerium inhibitor and the TMSP cross-linking agent was found not to exert a positive effect because the electrochemical behaviour was dominated by the phosphorus compound over the cerium.

2. Amiruddin H. Friction reduction of palm kernel activated carbon polymer composite by lubricant impregnation / Amiruddin H., Abdollah M.F.B., Ibrahim M. // Tribology Online. – 2019. – № 14 (5). – P. 411-416. – Mode of access: http://doi.org/10.2474/trol.14.411

The purpose of this research is to propose a technique for friction reduction of palm kernel activated carbon (PKAC) polymer composite by palm oil, paraffin oil and water impregnations. A biocomposite sample formed by mixing epoxy and PKAC was made using the method of powder metallurgy. Before test of dry sliding, the sample was impregnated with palm oil, paraffin oil, and water for about 1–8 days. The test of dry sliding was then conducted at room temperature and by applying constant load, sliding distance and sliding speed. The test of sustainability for checking the biocomposite's ability of maintaining the lubricant was also carried out without any more impregnation. A considerable amount of friction of lubricant-impregnated PKAC composite is reduced although there is increases in residual depth due to plastic deformation in comparison to the sample devoid of any impregnation. Water impregnation caused an unexpected rise in the coefficient of friction within the initial few hours following which it became comparatively steady. The sample impregnated with palm and paraffin oils can soak up the lubricant and sustain it for some time prior to the subsequent inflow. More decrease on the coefficient of friction and residual depth were noticed when the soaking time was raised. Besides, no wear is observed on the surface of all samples impregnated with palm oil. Thus, the application of bio-based lubricant to obtain an improved performance in comparison to the synthetic oil is more worthwhile.

3. Ananta Bhaskararao K. Microstructure, hardness and flexural strength of Ni/Al2O3 FGMs by pressure-less sintering with different cooling rates / Ananta Bhaskararao K., Ranga Janardhana G. // Boletin de la Sociedad Espanola de Ceramica y Vidrio. – 2020. – Mode of access: http://doi.org/10.1016/j.bsecv.2020.03.012

In this work, four-layered functionally graded materials (FGMs) are fabricated with nickel (Ni) and alumina (Al_2O_3) as principle materials. Four FGMs of different compositional layers such as PLS10, PLS15, PLS20 and PLS25 are prepared through powder metallurgy. Developing the Ni/Al_2O_3 FGMs starts

with weighing the elementary powders, blending, stacking and cold compacting followed by pressure-less sintering. The sintering is performed at 1200 °C for 90 min with different cooling rates such as 5 °C/min, 15 °C/min, 20 °C/min and 25 °C/min respectively. In microstructural context, SEM micrographs are the clear evidence for varying microstructure with different percentages of raw materials and cooling rate. Energy dispersive spectroscopy (EDS) technique is used to determine the composition of sintered FGM samples. As a part of mechanical characterization, both green and sintered densities, hardness and flexural strength are evaluated. The results indicate that densities decrease steadily with increased alumina composition and hardness increases with alumina content. The use of PLS15 layer composition with 20 °C/min sinter-cooling rate promoted the best results for the subject FGMs.

4. Aygul E. Microstructural analysis of sintered pure-titanium and titanium/hydroxyapatite (HA) surgical implant materials under different temperatures and HA doped conditions produced by powder metallurgy / Aygul E., Yalcinkaya S., Sahin Y. // Materials Research Express. – 2020. – № 7 (3). – Mode of access: http://doi.org/10.1088/2053-1591/ab7c88

In this study, pure titanium and hydroxyapatite (HA) doped titanium alloys used as Surgical Implant Materials by weight percentage (wt%) of 5 % and 10 % were sintered by powder metallurgy method. Total 9 samples of these alloys are produced, three of them are pure titanium's, which are sintered at 900, 1000 and 1150 °C temperatures, respectively, for 4 h. From the rest of 6 samples, 3 samples were added 5 wt % HA and the last 3 samples were produced by doped 10 wt % HA. Titanium alloys produced by admixture with HA are sintered for 4 h at 900, 1000, 1150 °C temperatures, respectively. Titanium and HA powders were milled for 2 h in a ball-milling mixer and then pressed for half an hour at 20 MPa pressure. EDX, SEM, XRD and Vickers hardness tests were carried out for the analysis of the samples. As a result of the analysis, it was observed that different sintering temperatures caused to various Vickers hardness values and micro-structural changes occurred for pure titanium and HA doped titanium alloys. In addition, multiple phase and Ti plus HA structures were detected in XRD diffractometers of the samples at these temperatures. Most importantly, for the first time in our study, P_3Ti_5 phase was revealed with 00-045-0888 > XRD card. Finally, the effects of sintering temperatures and HA-doped amounts on particle sizes and pore sizes of the samples were determined by SEM analysis.

5. Balancing strength and ductility in al matrix composites reinforced by few-layered mos2 through in-situ formation of interfacial al12mo / Fan L., Yang L., Zhao D., Ma L., He C., He F., Shi C., Sha J., Zhao N. // Materials. – 2021. – № 14 (13). – Mode of access: http://doi.org/10.3390/ma14133561

In this work, few-layered MoS_2 (FLM) nanosheet-reinforced Al matrix composites are developed through powder metallurgy and hot extrusion. The microstructure, mechanical properties, and strengthening mechanisms have been systematically investigated. It is found that $Al_{12}Mo$ and Al_2S_3 can be formed in-situ during the sintering process, resulting in the improvement of interfacial bonding between FLM and Al matrix. With 1.5 wt.% of FLM addition, an improved tensile strength of 234 MPa with a high elongation of 17% can be obtained. Moreover, the strengthening mechanisms are also demonstrated to be grain refinement, dislocation strengthening, and load transfer, and the calculation indicates that load transfer is the main contribution factor. This work will inspire more new designs of metal matrix composites with balanced strength and ductility.

6. Bhouri M. Analysis of thermo-elastic and physical properties of recycled 2017 Aluminium Alloy/Gp composites: Thermal management application / Bhouri M., Mzali F. // Materials Research Express. – 2020. – № 7 (2). – Mode of access: http://doi.org/10.1088/2053-1591/ab5eeb

This paper investigates the use of graphite in 2017 Aluminium matrix composite for thermal management systems by analyzing their thermo-elastic behavior. The composite samples were prepared with different graphite contents using powder metallurgy method based on recycled 2017 Aluminium alloy powder. The

distribution of graphite particles in the 2017 Aluminium alloy matrix was investigated by a scanning electron microscope (SEM). Sintered densities of the composite samples were examined by a gravimetric method and it is noticed that in the fact of increasing the graphite content decreases the densification of composites which is confirmed by SEM analysis. Thereafter, the obtained samples were analyzed by dilatometry through measuring the coefficient of thermal expansion (CTE), which showed a decrease with the addition of graphite.

7. Bio-mimic Ti–Ta composite with hierarchical “Brick-and-Mortar” microstructure / Xu S., Du M., Li J., Yan K., Cai B., H, Q., Fang Q. Magdysyuk O., Liu B., Yang Y., Liu Y. // Materialia. – 2019. – № 8. – Mode of access: http://doi.org/10.1016/j.mtla.2019.100463

Nature materials, such as bones and nacre, achieve excellent balance of toughness and strength via a hierarchical “brick-and-mortar” microstructure, which is an attractive model for engineering materials design. Here, we produced nacre-like Ti–Ta metallic composites via a powder metallurgy process, during which mixed powders were sintered by spark plasma sintering, followed by hot and cold rolling and then annealing. The structure consists of soft Ta-enriched regions and hard Ti-enriched regions in a hierarchical and laminated fashion. The microstructural heterogeneity spans several scales due to the diffusion between Ti and Ta. This yields a novel metal–metal composite with a balanced combination of strength and ductility (1226 MPa ultimate tensile strength and 20.8% elongation), outperforming most of conventional Ti based alloys and composites. Via the complementary in situ synchrotron X-ray diffraction and electron microscopies, it is found out that multiple micromechanisms are active, including nano-particle and dislocation localized strengthening as well as phase transformation induced plasticity. The manufacturing route developed here is versatile, capable of making high performance bio-mimic metallic composites.

8. Carbon fibers coated with graphene reinforced TiAl alloy composite with high strength and toughness / Cui S., Cui C., Xie J., Liu S., Shi J. // Scientific Reports. – 2018. – № 8 (1). – Mode of access: http://doi.org/10.1038/s41598-018-20799-y

To meet the more rigorous requirement in aerospace industry, recent studies on strengthening and toughening TiAl alloys mostly focus on high Nb addition, which inevitably bring in an increasing of density. In this study, a carbon fibers coated with graphene reinforced TiAl alloy composite was fabricated by powder metallurgy, melt spun and vacuum melting. This composite got remarkable mechanical properties combined with a prominent density reduction. In contrast with pure TiAl ingots, this sample exhibits an average fracture strain from 16% up to 26.27%, and an average strength from 1801 MPa up to 2312 MPa. Thus, we can achieve a new method to fabricate this low-density, good mechanical performance TiAl composite which could bring in more opportunities for application in aerospace industry.

9. Characterization of non-ferrous metal powders / Kraner J., Medved J., Godec M., Paulin I. // Materiali in Tehnologije. – 2020. – № 54 (1). – P. 149-153. – Mode of access: http://doi.org/10.17222/mit.2019.213

With the extended use of additive manufacturing in the past few years, powder metallurgy is quickly acquiring a more important role in world industry. Because the metal powder represents the initial material for most of additive-manufacturing processes, the properties of final products are directly influenced by the powder properties. Besides the product properties, the chosen process parameters are based on the characteristics of the powder. In this work the physical and thermal properties as well as the microstructure of different non-ferrous metal powders were investigated. The flow rate, tap and apparent density, angle of repose, compression factor and Hauser ratio were measured or calculated. The microstructures of separate metal powder particles were observed with a light microscope. The particles' shape, size and roughness were investigated with a scanning electron microscope and the correlations with the determined physical properties were found. From the heating and cooling cycle curves of different scanning calorimetries the

liquid and solidification temperatures were determined and the influence of the chemical composition on them was observed.

10. Densification, microstructure and mechanical performance of TiC/Fe composites by spark plasma sintering / Huang L., Pan Y., Zhang J., Liu A., Du Y., Luo F. // Journal of Materials Research and Technology. – 2020. – № 9 (3). – P. 6116-6124. – Mode of access: http://doi.org/10.1016/j.jmrt.2020.04.014

In this study, the effects of the TiC content (10, 20, 30 and 40 vol. %) on the densification, microstructure, mechanical performance and friction properties of TiC/Fe composites were investigated. The combination of powder metallurgy (PM) method and spark plasma sintering (SPS) was used to prepare high-density TiC/Fe composites. The results show that the TiC/Fe composites experienced the dominating densification below 600 ◦C. The subsequent densification was restricted by the limited diffusion and dissolution between the TiC particles and Fe matrix, which has been verified by thermodynamic calculations in the present work. The hardness and bending strength of TiC/Fe composites improved until the maximum value, and then followed a decreasing trend with TiC content further increasing. The 20 vol. % TiC/Fe composite reached the highest bending strength of 1318 MPa, while the maximum hardness of 36.0 HRC was attained for the composite with 30 vol. % TiC. Fe binder plastic tearing, transgranular failure and intergranular failure were the main fracture mechanisms of TiC/Fe composites. In addition, the specific wear rate of the TiC/Fe samples increased with increasing TiC content, which should be ascribed to the severe oxidation of worn surfaces under load of 10 N and slide distance of 800 m.

11. Dry sliding wear investigation on tungsten carbide particles reinforced iron matrix composites / Grairia A., Beliardouh N.E., Zahzouh M., Nouveau C., Besnard A. // Materials Research Express. – 2018. – № 5 (11). – Mode of access: http://doi.org/10.1088/2053-1591/aade07

WC particles reinforced Fe-based metal matrix composites were synthesized by powder metallurgy process. The microstructure and composition of the specimens were analyzed and the wear-resistant properties against WC and alumina balls were comparatively investigated by SEM/EDS analyses. The wear rates of specimens were evaluated by optical profilometry. Microstructure exhibited austenite Fe-FCC dendrites, eutectic (iron austenite + FOR carbides) and primary carbides. Two wear mechanisms have been identified from SEM as main mechanisms during dry sliding wear of Tungsten carbides reinforced iron matrix, namely oxidation and abrasion. The overall wear performance, which is obtained by considering the wear loss of the substrates, indicated less resistance against Alumina compared to WC ball contact.

12. Ductility improvement mechanism of Ti6Al4V+O sintered material / Kamiyama K., Kariy, S., Fukuo M., Umeda J., Kondoh K. // Materials Transactions. – 2020. – № 61 (3). – P. 430-437. – Mode of access: http://doi.org/10.2320/matertrans.Y-M2019869

The previous study indicated powder metallurgy (PM) Ti-64 alloys with oxygen showed the increment of not only their tensile strength but elongation. This study investigated the elongation improvement mechanism of Ti-64 alloys with oxygen atoms. The mix of Ti-64 alloy powder and TiO_2 particles (0~0.4 mass%) was used as starting materials and consolidated by spark plasma sintering (SPS). The following heat treatment in vacuum was applied to sintered materials. βtransus temperature increased by oxygen addition because it was one of α-phase stabilizer elements. Prior-β grains size and aspect ratio of α-Ti grains were changed by heat treatment conditions. For example, Ti-64+O alloys after heattreated at β-phase temperature range showed acicular α-Ti grains with a large aspect ratio (6.1~7.0) although those with heat treatment at α+β- phase temperature had α-grains with a small aspect ratio of 3.3~4.0. These grain morphology changes strongly depended on the temperature of heat treatment, not oxygen contents. In addition, the latter materials indicated high elongation (16~17 %) compared to the former with 9~10%.

When Ti-64+O alloy specimens after tensile test were analyzed by SEM-EBSD, Kernel average misorientation (KAM) maps showed many plastic strains induced in small aspect ratio α-Ti grains.

13. Dunstan M.K. The effects of microstructure and porosity on the competing fatigue failure mechanisms in powder metallurgy Ti-6Al-4V / Dunstan M.K., Paramore J.D., Fang, Z.Z. // International Journal of Fatigue. – 2018. – № 116. – P. 584-591. – Mode of access: http://doi.org/10.1016/j.ijfatigue.2018.07.006

In near-net-shape manufacturing methods, such as powder metallurgy, additive manufacturing, and metal injection molding, porosity has historically been viewed as the sole limiting factor for fatigue life. This is because pores tend to act as stress concentrators. However, in this work, a fractographic analysis of Ti-6Al-4V produced through several powder metallurgy techniques has shown that microstructural faceting due to slip can cause fatigue failure, even in the presence of porosity. The likelihood of pore related failure was found to be dependent on microstructure size and morphology. Additionally, a minimum pore size threshold was found to exist for each microstructure, under which pores will not cause fatigue failure. A simple model was developed to determine this threshold based on the microstructural characteristics of the material. This model was then compared to experimental data and properly predicted the fatigue failure mechanism in over 99% of the samples examined.

14. Effect of La on microstructures and mechanical properties of Cu/Ti3SiC2/C nanocomposites sintered by vacuum hot-pressing and hot isostatic pressing / Lv L., Jiang X.-S., Zhang M.-M., Sun H.-L., Shao Z.-Y., Fu N.-N., Jin W.-T. // Materials Research Express. – 2020. – № 7 (2). – Mode of access: http://doi.org/10.1088/2053-1591/ab5df6

Researches have shown that the addition of trace amounts of rare earth element lanthanum (La) to the alloys and composites can significantly improve their microstructure and properties. In this work, Cu/Ti_3SiC_2/C composites with 0.05wt%, 0.1wt% and 0.3wt% La were prepared by powder metallurgy methodthrough mechanical alloying, hot-pressing (HP) and hot isostatic pressing (HIP). The effects of different La contents on the microstructure and mechanical properties of Cu/Ti_3SiC_2/C composites were investigated. The results show that La has a refinement effect on the grain of the matrix, and with the increase of La content, the size of the matrix of the composite becomes smaller. As the content of La increases, the performance of the composite exhibits a tendency to increase first and then decrease. The composite of 0.1wt% La exhibited the best performance with a hardness of 97.8 MPa, a tensile strength of 174.9 MPa, and a compressive strength and shear strength of 461.1 MPa and 102.1 MPa, respectively. Since the dimple is observed, the tensile fracture indicates that the fracture mode is a ductile fracture. The enhancement mechanism of La mainly includes dispersion strengthening and fine grain strengthening.

15. Effects of compaction and heat treatment on the soft magnetic properties of iron-based soft magnetic composites / Pan Y., Peng J., Qian L., Xiang Z., Lu W. // Materials Research Express. – 2020. – № 7 (1). – Mode of access: http://doi.org/10.1088/2053-1591/ab6acc

Iron-based soft magnetic composites (SMCs) are promising substitutes for laminate steels in electromagnetic applications due to their excellent magnetic properties and productivity. However, the preparation process is a key factor in deciding the magnetic performance of SMCs. In this work, the Fe-based soft magnetic composites with improved soft magnetic properties were achieved by optimizing the compaction and the annealing process. Results showed that the core-shell structure of powders which would directly have an impact on the permeability and the core loss of the SMCs could be affected by the compaction and the annealing process. In addition, the magnetic properties were enhanced by tuning the microstructure. As a result, the optimal magnetic performance of the compact with high permeability and low total core loss was obtained. The real part of the permeability of the soft magnetic composites could reach a maximal value of 336.8 and a rather low core loss of 2.5 W Kg^{-1} (measured at 50 mT and 5 kHz).

Therefore, soft magnetic composites with enhanced magnetic properties were obtained by optimizing the powder metallurgy (PM) process in this study.

16. Effects of eutectic modification and grain refinement on microstructure and properties of PM AlSi7 metallic foams / Lehmhus D., Hünert D., Mosler U., Martin U., Weise J. // Metals. – 2019. – № 9 (12). – Mode of access: http://doi.org/10.3390/met9121241

For AlSi7 foams, microstructure modification by variation of solidification rates and addition of Sr, B and TiB2/TiAl3 was investigated and its transfer to powder metallurgical metal foaming processes demonstrated. Microstructural characterization focused on grain size and morphology of the eutectic phase. Cooling rates during solidification were linked to secondary dendrite arm spacing, establishing a microstructure-based measure of solidification rates. Effects of refining and modification treatments were compared and their influence on foam expansion evaluated. Studies on foams focused on comparison of micro-and pore structure using metallographic techniques as well as computed tomography in combination with image analysis. Reference samples without additives and untreated as well as annealed TiH2 as foaming agent allowed evaluation of pore and microstructure impact on mechanical performance. Evaluation of expansion and pore structure revealed detrimental effects of Sr and B additions, limiting the evaluation of mechanical performance to the TiB2 samples. These, as well as the two reference series samples, were subjected to quasi-static compression testing. Stress-strain curves were gained and density-dependent expressions of ultimate compressive strength, plateau strength and tangent modulus derived. Weibull evaluation of density-normalized mechanical properties revealed a significant influence of grain size on the Weibull modulus at densities below 0.4 g/cm^3.

17. Elumalai P.C. Synthesis and characterisation of magnesium matrix composite reinforced with titanium dioxide nanoparticulates / Elumalai P.C., Ganesh R. // Materials Research Express. – 2020. – № 7 (1). – Mode of access: http://doi.org/10.1088/2053-1591/ab6ca3

In the present work, magnesium matrix composite reinforced with titanium dioxide (TiO_2) nanoparticulates was synthesized using powder metallurgy (solid-state processing) technique followed by hybrid microwave heat treatment and hot extrusion. Commercially available magnesium particulates of average particle size 60-300 μm and titanium oxide nanoparticulates of average particle size ~21 nm was used in this study. Extruded samples of pure magnesium and magnesium titanium dioxide (Mg-TiO_2) nanocomposites were characterized for their physical, surface and internal microstructure (2D & 3D), elemental composition and mechanical behaviour. The experimental density and porosity of the composite specimens increases gradually with increase in addition of TiO_2. Scanning electron micrographs (SEM) composite samples revealed that the nano TiO_2 particulates distributed uniformly throughout the matrix with no significant agglomeration. The same was confirmed through 3D internal microstructure also. The elemental composition, crystalline structure was measured using X-ray diffractograms (XRD) which confirm that no foreign elements exists. Further, the microhardness and nanoindentation of composite samples showed an increasing trend with increase in addition of TiO_2 nanoparticles.

18. Enhanced arc erosion resistance of TiB2/Cu composites reinforced with the carbon nanotube network structure / Long F., Guo X., Song K., Jia S., Yakubov V., Li S., Liang S. // Materials and Design. – 2019. – № 183. – Mode of access: http://doi.org/10.1016/j.matdes.2019.108136

The continuous network structure induced by carbon nanotubes (CNTs) was introduced to TiB_2/Cu composites by electroless deposition, slurry dispersion and powder metallurgy to enhance arc erosion resistance. The arc erosion characteristics of the TiB_2/Cu-CNT composites at a current ranging from 10 A to 20 A were investigated. The mechanisms of enhanced arc erosion resistance by the CNT network structure were elaborated based on microstructure and physical characteristics as well. The results show that with the introduction of continuous CNT network structure, arc energy was reduced by more than 83%, there were almost no fluctuation of arc energy and the welding force was relatively low at current

above 15 A for TiB_2/Cu-1.2 vol% CNT composite in comparison with the CNT unreinforced TiB_2/Cu composite. The continuous network structure facilitated the cathode arc motion and dispersed the cathode arc, mitigating the concentrated deterioration of arc erosion. Simultaneously, CNTs could float much easily at the surface of molten pool to weaken the Cu splashing. The CNT network structure delayed the formation of the deeper crater on the cathode and the protrusion with a sharper tip on the anode. Furthermore, it could prevent the formation of cracks and fracture of anode protrusion.

19. Enhanced bending strength and thermal conductivity in diamond/Al composites with B4C coating / Sun Y., Zhang C., He L., Meng Q., Liu B.-C., Gao K., Wu J. // Scientific Reports. – 2018. – № 8 (1). – Mode of access: http://doi.org/10.1038/s41598-018-29510-7

Diamond/Al composites containing B_4C-coated and uncoated diamond particles were prepared by powder metallurgy. The microstructure, bending strength and thermal conductivity were characterized considering the B_4C addition and diamond fraction. The influence of B_4C coating and fraction of diamond on both bending strength and thermal conductivity were investigated. The bending strength increased with decreasing diamond fraction. Moreover, addition of B_4C coating led to an obvious increase in bending strength. The peak value at 261.2 MPa was achieved in the composite with 30 vt.% B_4C-coated diamond particles, which was about twice of that for 30 vt. % uncoated diamond/Al composite (140.1 MPa). The thermal conductivity enhanced with the increase in diamond fraction, and the highest value (352.7 W/m·K) was obtained in the composite with 50 vt. % B_4C-coated diamond particles. Plating B_4C on diamond gave rise to the enhancement in bending strength and thermal conductivity for diamond/Al composites, because of the improvement of the interfacial bonding between diamond and aluminum matrix.

20. Enhanced osteoinductivity and corrosion resistance of dopamine/gelatin/rhBMP-2–coated β-TCP/Mg-Zn orthopedic implants: An in vitro and in vivo study / Liu C., Wang J., Gao C., Wang Z., Zhou X., Tang M., Yu K., Deng Y. // PLoS ONE. – 2020. – № 15 (1). – Mode of access: http://doi.org/10.1371/journal.pone.0228247

Magnesium-based biomaterials are attracting increasingly more attention for orthopedic applications based on their appropriate mechanical properties, biodegradability, and favorable biocompatibility. However, the high corrosion rate of these materials remains to be addressed. In this study, porous β-$Ca_3(PO_4)_2$/Mg-Zn (β-TCP/Mg-Zn) composites were fabricated via a powder metallurgy method. The β-TCP/Mg-Zn composites with 6% porosity exhibited optimal mechanical properties, and thus, they were selected for surface modification. A novel dopamine/gelatin/recombinant human bone morphogenetic protein-2 (rhBMP-2) coating with demonstrated stability was prepared to further improve the corrosion resistance of the composite and enhance early osteoinductivity. The homogeneously coated β-TCP/Mg-Zn composite showed significantly improved corrosion resistance according to electrochemical and immersion tests. In addition, extracts from the dopamine/ gelatin/rhBMP-2–coated β-TCP/Mg-Zn composite not only facilitated cell proliferation but also significantly enhanced the osteogenic differentiation of Sprague–Dawley rat bone marrow-derived mesenchymal stem cells in vitro. Furthermore, in vivo experiments were performed to evaluate the biodegradation, histocompatibility, and osteoinductive potential of the coated composite. No obvious pathological changes in the vital visceral organs were observed after implantation, and radiography and hematoxylin-eosin staining showed strong promotion of new bone formation, matched composite degradation and bone regeneration rates, and complete absorption of the released hydrogen gas. Collectively, these results indicate that the dopamine/gelatin/rhBMP-2–coated β-TCP/Mg-Zn composite offers improved corrosion resistance, favorable biocompatibility, and enhanced osteoinductive potential for use in the fabrication of orthopedic implants.

21. Experimental and finite element simulation study of capsule-free hot isostatic pressing of sintered gears / Vattur Sundaram M., Khodaee A., Andersson M., Nyborg L., Melander A. // International Journal of Advanced Manufacturing Technology. – 2018. – № 99 (5-8). – P. 1725-1733. – Mode of access: http://doi.org/10.1007/s00170-018-2623-4

A novel approach to reach full density in powder metallurgy (PM) components is demonstrated in this work. Water-atomised Mo-prealloyed steel powder is utilised for manufacturing cylindrical and gear samples through double pressing and double sintering (DPDS) process route. The effect of sample geometry and powder size fraction on densification is investigated and it is found that the DPDS route enables a density level of > 95 % which is sufficient to eliminate the surface open pores. Reaching such high density is necessary, in order to perform capsule-free hot isostatic pressing (HIP). After HIP, full densification is achieved for the cylindrical samples and only near full density is realised for the gears resulting in neutral zone formation due to the density gradient. In order to predict the densification behaviour during the compaction, FEM simulations considering the gear geometry are performed for both the pressing stages and HIP. The simulation predicted a similar densification behaviour with the formation of the neutral zone. The proposed DPDS route with capsule-free HIP in combination with FEM simulation is demonstrated as a potential route for manufacturing full-density PM steel components, e.g. gears, suitable for high-performance applications.

22. Fabrication and properties of Al2O3-Al cermet materials using different raw material composition parameter / Song J., Liu Y., Wu C., Yang X., Gong Y., Huang J., He C., Luo H., Chen A. // Journal of Ceramic Processing Research. – 2020. – № 21 (1). – P. 21-25. – Mode of access: http://doi.org/10.36410/jcpr.2020.21.1.21

Cermet application is extensive because it retains the characteristics of ceramic materials and has the advantages of metal materials. In this paper, alumina/aluminum cermet materials were prepared through powder metallurgy method. The influence of raw material formula on the properties of alumina/aluminum cermet was investigated on the basis that ceramic materials have good wear resistance and high thermal conductivity. Results show that when the mass ratio of alumina to aluminum is 1:3, the prepared cermet samples have excellent properties, highest density, and uniform distribution of aluminum and alumina. MgO addition exhibits better effect, higher degree of densification, and renders higher hardness and strength for the sample as compared with SiO_2 and Y_2O_3 addition. The sintered cermet with composite powder prepared via precipitation has better properties and higher densities and surface hardness than that prepared via the ball mill method. The relative density was 97.1 %, surface hardness was 875 HV, and electric resistance was 0.0169 Ω·m.

23. Fabrication of Carbon Nanotubes and Rare Earth Pr Reinforced AZ91 Composites by Powder Metallurgy / Li N., Yan H., Wu Q., Cao Z. // Chinese Journal of Mechanical Engineering (English Edition). – 2021. – № 34 (1). – Mode of access: http://doi.org/10.1186/s10033-021-00545-8

It can be known from a large number of research results that improving the dispersibility of CNTs can effectively optimize the mechanical properties of the corresponding metal matrix composites. However, the crucial issue of increasing the bonding of CNTs and the matrix is still unsolved. In this paper, a novel method was developed to increase interfacial bonding strength by coating titanium oxide (TiO_2) on the surface of CNTs. The rare earth Pr and TiO2@CNTs-reinforced AZ91matrix composites were successfully fabricated by powder metallurgy. Hot press sintering and hot extrusion of the milled powder was performed. After hot extrusion, the influence of TiO_2@CNTs on the microstructure and mechanical properties of the composites were investigated. The results showed that the coating process can improve the distribution of CNTs in Mg alloy. The CNTs refined the grains of the matrix, and the CNTs were presented throughout the extrusion direction. When the TiO_2@CNTs content was 1.0 wt. %, the yield strength (YS), ultimate tensile strength (UTS), and elongation of the alloy attained maximum values. The values were improved by 23.5 %, 82.1 %, and 40.0 %, respectively, when compared with the AZ91 alloy.

Good interfacial bonding was achieved, which resulted in an effective tensile loading transfer at the interface. CNTs carried the tensile stress and were observed on the tensile fracture.

24. Grain refinement of Ti-15Mo-3Al-2.7Nb-0.2Si alloy with the rotation of TiB whiskers by powder metallurgy and canned hot extrusion / Hou J., Gao L., Cui G., Chen W. Zhang W., Tian W. // Metals. – 2020. – № 10 (1). – Mode of access: http://doi.org/10.3390/met10010126

In situ synthesized TiB whiskers (TiBw) reinforced Ti-15Mo-3Al-2.7Nb-0.2Si alloys were successfully manufactured by pre-sintering and canned hot extrusion via adding TiB_2 powders. During pre-sintering, most TiB2 were reacted with Ti atoms to produce TiB. During extrusion, the continuous dynamic recrystallization (CDRX) of β grains was promoted with the rotation of TiBw, and CDRXed grains were strongly inhibited by TiBw with hindering dislocation motion. Eventually, the grain sizes of composites decreased obviously. Furthermore, the stress transmitted from the matrix to TiBw for strengthening in a tensile test, besides grain refinement. Meanwhile, the fractured TiBw and microcracks around them contributed to fracturing.

25. Hybrid aluminum matrix composites containing carbon nanotubes and zirconium diboride particles: fractography, microstructure and mechanical performance / Farooqi A., Ahmed M., Subhani T., Husain S.W. // SN Applied Sciences, - 2019. – № 1 (12). – Mode of access: http://doi.org/10.1007/s42452-019-1767-7

Hybrid aluminum matrix composites (HAMCs) containing carbon nanotubes (CNTs) and zirconium diboride (ZrB_2) particles were prepared via solid-state powder metallurgy route. The constituents of HAMCs were initially ball milled for uniform dispersion, and subsequently composite mixtures were consolidated by cold compaction, which was followed by pressureless sintering. The fractions of nanotubes and ceramic particles in HAMCs were 0.5 wt % and 5.0 wt %, respectively. Individually reinforced composites containing 0.5 wt % MWCNTs and 5.0 wt % ZrB_2 particles were also prepared for reference together with pure aluminum. X-ray diffraction identified the crystalline phases while optical and scanning electron microscopy revealed uniform dispersion of reinforcements without their agglomeration. Mechanical characterization showed a significant rise in the properties of HAMCs over unreinforced aluminum and composites containing individual reinforcements. The improvements of ~ 26 %, ~ 34 % and ~ 19% in hardness, compressive strength and flexural strength were observed in comparison with pure aluminum, respectively. The examination of fractured surfaces revealed the strengthening mechanisms responsible for the improvement in mechanical performance of HAMCs.

26. Influence of multiwall carbon nanotube on mechanical and wear properties of copper - Iron composite / Hammood H.S., Irhayyim S.S., Awad A.Y., Abdulhadi H.A. // International Journal of Automotive and Mechanical Engineering. – 2020. – № 17 (1). – P. 7570-7576. – Mode of access: http://doi.org/10.15282/IJAME.17.1.2020.06.0561

Multiwall carbon nanotubes (MWCNTs) are attractive due to their novel physical and chemical characteristics, as well as their larger aspect ratio and higher conductivity. Therefore, MWCNTs can allow tremendous possibilities for the improvement of the necessarily unique composite materials system. The present work deals with fabrication of Cu-Fe/CNTs hybrid composites by powder metallurgy techniques. Copper powder with 10 vol. % of iron powder and different volume fractions of Multi-Wall Carbon Nanotubes (MWCNTs) were mixed to produce hybrid composites. The hybrid composites were fabricated by adding 0.3, 0.6, 0.9, and 1.2 vol. % of MWCNTs to Cu- 10 % Fe mixture using a mechanical mixer. The samples were compressed under a load of 700 MPa using a hydraulic press to compact the samples. Sintering was done at 900°C for 2 h at 5°C/min heating rate. The microscopic structure was studied using scanning electron microscope (SEM). The effect of CNTs on the mechanical and wear properties, such as micro-hardness, dry sliding wear, density, and porosity were studied in detail. The wear tests were carried out at a fixed time of 20 minutes while the applied loads were varied (5, 10, 15, and 20 N). SEM images revealed that CNTs were uniformly distributed with relative agglomeration within the Cu/Fe matrix. The

results showed that the hardness, density, and wear rates decreased while the percentage of porosity increased with increasing the CNT volume fraction. Furthermore, the wear rate for all the CNTs contents increased with the applied load.

27. Investigations into microstructure and mechanical properties of Mg-5 wt. % Cu-TiB2 composites produced via powder metallurgy route / Stalin B., Ravichandran M., Mohanavel V., Raj L.P. // Journal of Mining and Metallurgy, Section B: Metallurgy. – 2020. – 56 (1). – P. 99-108. – Mode of access: http://doi.org/10.2298/JMMB190315047S

Magnesium alloy matrix composite reinforced with constant weight fraction of 5% Cu and various weight fractions of (0 %, 5 %, 10 %, 15 %) titanium diboride (TiB_2) fabricated by Powder Metallurgy route. In this work, the mechanical properties like hardness, impact strength, compression strength, and wear rate of the Mg-Cu alloy and fabricated composites were investigated. The results showed that the addition of weight percentage of 15 % TiB_2 increased the hardness value about 58.56 HV, due to better bonding between the Mg-Cu and TiB_2. Further, impact and compressive strengths improved, as the weight percentage of TiB_2 increased. Uniform distribution of reinforced particles enhanced the impact strength and the work hardening effect improved the compression strength. Moreover, the wear rate decreased about 0.0112 mg by the addition of weight percentage of 15% TiB_2. X-ray diffraction (XRD) analysis was carried out for each composition. Optical microscopy, scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) tests were conducted to study the characterization of the base alloy and the prepared new composite.

28. Laser sintering of cold-pressed Cu powder without binder use / Constantin L., Fan L., Mortaigne B., Keramatnejad K., Zou Q., Azina C., Lu Y.F., Silvain J.-F. // Materialia. – 2018. – № 3. – P. 178-181. – Mode of access: http://doi.org/10.1016/j.mtla.2018.08.021

In this work, laser sintering (LS) of cold-pressed copper (Cu) powder without using a binder was demonstrated. To promote the densification of the final part, the Cu powder was cold pressed beforehand, thereby forming a densely packed powder bed for the LS. The densification and microstructural evolution study show that the cold-pressed powder led to an increase of up to 11 % in the relative density and a decrease of 10 times in the surface roughness. The influence of the scan speed on the densification and sintering quality was studied. A relatively slow scan speed, 25 μm/s, allowed sufficient atomic diffusion during the LS process and ultimately produced dense Cu parts without cracks and open pores. The introduction of the cold-pressing step into the LS process is critical for achieving high-density powder metallurgy parts without using binders.

29. Mechanical and wear properties of hybrid aluminum matrix composite reinforced with graphite and nano MgO particles prepared by powder metallurgy technique / Irhayyim S.S., Hammood H.S., Mahdi A.D. // AIMS Materials Science. – 2020. – № 7 (1). – P. 103-115. – Mode of access: http://doi.org/10.3934/MATERSCI.2020.1.103

In the present study, aluminum-5 wt% graphite self-lubricating composites with 0, 1.5, 2.5, 3.5, and 4.5 wt % of MgO nanoparticles were prepared by utilizing powder metallurgy route to achieve high mechanical and wear properties. The hybrid composites were characterized by using a scanning electron microscope (SEM) and X-ray Diffractometer (XRD). The dry sliding wear test was performed under various loads of 5, 10, 15 and 20 N at a constant sliding distance of 1810 m. It was found that increasing nano-MgO content results in a decrease in density and an increase in porosity. By increasing the weight fraction of MgO nanoparticles improved both the micro-hardness and diametral compressive strength, until an optimum value up to 2.5 wt % and then, the severe reduction was observed. The wear rate reduced with improving the amount of nano-MgO particles up to 2.5 wt % then increased for all applied loads and also the wear rate is still lower when the MgO content is 1.5 and 3.5 wt % compared with that without MgO nanoparticles. Additionally, the wear rate for all hybrid composites positively correlated with the applied

loads. Lastly, the results revealed that the hybrid composites with 2.5 wt % MgO nanoparticles showed better mechanical and wear properties.

30. Mechanical, corrosion and wear characteristics of powder metallurgy processed Ti-6Al-4V/B4C metal matrix composites / Soorya Prakash K., Gopal P.M., Anburose D., Kavimani V. // Ain Shams Engineering Journal. – 2018. – № 9 (4). – P. 1489-1496. – Mode of access: http://doi.org/10.1016/j.asej.2016.11.003

Titanium alloys are used in aerospace and automotive applications because of its high specific strength, stiffness and good machinability but its wear resistance is inadequate. To eliminate this property lag Boron Carbide (B_4C) ceramic particles are reinforced with Ti-6Al-4V through powder metallurgy route (PM). Reinforcement particles are mixed with base alloy for the weight percentage of 0,5 and 10 so as to analyse the effect of reinforcements on mechanical, corrosion and wear properties. This research outcome corresponds to decreased density, increased hardness and corrosion resistance capability for significant increase in B_4C content of the newer composite developed and tested. Applied load signify higher effect on wear performance of the composite specimens followed by B_4C addition percentage. Scanning Electron Microscope results reveal that B_4C reinforced Ti-6Al-4V composite comprise for higher wear resistance and illustrate mild worn surface when compared to that of unreinforced Ti alloy.

31. Microstructure and high-temperature wear performance of FeCr matrix self-lubricating composites from room temperature to 800°C / Cui G., Liu Y., Gao G., Liu H., Kou Z. // Materials. – 2020. – № 13 (1). – Mode of access: http://doi.org/10.3390/ma13010051

FeCr matrix high-temperature self-lubricating composites reinforced by Mo, Ag, and CuO were fabricated by the powder metallurgy technique. The tribological behaviors of composites were studied at temperatures up to 800°C. The CuO content was optimized according to the tribological results. Mo showed an obvious lubricating effect when it converted into MoO_3. The bimetallic oxide system formed high-temperature solid lubricants with low shear strength. CuO reacted with MoO3 and formed $CuMoO_4$ and $Cu_3Mo_2O_9$. The composites showed an increase in the friction coefficient with the increase of CuO. However, the wear rates decreased with the increase of CuO. The critical threshold at which there was a transition of friction coefficients and wear rates from room temperature (RT) to 800°C was 10 wt. % CuO. The Fe(Cr)-14 % Mo-10.5 % Ag-10 % CuO composite showed the most reasonable high-temperature tribological behaviors. This was ascribed to the synergistic effects of silver, Mo, in situ formed solid lubricants (metal oxides and salt compounds), and the stable oxide film on the worn surfaces. At elevated temperatures, the dominant wear mechanism was oxidation wear.

32. Microstructure and mechanical behavior of Ti25Nb25Zr alloy prepared from pre-alloyed and hydride-mixed elemental powders / Sharma B., Vajpai S.K., Kawabata M., Nakano T., Ameyama K. // Materials Transactions. – 2020. – № 61 (4). – P. 562-566. – Mode of access: http://doi.org/10.2320/matertrans.MT-MK2019001

A study has been undertaken on the feasibility of the powder-metallurgy manufacturing process to fabricate β-type Ti25Nb25Zr alloy (mass %) for biomedical applications. The Ti25Nb25Zr alloy was fabricated from a mixture of TiH_2 with constituent elemental powders, and from a pre-alloyed Plasma Rotating Electrode Processed (PREP) Ti25Nb25Zr powder, separately. It is shown that different processing methods led to different microstructures and mechanical properties. The Ti25Nb25Zr compact prepared by pre-alloyed powder exhibits poor strength whereas TiH_2 processed Ti25Nb25Zr compact exhibits comparatively ultra-fine grained microstructure with significantly improved strength. The proposed fabrication method may have several opportunities to fabricate metallic alloys with enhanced mechanical properties.

33. Microstructure and mechanical performance of graphene nanosheets reinforced nickel-based superalloy FGH95 composite / Gao Y., Zou J., Wang X., Wang X., Yang J., Wang H. // Nanomaterials. – 2020. – № 10 (1). – Mode of access: http://doi.org/10.3390/nano10010100

Graphene nanosheet (GNS)-reinforced nickel-based superalloy FGH95 (GNSs/FGH95) matrix composites are prepared via the powder metallurgy approach. Scanning electron microscopy, transmission electron microscope and static tensile tests are used to investigate the microstructure and mechanical properties of GNS-reinforced nickel-based superalloy FGH95. Mechanical properties and failure behavior at room temperature and high temperature are studied. Static tensile tests at room temperature and high temperature confirm that the strength and plasticity of GNS-reinforced FGH95 have been improved, compared to the unreinforced superalloy. The results show that with the increase of temperature, the failure behavior of GNSs/FGH95 composite changes from the interface debonding of the GNSs/matrix to the failure of the FGH95 matrix. This work suggests that GNSs/FGH95 composite has great potential to be a structural material in aero-engine fields.

34. Microstructure and mechanical properties of hetero-designed Ti-25Nb-25Zr alloy fabricated by powder metallurgy route / Sharma B., Nagano K., Kawabata M., Ameyama K. // Letters on Materials. – 2019. – № 9 (4S). – P. 511-516. – Mode of access: http://doi.org/10.22226/2410-3535-2019-4-511-516

The harmonic structured (HS) materials have a heterogeneous microstructure consisting of bimodal grain size together with a controlled and specific topological distribution of ultra-fine grains (“Shell”) and coarse-grains (“Core”) areas. They have excellent strength combined with good ductility due to their unique heterogeneous “three-dimensionally (3D) gradient microstructure”, the two properties being rather an antagonist from the classical metallurgy point of view. In the present study, HS Ti-25Nb-25Zr alloy (mass %), compacts were successfully fabricated by a powder metallurgy method consisting of controlled mechanical milling (MM) of pre-alloyed Ti-25Nb-25Zr (TNZ) powder, followed by Spark Plasma Sintering. The MM leads to the severe plastic deformation at the powder particle surface. As a result, bimodal grains, with ultra-fine grains at the particle surface, and coarse-grains at the powder core, was achieved. After sintering of MM powder, the TNZ compacts with HS was achieved. The HS TNZ exhibited higher strength together with acceptable ductility as compared to the homogeneous microstructured TNZ alloy fabricated by SPS of as-received TNZ powder. The systematic characterization was done using Scanning Electron Microscope (SEM) equipped with a backscattered detector (BSE), Electron Back Scatter Diffraction (EBSD) and Energy Dispersive X-ray spectroscopy (EDX), XRD, and tensile testing. It is shown that different powder conditions led to significantly different microstructures. Also, it was observed that the high ductility and low strength was achieved for the compact prepared from as-received powder whereas a good combination of strength and ductility was achieved for the specimen prepared from MM of as-received powder.

35. Microstructure and mechanical properties of sintered and heat-treated hfnbtatizr high entropy alloy / Málek J., Zýka J., Lukáč F., Čížek J., Kunčická L., Kocich R. // Metals. – 2019. – № 9 (12). – Mode of access: http://doi.org/10.3390/met9121324

High entropy alloys (HEAs) have attracted researchers’ interest in recent years. The aim of this work was to prepare the HfNbTaTiZr high entropy alloy via the powder metallurgy process and characterize its properties. The powder metallurgy process is a prospective solution for the synthesis of various alloys and has several advantages over arc melting (e.g., no dendritic structure, near net-shape, etc.). Cold isostatic pressing of blended elemental powders and subsequent sintering at 1400°C for various time periods up to 64 h was used. Certain residual porosity, as well as bcc2 (Nb-and Ta-rich) and hcp (Zr-and Hf-rich) phases, remained in the bcc microstructure after sintering. The bcc2 phase was completely eliminated during annealing (1200°C/1h) and subsequent water quenching. The hardness values of the sintered specimens ranged from 300 to 400 HV10. The grain coarsening during sintering was significantly limited and the maximum average grain diameter after 64 h of sintering was approximately 60 μm. The

compression strength at 800°C was 370 MPa and decreased to 47 MPa at 1200°C. Porosity can be removed during the hot deformation process, leading to an increase in hardness to ~450 HV10.

36. Microstructure evolution and mechanical properties of PM-Ti43Al9V0.3Y alloy / Zhang D., Liu N., Chen Y., Zhang G., Tian J., Kong F., Xiao S., Sun J. // Materials. – 2020. – № 13 (1). – Mode of access: http://doi.org/10.3390/ma13010198

A novel strategy of microstructure design is introduced to improve the mechanical properties of TiAl alloys, fabricated by powder metallurgy. The gas atomization powder and as-HIPed (Hot isostatic pressing) TiAl are investigated by scanning electron microscopy, energy dispersive spectrometry, transmission electron microscopy, and electron backscattered diffraction. The dispersed submicron precipitate in the microstructure is determined to be Y_2O_3. A microstructure with uniform fine grain is obtained. The room temperature strength and strain reach 793 MPa and 1.5 %, respectively. The strength and strain at 700°C are still as high as 664 MPa and 9.2 %, respectively. The fine grain and precipitate lead to a high room-temperature plasticity.

37. Miklaszewski A. Hydrothermal surface treatment of biodegradable Mg-materials / Miklaszewski A., Kowalski K., Jurczyk M. // Metals. – 2018. – № 8 (11). – Mode of access: http://doi.org/10.3390/met8110894

Paper presents study on the hydrothermal treatment for hydroxyapatite layer formation on the different biodegradable Mg-substrates. The evaluation of corrosion resistance in Ringer's solution and contact angle measurements in glycerol were performed. Alloys and composites substrates obtained by mechanical alloying and powder metallurgy route are characterized by submicron range microstructure, which is responsible for further surface processing characteristic. Hydrothermal treatment in Ca-EDTA (ethylenediaminetetraacetic acid calcium disodium salt) led to formation of hydroxyapatite layers, which improves both the corrosion resistance and surface wetting properties compared to microcrystalline magnesium

38. Reducing the tension-compression yield asymmetry in an extruded ZK60 alloy by ultrafine grains / Wang J., Li X., Jin P., Li S., Ma G., Zhao L. // Materials Research Express. – 2018. – № 5 (11). – Mode of access: http://doi.org/10.1088/2053-1591/aadd6b

Ultrafine-grained ZK60 alloys were successfully fabricated by powder metallurgy followed by hot extrusion at different temperatures. The effects of the texture changes of ultrafine-grained ZK60 magnesium alloy on the asymmetry of tension-compression yield under different extrusion temperatures, and the relation between texture evolution and mechanical properties of the alloys during axial tension-compression deformation were studied. The results show that, in the ultrafine-grained ZK60 alloy, the initial texture of the alloy is a weak (0002) basal fiber texture. As the extrusion temperature increases from 523 to 623 K, the fibrous texture of the base material is weakened, and the tension-compression yield asymmetry is depressed from 1.1 to 1.0. During axial tensile deformation, twinning is not activated. With increasing tensile strain, no significant rotation of crystal grains occurs, and the stress remains stable until tensile fracture occurs. In the early stage of axial compression yield, no significant rotation of crystal grains occurs. As the compressive strain increases until the end of the compressive strain, the (0002) basal plane of the crystal grains rotates in a direction approximately perpendicular to the compression axis. At this point, the grain orientation factor is low, and the slip system is still in a hard orientation and is inhibited by the ultrafine grains. Twinning is difficult to start, so that the strain hardening rate rises rapidly until compression fracture occurs. Therefore, the weak extruding fiber texture of the basal plane and the ultrafine-grained structure both determine the deformation mechanism of ZK60 alloys at room temperature during axial tension and compression deformation, thereby significantly depressing the axial tension-compression asymmetry of ZK60 alloys.

39. Rietveld refinement of powder X-ray diffraction, microstructural and mechanical studies of magnesium matrix composites processed by high energy ball milling / Ramkumar T., Selvakumar M., Vasanthsankar R., Sathishkumar A.S., Narayanasamy P., Girija G. // Journal of Magnesium and Alloys. – 2018. – № 6 (4). – P. 390-398. – Mode of access: http://doi.org/10.1016/j.jma.2018.08.002

This research reports the processing of magnesium matrix composites reinforced with silicon carbide (SiC) and aluminium oxide (Al_2O_3) using powder metallurgy technique through high energy milling. Samples of Mg–SiC and Mg–Al_2O_3 composites subjected to high energy ball milling for different vol % of secondary particles 20, 30 and 40 % of SiC and Al_2O_3 are studied by X-Ray diffraction technique. The rietveld method as implemented in the Fullprof program is applied in order to determine the quantities of the resulting crystalline phases and amorphous phases at each stage of the mechanical treatment. Microstructural examination is carried out using Scanning Electron Microscope (SEM). In addition, crystal structural analysis using appropriate size and strain models is performed in order to handle the distinctive anistrophy that is observed in convinced crystallographic directions for the magnesium composite. The results are furnished in terms of crystalline domains size enlargement of the magnesium composites phases upon prolonged milling duration and discussed in the light of up to date views and theories on crystal growth of nanocrystaline materials. The hardness of the composite samples is calculated by Vickers's Hardness tester. Further, dry sling wear test and corrosion test are performed for the fabricated composites. Composite with 30 % secondary particles incorporated magnesium composites exhibits better wear and corrosion resistance than the other composites.

40. Role of supersaturated Al-C phases in mechanical properties of Al/fullerene composites / Nam S., Lee S., Roh A., Son H., Kim M., Choi H. // Scientific Reports. – 2021. – № 11 (1). – Mode of access: http://doi.org/10.1038/s41598-021-92551-y

We investigated the reinforcing effect of supersaturated Al-C phases on the mechanical properties of Al/C_{60} composites produced via powder metallurgy followed by thermal treatment. We controlled the fractions of C_{60}-fullerenes, nano-scale carbides, and Al-C supersaturated phases in the Al/C_{60} composites by adjusting the heat-treatment temperature and duration. Furthermore, we examined the contribution of each phase on the elastic and plastic behavior of the composites using scanning acoustic microscopy (SAM) and hardness measurements. After heat treatment, a supersaturated Al-C phase and an Al carbide were formed in the Al/C composites by decomposition of individually dispersed C_{60}. This led to enhancement of the hardness and elastic modulus of the Al/C composites heat-treated at 450 and 500 °C, while these properties were reduced in the 650 °C heat-treated composite. Notably, the 500 °C heat-treated composites showed significantly high hardness and elastic modulus (approximately 250 Hv and 77.8 GPa, respectively) owing to the substantially large contribution of the supersaturated Al-C phases, which was theoretically calculated to be 851 GPa/vol % and 227 GPa/vol %, respectively. This is possibly because the well-dispersed C in the atomic scale changed the elastic bonding characteristics of the metallic bonds between the Al atoms.

41. Senthil Kumar S. A study on tribological behavior of Al-4%Mg incorporated with MoS2 / Senthil Kumar S., Sudhakara Pandian R., Pitchipoo P. // Materials Research Express. – 2020. – № 7 (1). – Mode of access: http://doi.org/10.1088/2053-1591/ab6a4e

This investigation studies the dry sliding wear behavior of Al-4Mg matrix composites reinforced with different wt % of molybdenum disulfide (2, 4 & 6 wt %) produced using powder metallurgy route. The processed powders are initially characterized by Scanning Electron Microscopy (SEM) equipped with Energy Dispersive X-ray Spectroscopy (EDS). To authenticate the decisive distribution of the reinforcement particles with the matrix material, SEM analysis has been employed. The wear test is conducted on a pin-on-disc machine based on L_{27} orthogonal array with three control factors (three level) sliding velocity (0.5, 2.0, 3.5 m s^{-1}), applied load (5, 15, 25 N) and sliding distance (500, 750, 1000 m) to

inspect the responses namely wear loss and coefficient of friction. Moreover, the worn surface and wear debris analysis of the composite pin surface have been examined through SEM to identify the wear mechanism. It has been identified that the development of lubricant layer is diminished by increasing the wt % of MoS_2 particulates and the wear loss is diminished. Likewise, diminutive debris have attained in the worn surface of Al-Mg-6 wt % MoS_2 composite material, since effectual solid lubricant properties have been exposed. Higher plastic deformation is attained at amplified load and it affects the pin surface and thus, Coefficient of Friction (COF) is augmented.

42. Silicon carbide nanocomposites reinforced with disordered graphitic carbon formed in situ through oxidation of Ti3C2 MXene during sintering / Petrus M., Woźniak J., Cygan T., Lachowski A., Rozmysłowska-Wojciechowska A., Wojciechowski T., Ziemkowska W., Chlubny L., Jastrzębska A., Adamczyk-Cieślak B., Olszyna A. // Archives of Civil and Mechanical Engineering. – 2021. – № 21 (3). – Mode of access: http://doi.org/10.1007/s43452-021-00236-0

This article describes the manufacturing of silicon carbide composites with the addition of quasi-two-dimensional titanium carbide Ti_3C_2, known as MXene. The composites were obtained by the powder metallurgy technique, consolidated with the use of the Spark Plasma Sintering method at 1900 °C and dwelled for 30 min. The influence of the Ti_3C_2MXene addition on the microstructure and mechanical properties of the composites was investigated. The structure of the MXene phase after the sintering process was also analyzed. The results showed a significant increase (almost 50 %) of fracture toughness for composites with the addition of 0.2 wt % Ti_3C_2MXene. In turn, the highest hardness, 23.2 GPa, was noted for the composite with the addition of the 1.5 wt % Ti3C2 MXene phase. This was an increase of over 10 % in comparison to the reference sample. The analysis of chemical composition and observations using a transmission electron microscope showed that the Ti3C2 MXene phase oxidizes during sintering, resulting in the formation of crystalline, highly defected, disordered graphite structures. The presence of these structures in the microstructure, similarly to graphene, significantly affects the hardness and fracture toughness of silicon carbide.

43. Sintering of bimodal micrometre/nanometre iron powder compacts - A master sintering curve approach / Manchili S.K., Wendel J., Hryha E., Nyborg L. // Powder Technology. – 2021. – № 391. – P. 557-568. – Mode of access: http://doi.org/10.1016/j.powtec.2021.06.052

Though press and sinter powder metallurgy (PM) steel offers cost-effective solutions for structural applications, there is a constant drive for improvement in their density. Addition of nanopowder to the conventional micrometre-sized metal powder is explored to improve the sinter density. In this study, the effect of nanopowder addition in varying amounts has been studied. Carbonyl iron powder (<5 μm) and water atomized iron powder (<45 μm) were used as the base powder to which varying amounts of iron nanopowder (<100 nm) was added. Dilatometric sintering studies under pure hydrogen atmosphere were carried out to analyze the densification behavior. The results revealed that the bimodal powder mixture containing 25 % nanopowder exhibited the highest green density for both carbonyl and ASC 300 compacts. Master sinter curve for compacts was developed based on the dilatometer data. The apparent activation energy for sintering decreased with an increase in nanopowder content. This is reflected in the values of work of sintering.

44. Size-dependent structural properties of a high-NbTiAl alloy powder / Liu B., Wang M., Du Y., Li J. // Materials. – 2020. – № 13 (1). – Mode of access: http://doi.org/10.3390/ma13010161

TiAl-based alloys are promising light weight structural materials for high temperature applications in the field of aerospace. Recently, fabrication technologies starting from powders including powder metallurgy and additive manufacturing have been developed to overcome the difficulties in the processing, machining and shaping of TiAl-based alloys. Spherical alloy powders with different particle size distributions are usually used in these fabrication techniques. The purpose of this study is to reveal the size-dependent

structural properties of a high-NbTiAl powder for these fabrication technologies starting from powders. A high-NbTiAl pre-alloyed powder with nominal composition of Ti-48Al-2Cr-8Nb (at. %) was prepared by the electrode induction melting gas atomization (EIGA) method. The phase structure and morphology of the as-atomized powders were characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM). The size-dependent structural changes of the as-atomized powders with different sizes were studied by differential scanning calorimetry (DSC) and in situ high temperature XRD. It was found that with decreasing the powder size, the content of the γ-TiAl phase decreases and the α_2-Ti_3Al phase increases. The α_2-Ti_3Al to γ-TiAl phase transformation was found in the temperature range of 600-770 °C. Based on the present work, the structural characteristics of TiAl powders are strongly dependent on their particle size, which should be considered in optimizing the process parameters of TiAl alloys fabricated from powders.

45. Strength-conductivity synergy in cold-drawn reduced graphene oxide (RGO)-aluminum composite wires for electrical applications / Vogel T., Liu Y., Guo Q., Zhang D. // Materials and Design. – 2021. – № 209. – Mode of access: http://doi.org/10.1016/j.matdes.2021.109951

We present a breakthrough of the strength-conductivity trade-off in cold wire drawn reduced graphene oxide (RGO)-aluminum (Al) composite. The composite was fabricated by a full glovebox powder metallurgy process, followed by hot rolling and wire drawing down to 0.5 mm wire diameter. Compared to the unreinforced Al fabricated by the same methodology, the incorporation of RGO in the 0.5 mm wire sample gave rise to approximately 20.7 % improvement in mechanical strength, with only ~3.6 % sacrifice in electrical conductivity. Furthermore, the 331.6 ± 6.8 MPa compressive strength and ~54.1 % International Annealed Copper Standard (IACS) of the 0.5 mm wire RGO-Al composite exhibited a strength-conductivity combination comparable or even superior to conventional Al alloy conductors that go through complex thermal-mechanical treatments. Such a property synergy was interpreted by the ultra-fine Al grain structure and the elongated grain morphology rendered by the deformation processing steps, and an Orowan-typed strengthening mechanism owing to the homogenously dispersed natural amorphous alumina and RGO nanosheets in the composite.

46. Structural characterization of semi-heusler/light metal composites prepared by spark plasma sintering / Kopeček J., Bartha K., Mušálek R., Pala Z., Chráska T., Beran P., Ryukhtin V., Strunz P., Nováková J., Stráský J., Novák P., Heczko O., Landa M., Seiner H., Janeček M. // Scientific Reports. – 2018. – № 8 (1). – Mode of access: http://doi.org/10.1038/s41598-018-29479-3

A composite of powders of semi-Heusler ferromagnetic shape memory and pure titanium was successfully prepared by spark plasma sintering at the temperature of 950 °C. Sintering resulted in the formation of small precipitates and intermetallic phases at the heterogeneous interfaces. Various complementary experimental methods were used to fully characterize the microstructure. Imaging methods including transmission and scanning electron microscopy with energy dispersive X-ray spectroscopy revealed a position and chemical composition of individual intermetallic phases and precipitates. The crystalline structure of the phases was examined by a joint refinement of X-ray and neutron diffraction patterns. It was found that $Co_{38}Ni_{33}Al_{29}$ decomposes into the B2-(Co,Ni)Al matrix and A1-(Co,Ni,Al) particles during sintering, while Al, Co and Ni diffuse into Ti forming an eutectic two phase structure with C9-Ti_2(Co,Ni) precipitates. Complicated interface intermetallic structure containing C9-Ti_2(Co,Ni), B2-(Co,Ni)Ti and $L2_1$-(Co,Ni)(Al,Ti) was completely revealed. In addition, C9-Ti_2(Co,Ni) and A1-(Co,Ni,Al) precipitates were investigated by an advanced method of small angle neutron scattering. This study proves that powder metallurgy followed by spark plasma sintering is an appropriate technique to prepare bulk composites from very dissimilar materials.

47. Study on formability and strain hardening index: Influence of particle size of boron carbide (B4C) in magnesium matrix composites fabricated by powder metallurgy technique / Rajkumar P.R., Kailasanathan C., Senthilkumar A., Selvakumar N., Johnrajan A. // Materials Research Express. – 2020. – № 7 (1). – Mode of access: http://doi.org/10.1088/2053-1591/ab6c0b

In the present investigation, Magnesium composites have been fabricated with boron carbide (B_4C) as reinforcement by powder metallurgicaltechnique. Two different particle sizes-micro and nano B_4C particles with weight percentage of 0 %, 5 % and 10 % has been studied. The green compacts were prepared by cold pressing and then sintering the specimens before being subjected to cold upsetting under triaxial stress state condition in order to study the phenomenon of workability and instantaneous strain hardening index. Powder characterizations are discussed using X-ray Diffraction peaks, Scanning Electron Microscope images and Energy Dispersive Spectrum analysis. Cold upsetting has been preferred to investigate the performance of the composites. The values of formability stress index factor (β_σ), various stress ratio ($\sigma_\theta/\sigma_{eff}$, σ_m/σ_{eff}andσ_z/σ_m) parameters and instantaneous strain hardening index (n_i) are observed for increase in % of B_4C particles and its sizes. The experimental results were analyzed pertaining to relative density. The results reveal that Mg-10 % nano B_4C composite has higher relative density, formability stress index factor and hence high workability than the other composites. The addition of B_4C particles as reinforcement affects the strain hardening index due to geometric and work hardening of the composites.

48. Study on strengthening effects of Zr-Ti-Nb-O alloys via high throughput powder metallurgy and data-driven machine learning / Si S., Fan B., Liu X., Zhou T., He C., Song D., Liu J. // Materials and Design. – 2021. – № 206. – Mode of access: http://doi.org/10.1016/j.matdes.2021.109777

Multi-principal elements alloys (MPEAs) have been attracted extensive attention in industry due to their extraordinary properties. However, owning to their large degree of freedom in composition design, finding the principal influence factors of the material properties and further coordinating a desirable combination of conflicting properties is always a challenge. In this respect, we have developed a strategy on studying the MPEAs for its composition design in a certain mechanical property by high throughput preparation of powder metallurgy and by machine learning. We chose Zr-Ti-Nb-O alloys as target materials. To unveil key features that mainly influence the mechanical properties, models selection, features screening, and further features importance ordering were performed. The results indicate that the strength and plasticity are dominated by Λ parameter, difference of atomic radius, difference of shear modulus, etc. The prediction error for the strength and plasticity can reach to below 10 % and 16 %, respectively. According to analysis of the key features, a strength model is modified and used for evaluating the contributions of solid solution strengthening among principle and trace elements. The strategy proposed here will be applicable on element selections for a large variety of material property modulations in the MPEAs prepared by powder metallurgy.

49. Synthesis and characterization of an open-pore toxic-element-free Ti-based bulk metallic glass foam for bio-implant application / Liao Y.C., Song S.M., Li T.H., Li J.B., Tsai P.H., Jang J.S.C., Huang C.H., Huang J.C., Huang Y.S., Lin C.H., Lin Y.S., Chen C.H. // Journal of Materials Research and Technology. – 2020. – № 9 (3). – P. 4518-4526. – Mode of access: http://doi.org/10.1016/j.jmrt.2020.02.079

A series of porous toxic-element-free $Ti_{42}Zr_{40}Si_{15}Ta_3$ bulk metallic glass with 13-54 vol. % porosity are produced via powder metallurgy by the space holder method. The amorphous nature, foam morphology, mechanical properties, electrochemical response in simulation body fluid and in-vivo biocompatibility responses are systematically investigated. Results show that these open-cell Ti-based bulk metallic glass foams (BMGFs) exhibit yield strength from 140 to 730 MPa and Young's moduli from 8 to 53 GPa, matching very well with the mechanical properties of human bone and the estimated data by theoretical models. Compared to the bulk metallic glass (BMG) of the same composition, the high exposed surface

area of the produced Ti-based BMGFs exhibited higher current in the cyclic voltammetry (CV) and potential state tests. However, no specific peak corresponding to the oxidation or reduction response of the composition elements is found in the electrochemical test. Moreover, the six-month in-vivo tests in New Zealand white rabbits shows that the good osteo-integration between the newly growth bone and the implanted Ti-based BMGFs, making them promising new candidates for bio-implant applications in avoiding stress shielding or bio-unfriendly symptoms.

50. Synthesis and characterisation of floatable magnesium alloy syntactic foams with hybridised cell morphology / Akinwekomi A.D., Tang C.-Y., Tsui G.C.-P., Law W.-C., Chen L., Yang X.-S., Hamdi M. // Materials and Design. – 2018. – № 160. – P. 591-600. – Mode of access: http://doi.org/10.1016/j.matdes.2018.10.004

Powder metallurgy and rapid microwave (MW) sintering techniques were successfully applied to engineer a hybrid cell structure into magnesium alloy AZ61 syntactic foams. The hybrid cell structure, comprising open- and closed-cells, originated from leached carbamide granules and hollow microspheres of fly ash (HS), respectively. External MW susceptors accelerated the sintering process and greatly mitigated the formation of undesirable interfacial reactions. The cell hybridisation technique facilitated control over the density and strength of the syntactic foams. Accordingly, floatable syntactic foams with a density of about 0.79 g/cm3 and compressive strength of 16 MPa were synthesised without recourse to any surface modification or chemically-induced superhydrophobicity. The processing techniques were capable of mitigating damage to the HS microspheres as confirmed by microstructural examinations. Furthermore, potential applications of the floatable syntactic foam sample, as a microboat and chemical release agent, were demonstrated by using ethanol as a propellant. AZ61 syntactic foams synthesised in this study exhibited low density and adequate strength, suggesting their applicability as alternative materials to polymer composite foams.

51. Synthesis of a bulk nanostructured metastable Al alloy with extreme supersaturation of Mg / Han J.-K., Liss K.-D., Langdon T.G., Kawasaki M. // Scientific Reports. – 2019. – № 9 (1). – Mode of access: http://doi.org/10.1038/s41598-019-53614-3

Nanostructuring of bulk metals is now well documented with the development of severe plastic deformation (SPD) for improving the physical and mechanical properties of engineering materials. Processing by high-pressure torsion (HPT), which was developed initially as a grain refinement technique, was extended recently to the mechanical bonding of dissimilar metals during nanostrcturing which generally involves significant microstructural heterogeneity. Here we introduce, for the first time, a bulk metastable Al-Mg supersaturated solid solution by the diffusion bonding of separate Al and Mg metal solids at room temperature using HPT. Exceptional hardness was achieved homogeneously throughout the metastable alloy with a record maximum supersaturated Mg content of ~38.5 at. % in the Al matrix having a grain size of ~35–40 nm. Our results demonstrate the synthesis of a bulk nanocrystalline metastable alloy with good microstructural stability at room temperature where such bulk solids are not yet reported for mechanical alloying by powder metallurgy.

52. Synthesis of spherical V-Nb-Mo-Ta-W high-entropy alloy powder using hydrogen embrittlement and spheroidization by thermal plasma / Lee W.-H., Park K.B., Yi K.-W., Lee S.Y., Park K., Lee T.W., Na T.-W., Park H.-K. // Metals. – 2019. – № 9 (12). – Mode of access: http://doi.org/10.3390/met9121296

V-Nb-Mo-Ta-W high-entropy alloy (HEA), one of the refractory HEAs, is considered as a next-generation structural material for ultra-high temperature uses. Refractory HEAs have low castability and machinability due to their high melting temperature and low thermal conductivity. Thus, powder metallurgy becomes a promising method for fabricating components with refractory HEAs. Therefore, in this study, we fabricated spherical V-Nb-Mo-Ta-W HEA powder using hydrogen embrittlement and spheroidization by thermal plasma. The HEA ingot was prepared by vacuum arc melting and revealed to

have a single body-centered cubic phase. Hydrogen embrittlement which could be achieved by annealing in a hydrogen atmosphere was introduced to get the ingot pulverized easily to a fine powder having an angular shape. Then, the powder was annealed in a vacuum atmosphere to eliminate the hydrogen from the hydrogenated HEA, resulting in a decrease in the hydrogen concentration from 0.1033 wt % to 0.0003 wt %. The angular shape of the HEA powder was turned into a spherical one by inductively-coupled thermal plasma, allowing to fabricate spherical V-Nb-Mo-Ta-W HEA powder with a d50 value of 28.0 μm.

53. The corrosion rate of B 4 C particles reinforced with Al-Si alloyprepared by powder metallurgy in acidic solution using RSM / Abraham Subaraj M., Bensam Raj J., Christopher EzhilSingh S., Sankar C. // International Journal of Mechanical and Production Engineering Research and Development. – 2018. – № 9 (1). – P. 31-40. – Mode of access: http://doi.org/10.24247/ijmperdfeb20194

This present study is to progress the arithmetical model that might be utilized to determine the corrosion rate (CR) of Al–12Si-x B 4 C (x = 0, 4, and 8 wt. % of B 4 C) composites have faith in densification of the powder metallurgy throughout compaction and sintering. The acidic solutions used for corrosion is 1 N HCl, 1 N H 2 SO 4 and 1 N HNO 3 for varying plummeting time (i.e., 72, 144, and 216h) correspondingly. The hardness of the composites will rise because of the increased wt. % of B 4 C. The result indicates that with the enhancement of nanoB4C particles into the matrix decrease the corrosion rate respectively. The corrosion behaviour of composites was studied by SEM and corrosion rate method. As input parameters such as reinforcement, acid and time were designed by RSM design and the response parameter was corrosion rate was obtained experimentally by the corrosion rate method. The L17 orthogonal array was selected for investigating the response surface methodology (RSM) design using three factors with one replicate. RSM design was investigated for the evaluation of interactions between response parameter and input parameters. Analysis of variance was utilized to explore the influencing input factors on corrosion rate (CR). The corrosion rate specifies varying results depending on the input values of the response parameters. The outcomes revealed that all the parameters had significant effects on the corrosion rate at 95 % confidence level.

54. The Effect of Cooling Rate on High-Temperature Precipitation in a Powder-Metallurgy, Gamma/Gamma-Prime Nickel-Base Superalloy / Semiatin S.L., Mahaffey D.W., Levkulich N.C., Senkov O.N., Tiley J.S. // Metallurgical and Materials Transactions A: Physical Metallurgy and Materials Science. – 2018. – № 49 (12). – P. 6265-6276. – Mode of access: http://doi.org/10.1007/s11661-018-4896-5

The effect of cooling rate in the range of 10 K/s to 250 K/s (10 °C/s to 250 °C/s) on the precipitation of secondary gamma prime following supersolvus solution treatment of the powder-metallurgy superalloy LSHR was determined via a suite of critical experiments, analytical and FEM analysis of local temperature transients in test samples, and fast-acting numerical simulations based on classical (homogeneous) nucleation and growth. Using high-resolution scanning-electron microscopy, average 2D precipitate diameters were found to range from approximately 10 to 100 nm in various regions of small cubes that had been water quenched, oil quenched, or air cooled. After applying a stereological correction to estimate the equivalent 3D diameters, the precipitate sizes were plotted as a function of cooling rate deduced from analytical/numerical heat-transfer simulations that had been validated using selected thermocouple measurements. This plot revealed an approximately linear dependence of size on the inverse square root of the cooling rate within the temperature range for which nucleation was initiated and essentially completed. However, the present size-dependence on cooling rate was approximately 60 pct higher than that based on an extrapolation of the trend deduced from previous measurements for slower cooling rates and precipitation simulations over the entire cooling-rate range. Several sources of this difference, including the effect of small local plastic straining on nucleation, were hypothesized. The effect of stored work on precipitation was also underscored in a comparison of laboratory observations and the size of precipitates

developed near the joint in inertia-friction-welded LSHR samples whose cooling rate after local supersolvus exposure had been of the order of 150 K/s (150 °C/s).

55. The effect of powder size on the mechanical and corrosion properties and the ignition temperature of WE43 alloy prepared by spark plasma sintering / Dvorský D., Kubásek J., Roudnická M., Průša F., Nečas D., Minárik P., Stráská J., Vojtěch D. // Journal of Magnesium and Alloys. – 2021. – № 9 (4). – P. 1349-1362. – Mode of access: http://doi.org/10.1016/j.jma.2020.12.012

Powder metallurgy is a powerful method for the preparation of materials with superior properties. This work aimed to investigate the effect of powder size on the microstructure, mechanical, and corrosion properties of advanced WE43 (Mg-4Y-3REE-Zr) alloy prepared by spark plasma sintering (SPS). At the same time, the effect of HF pre-treatment of the powder on the properties of final compacted products is studied. Smaller powder particles yielded microstructure with more interfaces formed by Y_2O_3, or MgF_2 and YF_3. These interfaces work as barriers against corrosion, which greatly improves corrosion resistance. The suggested pre-treatment of powder in HF further reduced the corrosion rate of the compacted materials. On the contrary, fragile interfaces of YF_3 decreased mechanical properties as the crack primarily propagates through these interfaces. The original powder containing the mixture of all powder fractions exerted the best combination of mechanical properties. Powder size has also shown to affect ignition temperature. The highest ignition temperature was measured for the finest powder fraction.

56. The effect of processing route on properties of HfNbTaTiZr high entropy alloy / Málek J., Zýka J., Lukáč F., Vilémová M., Vlasák T., Čížek J., Melikhova O., Macháčková A., Kim, H.-S. // Materials. – 2019. – № 12 (23). – Mode of access: http://doi.org/10.3390/ma12234022

High entropy alloys (HEA) have been one of the most attractive groups of materials for researchers in the last several years. Since HEAs are potential candidates for many (e.g., refractory, cryogenic, medical) applications, their properties are studied intensively. The most frequent method of HEA synthesis is arc or induction melting. Powder metallurgy is a perspective technique of alloy synthesis and therefore in this work the possibilities of synthesis of HfNbTaTiZr HEA from powders were studied. Blended elemental powders were sintered, hot isostatically pressed, and subsequently swaged using a special technique of swaging where the sample is enveloped by a titanium alloy. This method does not result in a full density alloy due to cracking during swaging. Spark plasma sintering (SPS) of mechanically alloyed powders resulted in a fully dense but brittle specimen. The most promising result was obtained by SPS treatment of gas atomized powder with low oxygen content. The microstructure of HfNbTaTiZr specimen prepared this way can be refined by high pressure torsion deformation resulting in a high hardness of 410 HV10 and very fine microstructure with grain size well below 500 nm.

57. Tribological behavior of copper-graphite composites reinforced with Cu-coated or uncoated SiO2 particles / Zou H., Ran X., Zhu W., Wang Y., Zhan S., Hao Z. // Materials. – 2018. – № 11 (12). – Mode of access: http://doi.org/10.3390/ma11122414

Copper-graphite composites reinforced with SiO_2 particles were fabricated by powder metallurgy technique. Electroless copper plating was introduced to improve the interfacial bonding between SiO_2 particles and copper matrix. The microstructure, density, and hardness of the composites were characterized. The tribological properties, such as friction coefficient and wear rate of the composites, were studied using a pin-on-ring tribometer. The results show that the hard SiO_2 can restrict the severe plastic deformation and adhesion contact in the process of wear. At the same time, parts of SiO_2 particles can be broken into fine particles during wear process, which is helpful for decreasing adhesion wear and abrasive wear. Therefore, the addition of SiO_2 leads to increasing friction stability and friction coefficient, and decreasing wear rate. In addition, the electroless copper plating improves the interfacial bonding between SiO_2 and copper matrix, which prevents separation of SiO_2 from copper matrix and further increase tribological properties of the composites.

58. Vaziri H.S. Synthesis of WS2/CNT hybrid nanoparticles for fabrication of hybrid aluminum matrix nanocomposite / Vaziri H.S., Shokuhfar A., Afghahi S.S.S. // Materials Research Express. – 2020. – № 7 (2). – Mode of access: http://doi.org/10.1088/2053-1591/ab70e1

In this study, a simple, safe and cost-effective method was developed for fabricating the tungsten disulfide/carbon nanotube (WS_2/CNT) hybrid nanoparticles via chemical vapor deposition (CVD) process. Hybrid nanoparticles used for reinforcing the aluminum matrix. The hybrid nanocomposites were prepared by powder metallurgy processing and consolidated by the Hot-Pressing process. The chemical composition and morphology of the WS_2/CNT hybrid particles were studied by x-ray diffraction (XRD), filed emission scanning electron microscopy (FESEM), Raman spectra, Fourier-transform infrared spectroscopy (FTIR) and thermo gravimetric analysis (TGA). The results proved that the uniform, pure and tubular WS_2/ CNT hybrid nanoparticles were produced and WS_2 nanoparticles were decorated the CNT surface successfully. Optical microscopy (OM) and FESEM used for characterization of the microstructure of hybrid nanocomposite, indicate a good distribution of hybrid nanoparticles in the aluminum matrix. Maximum values of relative density, hardness and compressive strength were measured for sample with WS_2/CNT ratio of 1:1. A relative density of more than 99.5 % was obtained for this sample. Hardness and compressive strength were improved by 43 % and 60 % compared with pure aluminum respectively.

59. Vibratory powder feeding for powder bed additive manufacturing using water and gas atomized metal powders / Sinclair C.W., Edinger R., Sparling W., Molavi-Kakhki A., Labrecque C. // Materials. – 2021. – № 14 (13). – Modeofaccess: http://doi.org/10.3390/ma14133548

Commercial powder bed fusion additive manufacturing systems use re-coaters for the layer-by-layer distribution of powder. Despite the known limitations of re-coaters, there has been relatively little work presented on the possible benefits of alternative powder delivery systems. Here, we reveal a feeding technology that uses vibration to control flow for powder bed additive manufacturing. The capabilities of this approach are illustrated experimentally using two very different powders; a ‘conventional’ gas atomized Ti-6Al-4V powder designed for electron beam additive manufacturing and a water atomized Fe-4 wt. % Ni alloy used in powder metallurgy. Single layer melt trials are shown for the water atomized powder to illustrate the fidelity of the melt tracks in this material. Discrete element modelling is next used to reveal the mechanisms that underpin the observed dependence of feed rate on feeder process parameters and to investigate the potential strengths and limitations of this feeding methodology.

60. Young’s Modulus Enhancement and Measurement in CNT/Al Nanocomposites / Yu Z.-Y., Tan Z.-Q., Fan G.-L., Lin R.-B., Xiong D.-B., Guo Q., Su Y.-S., Li Z.-Q., Zhang D. // Acta Metallurgica Sinica (English Letters). – 2018. – № 31 (11). – P. 1121-1129. – Mode of access: http://doi.org/10.1007/s40195-018-0730-8

Young’s modulus is a critical parameter for designing lightweight structure, but Al and its alloys only demonstrate a limited value of 70–72 GPa. The introduction of carbon nanotubes (CNTs) is an effective way to make Al and its alloys stiffer. However, little research attention has been paid to Young’s modulus of CNT/Al nanocomposites attributed to the uncertain measurement and unconvincing stiffening effect of CNTs. In this work, improved Young’s modulus of 82.4 ± 0.4 GPa has been achieved in 1.5 wt % CNT/Al nanocomposite fabricated by flake powder metallurgy, which was determined by resonance test and 13.5 % higher than 72.6 ± 0.64 GPa of Al matrix. A comparative study and statistical analysis further revealed that Young’s modulus determined by tensile test was relatively imprecise (83.1 ± 4.0 GPa) due to the low-stress microplasticity or interface decohesion during tensile deformation of CNT/Al nanocomposite, while the value (98–100 GPa) was highly overestimated by nanoindentation due to the “pile-up” effect. This work shows an in-depth discussion on studying Young’s modulus of CNT/Al nanocomposites.

Використані джерела:

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