SYNTHESIS OF ZIRCONIA NANOPOWDER USING PLANETARY BALL MILLING METHOD AND ITS POLYMERIC NANOCOMPOSITE

PROJECT REPORT
Submitted by

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Under the guidance of

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ABSTRACT

The project deals with preparation of nano zirconia powder using planetary ball mill and then characterizing the powder to analyze the particle size. Powder is characterized using Field Emission Spectroscopy (FE-SEM), X-ray diffraction (XRD) and particle size analysis techniques. FE-SEM results showed decrease in particle size from 200-500 nm to 50 nm with some amount of agglomeration. XRD shows that ball milled zirconia powder has a mixture of monoclinic and tetragonal crystalline structures. Laser particle size analyzer noted a significant decrease in particle size, i.e., from about 53 nm to 13 nm. Using the 20 h milled Zirconia nanopowder, PAEK-Zirconia nanocomposites were prepared using suspension method followed by hot pressing. The content of Zirconia nanopowder was varied between 0 and 30 wt%. It was observed that presence of Zirconia enhanced microhardness, thermal stability and dielectric constant properties of the PAEK. SEM showed good dispersion of milled Zirconia in the PAEK matrix as compared to as received Zirconia powder in the matrix. Theoretical and experimental

density was nearly same for nanocomposites when milled Zirconia was used. When unmilled Zirconia was used nanocomposite showed significant difference in theoretical and experimental density. Microhardness of the nanocomposite increased from 20 for pure PAEK to 35.4 HV for 30 wt% milled Zirconia powder filled nanocomposite. TGA showed that decomposition temperature of the nanocomposites increased up to 50 oC. Dielectric constant of the nanocomposites remained constant over frequency range of 100 Hz to 1 MHz. The dielectric constant of the nanocomposites measured at 1 kHz increases slightly with increasing Zirconia content in the PAEK matrix.

Fabrication, optimization of cryomill and reduction of mill scale using hydrogen

A BTECH PROJECT REPORT
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Under the guidance of
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ABSTRACT

Cryomilling is the mechanical attrition where powders are milled in slurry formed by ball milling media and liquid nitrogen at low temperature (cryogenic temperature). This is a top-down approach for bulk production of nanoparticles. The cryomilling machine would stress maximum number of individual particles in a powder mass to undergo plastic deformation or initiate fracture. Process variables such as milling speed, milling time and temperature, milling atmosphere, grinding media, powder to be ground and ball-to-powder ratio affect the quality and quantity of the cryomilled powder. Consequently, iron powder is cryomilled and the formation of nanosized particles is detected using XRD, SEM characterization techniques. Also, to obtain pure iron powder from mill scale, processes such as static and counter current hydrogen reduction have been discussed. To increase the reducibility of mill scale, reduction is carried out after oxidizing the entire mill scale to hematite. Thus, this project report reviews the various aspects of mechanical milling, cryomilling and also eco-friendly ways of reducing mill scale.

EVALUATION OF POTASSIUM ZINC PHOSPHATE AS ANTICORROSIVE PIGMENTFINAL PROJECT

PROJECT REPORT

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ABSTRACT

Potassium Zinc Phosphate was synthesized by co precipitation method. The Synthesized pigment was characterized by Fourier Transform Infrared Spectroscopy(FTIR). Paint was prepared and applied on Low Carbon Steel samples.The Inhibition efficiency of this pigment in 3.5% NaCl solution was calculated by means of Electrochemical Impedance Spectroscopy (EIS). Electrochemical studies were carried out using open circuit potential measurements, Tafel Analysis and Impedance Spectroscopy. Nyquist and Bode plots were obtained at different times of Immersion. The Bode plotsreveal an intact nature of coating with excellent corrosion protection properties even after 96 hours of immersion.The semi circle obtained in the Nyquist plots attributes to corrosion prevention by barrier mechanism. The coating resistance of PZP decreases from 219.53 to88.17 □ for 0 hrs to 48 hrs and then increases to 332.01□ for 96 hrs. The coating capacitance increased from 0.0980 to 1.306 F as time increased from 0hrs to 72 hrs and then decreased to 0.67656 F for 96 hrs. The Corrosion rate was found out to be 11.6mpy. FTIR characterization confirmed the presence of KZnPO4and KZn2 PO 4 .HPO 4 and ZnO phase which contributes to coating properties.

DEVELOPMENT OF BIPOLAR PLATE BY USING CARBON/POLYMER COMPOSITE

A PROJECT REPORT

Submitted by

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ABSTRACT

The bipolar plate is a important component of the proton exchange membrane (PEM) fuel cell stack. Also it takes a large portion of stack cost. There are different materials for bipolar plate. But, as alternative material for bipolar plate of PEM fuel cells is expanded graphite-polymer composite. This composite fulfill required properties of bipolar plate. It is fabricated by hot compression molding.

Expanded graphite (EG) is produced by heating of natural graphite at 750OC. The volume expansion of expanded graphite is 20 times natural graphite. In hot compression molding process, 70%ofExpandedGraphitepowder mixed manually with 30% of Phenolic resin (Resole). Expanded graphite provides electrical conductivity and phenolic resin provides mechanical strength to the bipolar plate. This shows that the expanded-polymer composite has maximum electrical conductivity. These light weight bipolar plates reduced the volume and weight of ultimate fuel cell stack and helped in improving the fuel cell performance. This gives that Expanded Graphite-Polymer composite is good material for bipolar plate.

THERMOELECTRIC INTERMETALLIC MATERIAL β-$FeSi_2$: SYNTHESIS AND PROPERTY EVALUATION

PROJECT REPORT

Submitted by

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ABSTRACT

With the Industrial Revolution, rose the demand for energy resources. Almost any activity which we perform in today‟s world requires energy. With the conventional, non-renewable energy sources getting depleted, man has been engaged in the search of new sources and increasing the efficiency of the existing ones. Thermoelectric materials, which convert heat into electrical energy, are the energy resources of the future. An intermetallic phase β-FeSi2 is one such promising thermoelectric material because of its abundantly available raw materials and especially because of its high-temperature stability. In the current work, elemental powders of iron, silicon, manganese (for *p*-type semiconductor) and cobalt (for *n*-type semiconductor) have been mechanically alloyed using ball mills. These were then compacted into desired dimensions of semiconductor pellets. The pellets were then sintered using inert atmosphere and in vacuum furnace. The sintered pellets were characterized using XRD and SEM. Theoretical calculations for determination of number of semiconductor pellets in a thermoelectric generator/cell for good efficiency have also been done.

Keywords: β-FeSi2, Thermoelectric materials, Mechanical alloying, Figure of Merit.

PARAMETER OPTIMIZATION FOR FRICTION STIR SPOT WELDING OF AUSTENITE STAINLESS STEEL SHEETS

A PROJECT REPORT

Submitted by

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ABSTRACT

Friction stir spot welding (FSSW) is an emerging innovative technique for joining in automobiles and aerospace application, The chief material for this are aluminium and stainless steel because of light weight and corrosion resistance. This process is an energy saving joining method.

FSSW of stainless steel is under development. Hence FSSW on austenitic stainless steel was studied. Various parameters such as tool rotation speed; plunge depth and dwell time are varied. The varying parameters provides a range of hardness and lap shear strength. Microstructure analysis of weld joint shows a varying nature nature of grain size from base metal to stir zone, where the stir zone shows a finer structure in comparison with the base metal.

EQUAL CHANNEL ANGULAR PRESSING OF 6061 ALUMINUM
B.TECH PROJECT REPORT

Submitted by

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ABSTRACT

The project report is on Equal Channel Angular Pressing Of 6061 aluminium which is one the techniques of severe plastic deformation. This text covers principles of all the severe plastic deformation techniques before approaching the ECAP technique. Background of SPD is provided in the introductory part along with the necessary figures wherever required.

Basically Severe plastic deformation (SPD) methods are processes in which very high plastic strains are applied to materials. The difference between these methods and the common forming techniques is that, after the application of strain to the samples undergoing the process, the samples final dimensions remain unchanged. Thus ECAP provides a technique for producing microstructures with ultrafine grain size in the materials thereby improving the mechanical properties significantly. The details will be discussed further in the report along with the mechanism and the planned experiments.

CONDUCTING POLYANILINE BASED COATINGS FOR BURIED PIPELINE

A PROJECT REPORT

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ABSTRACT

Polyaniline is synthesized by chemical methods from the monomer aniline. Paint preparation by using additives in appropriate quantities and ball milling for 16 hours is done. The corrosion performance of low carbon bare steel and when coated with conducting polyaniline are investigated in 3.5wt% NaCl soil medium by potentiodynamic polarization studies and electrochemical impedance studies. Corrosion rate of polyaniline coated steel is found to be 1.577 mpy which is approximately 10 times better as compared to 11.68 mpy for that of bare steel in the same medium. The coating capacitance Cc for polyaniline coated steel is 0.8469 nF/cm2 which is increased as compared to that of bare steel that is 0.3947. This indicates that the coating remains intact and provides good corrosion protection. The polarization resistance for bare steel is 5.475 Ω which increased drastically to 28.93Ω after coated with conducting polyaniline. Increment in the coating resistance of intact coating and damaged coating value indicated the dissolution of iron but subsequent possible formation of passive Fe2O3 layer which reveals that polyaniline coating is better for long term corrosion protection. Conducting polyaniline based paint controls corrosion of low carbon steel in acidic soil medium by anodic protection. Polyaniline paint coatings are obtained on low carbon steel. Low carbon steel can be protected for long time. Immersion testing in soil is also done on Polyaniline coated specimen and it shows greater corrosion resistance upto 72 hours of immersion and it drastically drops on 96 hours of immersion.

STUDY ON POLYMER /ZnO NANOCOMPOSITE FOR VARISTOR APPLICATION

PROJECT REPORT

Submitted by

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ABSTRACT

ZnO based polymeric nanocomposite materials have attracted scientific community due to their good electrical properties. ZnO dispersed in suitable polymer matrix called as composite is suggested for the purpose of using low voltage varistors for a long service time. Polycarbonate has high resistivity (106-1014 Ω m) in composite varistors. The main motto of the project is to develop nanocomposite of undoped-ZnO and doped-ZnO in a polycarbonate matrix to compare their respective properties required for varistor application. Nanocomposite produced by Solution casting method was characterized with experimental density, Scanning electron microscopy, X-ray diffraction, micro hardness, dielectric constant, volume resistivity, and I-V characteristics. Scanning electron micrographs revealed the good dispersion of the filler in the matrix, having an average size of 64.23 nm. In addition to this, it was found that these nanocomposite have good varistor properties and can be used to guard the circuit from 350 V to 600 V over voltage. The non-linear coefficient α was in the range of 3.5 to 5.73. In Comparison to undoped-ZnO/PC nanocomposite, doped-ZnO/PC exhibited better properties.

EFFECT OF CRYOGENIC TREATMENT ON AISI H11 AND AISI H13 HOT WORK TOOL STEEL

A PROJECT REPORT

Submitted by

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ABSTRACT

Hot work tool steel like H11 and H13 are used mainly for high temperature metal forming operations (except cutting). Die failure is an important issue in industries. Many operating difficulties and loss of production arise through die wear. This project mainly focuses on the study of cryogenic treatment and its effect on wear performance of AISI H11and AISI H13 and to establish standardized parameters. Hardened (1020 C) and hardened – cryotreated (-185 C) samples were double tempered at three different temperature to standardize temering temperature for conventional and cryogenic treatment respectively. In another experiment, samples were hardened (1020 c), double tempered (500 C each for 2h), cryotreated (-185C) for varying period viz.,8,16,24,32 h and soft-tempered at different temperature viz.,50C, 100C, 150C, 200C. Various characterization techniques like microstructural analysis , hardness testing ,wear testing were used . standardized parameters were established for achieving improved were resistance. For both AISI H11 and AISI H13 , cryosoaking period was standardized at 24 h. Soft-tempering temperature for AISI H11 was 30% of conventional tempering temperature and for AISI H13 was 10%. Wear activation energy for AISI H13 was found to be greater than AISI H11, thus making it more wear resistance

EFFECT OF SEVERE PLASTIC DEFORMATION BY SHOT PEENING, ON NITRIDING KINETICS OF AISI 4140 STEEL

A PROJECT REPORT

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ABSTRACT

This work presents the study of effect of severe plastic deformation on nitriding kinetics of AISI 4140 steel. An air blast shotpeening reactor was fabricated and parameters. Such as shot velocity, shot size and shot peening duration are optimized. The specimen shotpeened for optimum parameters are characterized before and after nitriding. The samples were characterized using X-ray diffraction, scanning and transmission electron microscopy and optical microscopy and using Vickers micro hardness tester. The study concluded with –claim of formation of nanocrystalline surface layer by means of shot peening, which enhances the nitriding kinetics of the surface at lower temperatures

EXPERIMENTAL STUDY ON THE FORMATION OF ELECTROLESS NICKEL-BORON COATING

A PROJECT REPORT

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Under the Guidance of

Prof. S. U. Dangarikar

ABSTRACT

Nickel-Boron electroless plating on component is carried out by a chemical reaction and without the use of an external source of electricity. In nickel-boron electroless plating, nickel chloride will come as a metallic salt and is reduced by using Sodium borohydride as the reducing agent to nickel-boron metal, which then is deposited on the mild steel.

In this experiment, the effect of solution concentration on thickness and mechanical properties of nickel-boron plating on mild steel and cast iron using electroless plating process was investigated. The solutions used in this experiment were nickel chloride and Sodium borohydride as the reducing agent was used to prepare the electroless Ni–B coatings. Electroless plating were done for few hours. Then the surface structure and morphology nickel plating was evaluated using Optical Microscope while its hardness was evaluated using Vickers hardness test. In electroless plating, anode is the movements of negative ions toward the positive electrode and the sample as the cathode because the movement of positive ions toward the negative electrode. The instruments that were applied in the experiment were magnetic stirrer with heating arrangement, thermometer, optical microscope, micro hardness tester. And the coating is done on prepared sample.

Effect of Inhibitors on Heat Exchanger Corrosion

PROJECT REPORT

Submitted by

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Under the Guidance of

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Abstract

Coolants must give corrosion protection in both the standard cast iron and brass and the newer aluminium cooling systems. The formulation of coolants for this dual protection will be studied by investigating the effect of various corrosion inhibitors on cooling system corrosion. Inhibitors are used to minimize or prevent the corrosion. For different applications use of inhibitor reduces the corrosion rate. It is essential to study the behavior of different inhibitor in corrosive media. Most of the coolants are corrosive in nature; therefore it is decided to study the effect of different inhibitor on corrosion of copper alloys (used in heat exchangers).Azoles have been used as a corrosion inhibitor for copper and its alloys for the prevention of both atmospheric corrosion and particularly for protection of copper under immersed conditions (like in Heat Exchangers the copper is immersed in coolant). In this project the following techniques: weight loss measurement (test 1), open circuit potential (test 2), potentiostatic EIS (test 3), Polarization (test 4), to examine sample's surface topography and composition of phases by Scanning Electron Microscope (test 5) were employed to investigate the inhibition efficiency of with 3 Benzotriazole (Inhibitor 1)and 2-phenylbenzimidazole (Inhibitor 2) for copper corrosion.

SYNTHESIS AND CHARACTERIZATION OF ZnO BASED VARISTOR FOR ELECTRONIC SENSOR APPLICATION

A PROJECT REPORT

Submitted by

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ABSRACT

Zink oxide varistor are novel semiconducting ceramics having highly non-ohmic voltage-current characteristics, which originate at the grain boundaries. These varistors are widely utilized in protecting electrical power lines and electronic component against dangerous voltage surge.

ZnO based varistor containing different additives have been made and important metallurgical aspects to obtain good sintered density are being optimized. The effect of various composition of additives (BI_2O_3, CuO and V_2O_5), varying sintering temperature (850-1000 °C) & sintering atmosphere (Air, O_2, N_2) on non-linear behavior of varistor was investigated.

It was possible to reduce sintering temperature to 800°C vis-à-vis required temperature of 1000°C, for most of the commercially available varistor. The maximum breakdown voltage of ZnO varistor fabricated in this investigation was about 500 V/mm, which could be varied in the range 200-500 V/mm by varying the composition and choosing proper sintering atmosphere.

POWDFR METALLURGY OF NON-FERROUS METALS/ALLOYS; ROLL OF EQUAL CHANNEL ANGULAR PRESSING (ECAP)

A PROJECT REPORT

Submitted by

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ABSTRACT

In this study, SPD (severe plastic deformation) examined in order to achieve both full density and grain refinement of metallic powder with least grain growth, which is considered as a conventional powder metallurgy of composition. ECAP (Equal channel angular pressing), one of the most promising method in SPD, was used for the powder consolidation. In the ECAP process of not only solid but also powder metals, it is also important to get a good understanding of the density as well as internal stress, strain and strain rate distribution. We will investigate the consolidation, plastic deformation and microstructure evolution behavior of the metallic powders during ECAP using an experimental method. It was found that high mechanical strength could be achieved effectively due to the well bonded powder contact surface during ECAP process. SPD processing of powder is a viable method to achieve both fully density and nanostructured materials.

LASER SURFACE HARDENING OF STEELS

A PROJECT REPORT

Submitted by

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ABSTRACT

Laser surface is one of the surface hardening process for obtaining controlled hardness profile. The process does not need a quenching medium to harden the case. Localized hardening of of parts with complex shapes can also be done with minimum part distortion.

It was decided to perform laser surface hardening of three steels – AISI D3 tool steel, high carbon chromium steel (En31) and medium carbon low alloy steel (En24 steel). The process was conducted with different powers and scanning speeds of the laser beam. Surface hardening with and without graphite coating was conducted. The hardness profile were determined. The microstructures of the various zones were studied.

It was found that for D3 steel the laser hardening with 380 W power and 3 mm/s scanning speed resulted into optimum surface hardness of 813.2$HV_{0.3}$ and a case depth of 220 µm. For high carbon high chromium (HCHC) steel, laser hardening with 360W power and 3mm/s scanning speed resulted into optimum hardness of 786 $HV_{0.3}$ at the surface and a case depth of 380 µm. For En24 steel, the laser hardening with 360 W power and 1 mm/s scanning speed resulted into optimum case depth of 730 µm with an almost uniform hardness of 719.9 $HV_{0.3}$ throughout the hardened case.

For D3 steel coated with graphite, the optimum parameters were 320 W power and 3 mm/s scanning speed resulted in a surface hardness of 599.2 $HV_{0.3}$ and a case depth of 125 µm. For HCHC steel coated with graphite, the optimum parameters were 320 W power and 3 mm/s scanning speed resulting in a surface hardness of 855 $HV_{0.3}$ and a case depth of 260 µm. For En24 steel coated with graphite, the optimum parameters were 340 w power and 1 mm/s scanning speed resulting in a surface hardness of 865.1 $HV_{0.3}$ and a case depth of 718 µm.

WEAR BEHAVIOUR OF TOTAL HIP REPLACEMENT BIOMATERIALS

A PROJECT REPORT

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ABSTRACT

Total hip replacement surgeries involve use of artificial hip implant and main concern with these current implants in total hip replacement (THR) is the limited life span (15 years max). The limited life span makes it highly inconvenient for use of hip implants in younger patients. The life span is primarily governed by wear between the bearing surfaces of the implant i.e. the femoral head and the acetabular cup liner materials.

The most extensively used ball-cup liner combination currently is ASTM F1537 Co-Cr alloy ball on Ultra-high-molecular-weight-polyethylene (UHMWPE). This combination has problems of considerable polyethylene wear debris which leads to implant loosening over time, bone absorption and loss of biocompatibility resulting in formation of tumors etc.

The project aims to study wear properties of 30% carbon fiber reinforced Poly-ether ether-ketone (PEEK) as an alternative to UHMWPE as a cup-liner material.

Surface modification of AISI 304 steel; the role of Surface Mechanical Attrition Treatment (SMAT) process parameters

PROJECT REPORT

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Abstract

Surface of any material is the critical area of study as most of the failures originate from there. In this project the surface of AISI 304 was modified to obtain surface nanocrystalline layer. The fact that nanocrystalline materials have many crucial properties superior to regular micrometer size grains has resulted in huge attention towards severe plastic deformation(SPD).SMAT is one such process; in SMAT i.e. surface mechanical attrition treatment, shots/balls which are mostly metallic ones are made to strike the sample surface in multiple directions

to generate high strains. These large strain rates results in the generation and accumulation of dislocations, twins and related slip phenomenon resulting in grain refinement up to nanometre range at the surface (average depth of ~50 μm). This project aims to study the effect of various process parameters such as ball diameter, time, strain, strain rate, frequency and no of balls on the SMAT behaviour of AISI 304. High speed camera was also utilized to find the velocities of metallic balls striking the surface. The velocities were used to model the strain rate and related effects on SMAT of AISI 304. Possible reasons are provided in the end to explain the results of various process parameters.

Fabrication and Properties of Transparent Polycrystalline Nd: YAG Ceramics for Laser Applications

A PROJECT REPORT

Submitted by

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ABSTRACT

Polycrystalline Nd: YAG Ceramics were fabricated by mixing the powders of Al_2O_3 (99.9%), Y_2O_3 (99.9%) and Nd_2O_3 (99.7%) in stoichiometric proportions. Wet ball milling for 12 h at 250 rpm in planetary ball mill was carried out with addition of TEOS and Ethanol. Two different routes were adapted while subsequent processing. In the first route, addition of sintering aids (1, 5 and10 wt. %) such as CaO, MgO, SiO_2, ZnO, TiO_2 and ($2\%Al_2O_3$ $+6\%Y_2O_3$) was made to milled powders to lower down sintering temperature. These powders were uniaxial compacted to form pellets. Sintering was done at 1530 ^oC for 10 h in $MoSiO_2$ sintering furnace. In the second route, cold isostatic pressing was carried at ~ 100 MPa pressure on the milled powders and the pellets were formed. Sintering was done at 1650^0 C for 20 h. Results of the samples with 5 wt. % ZnO, 5 wt. % TiO_2 and mixture of 2% Al_2O_3 plus $6\%Y_2O_3$ as sintering aids demonstrated very good sintered density. XRD pattern revealed identical phase structure for the ceramics fabricated by both routes. SEM microstructures supported the densities obtained. Hardness values of more than 1000 H_v was obtained for ZnO, SiO_2 and TiO_2 as sintering aids.