"Synthesis, Characterization and Corrosion Protection Performance of Conducting Polyaniline and Micaceous Iron Oxide Composite coatings on Low Carbon Steel"

Submitted in partial fulfilment of the requirements

Of the degree of

Master of Technology

in

(PHYSICAL METALLURGY)

By

UPADHYAY JAY MUKESHBHAI

(121426001)

Guide

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(AN AUTONOMOUS INSTITUTE OF GOVT. OF MAHARASHTRA)

2015-16

Abstract

Micaceous Iron Oxide powder (MIO) were used for making conducting polyaniline Micaceous Iron Oxide(MIO) composite by chemical oxidative method. The product was characterized by UV- Visible absorption spectroscopy. The morphology and thermal stability of the product was studied by transmission electron microscopy and thermo gravimetric analysis respectively. The epoxy based paint containing conducting polyaniline-MIO composite pigment was applied on low carbon steel samples. Corrosion protection performance of the painted low carbon steel samples in 3.5 mass % sodium chloride solution was evaluated by using electro-chemical technique. Transmission electron microscopic image revealed the formation of core shell structure of the composite. Composite was found to be more thermally stable than the conducting polyaniline. The corrosion rate of conducting polyaniline Micaseous iron oxide(MIO)painted low carbon steel was found to be 2.5×10^{-3} mm per year, about 80 times lower than that of unpainted low carbon steel and 15 times lower than that of epoxy Micaceous iron oxide(MIO)paint coated steel. The study reveals the possibility of using conducting polyaniline Micaceous iron oxide (MIO) as a pigment for corrosion protection.

A
DISSERTATION
REPORT ON

ELECTRICAL PROPERTIES OF THREE PHASE POLYMERIC NANOCOMPOSITES

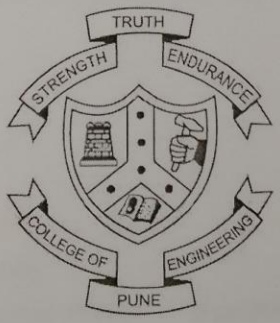
Submitted in partial fulfilment of the requirements of the degree of
Master of Technology in Physical Metallurgy

BY

KANTHARIYA BHAVESHKUMAR ISHVARBHAI
[121426003]

UNDER THE GUIDANCE OF

Dr. R. K. GOYAL



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE-05
(An autonomous institute of Govt. of Maharashtra)

(2016)

ABSTRACT

In recent years, a lot of research effort has been carried out to improve electrical properties of polymer nanocomposites. In present work, fabrication of PAEK/graphene two phase PAEK/graphene nanocomposites was fabricated successfully using solution mixing followed by hot compaction. Also solution method was used for fabrication of PAEK/$BaTiO_3$/graphene and PAEK/$BaTiO_3$/MWCNT three phase nanocomposites. The density of the nanocomposites is close to the theoretical density. The AC and DC electrical conductivities increase with increasing graphene content in PAEK matrix. In all nanocomposites, the conductivity increases by 14 orders of magnitude compared to pure matrix. Three dimensional dispersion of graphene was found in the PAEK/graphene nanocomposites. In three phase PAEK/$BaTiO_3$/MWCNT nanocomposite, electrical conductivity varies between 2-4 orders of magnitude depending upon the direction of measurement. All nanocomposites below percolation showed electrical insulator behaviour.

A Dissertation Report On

POLYANILINE/TiO_2, $Zn_3(PO_4)_2$ AND POLY(o-ANISIDINE)/TiO_2, $Zn_3(PO_4)_2$ COATINGS ON LOW CARBON STEEL FOR CORROSION PROTECTION

Submitted in partial fulfilment of the requirements

of the degree of

Master of Technology

(PHYSICAL METALLURGY)

by

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2015-16

ABSTRACT

Polyaniline/TiO_2, polyaniline/$Zn_3(PO_4)_2$, poly(o-anisidine)/TiO_2 and poly(o-anisidine)/$Zn_3(PO_4)_2$ nano particle composite coatings on low carbon steel substrate have been synthesized successfully under galvanostatic conditions. The electrochemical medium was used for the synthesis of these coatings. Characterization of the coatings being synthesized was performed using ultraviolet visible spectroscopy (UV-Vis) and Fourier transform infrared spectroscopy (FTIR) techniques. UV-Vis spectroscopy revealed peaks at 325 nm and 630 nm indicating partially conducting phase formation of the respective polymers. FTIR spectroscopy revealed that the electrochemical polymerization of monomers has occurred and resulted in the formation of respective nanoparticle composite coatings on the low carbon steel substrate. Corrosion protection performance of the coatings being synthesized was studied using Tafel polarization and electrochemical impedance spectroscopy (EIS) techniques. Tafel analysis in 3.5 wt% NaCl solution reveals the corrosion rate of the coatings being synthesized. For Polyaniline/TiO_2, polyaniline/$Zn_3(PO_4)_2$, poly(o-anisidine)/TiO_2 and poly(o-anisidine)/$Zn_3(PO_4)_2$ nano particle composite coatings corrosion rate is 5.427 mpy, 4.886 mpy, 1.469 mpy and 2.415 mpy respectively. Electrochemical impedance spectroscopy shows that the passivation for polyanilne/TiO_2 and poly(o-anisidine)/TiO_2 begins after 48 hours. For polyaniline/$Zn_3(PO_4)_2$, the passivation occurs after 24 hours and for poly(o-anisidine)/$Zn_3(PO_4)_2$ it begins just after immersion according to the study based on electrochemical impedance spectroscopy. The specialty of synthesized nano particle composite coatings lies in corrosion protection of low carbon steel by simultaneously operating mechanisms viz. enhanced barrier protection, formation of passive oxide layer and formation of p-n junction which prevents charge transport.

A

DISSERTATION REPORT

ON

A Study On Sintering Characteristics and Dielectric Properties of Aluminium Nitride Ceramics

Submitted in partial fulfilment of the requirements

of the degree of

Master of Technology

(Physical Metallurgy)

By

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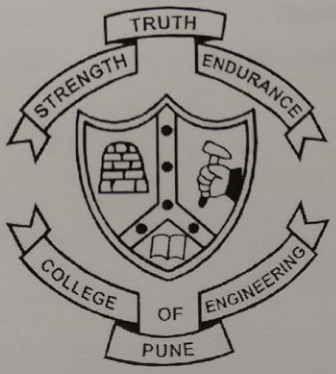
And Under the Co-guidance of

Mr. K. R. Kambale



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

College of Engineering, Pune

(An Autonomous Institute of Govt. of Maharashtra)

August-2016

ABSTRACT

Aluminium nitride (AlN) possesses excellent properties for use as a substrate or packaging material in the flourishing microelectronics industry. However, AlN is exceptionally difficult to sinter through conventional sintering processes, and pure AlN does not attain full density even at sintering temperatures above 1800 °C. In this study, pure AlN with Y_2O_3 ,and Bi_2O_3 additives were investigated as sintering aids.

AlN powders are sintered using the spark plasma sintering (SPS) method at 1750°Cand pressure less sintering at 1600°C in N_2 environment. In SPS, densification is enhanced by the application of electrical discharges combined with electrical resistance heating and concomitant uniaxial pressure (45 MPa). The microstructure, density and dielectric constant of SPS AlN samples are examined. X-Ray diffraction was used for characterization and phase determination of samples. Scanning electron microscopy analysis was carried out to investigate the grain morphology, grain size, and pores distribution. Bulk density was calculated. Mainly observation on dielectric behaviour of AlN ceramic with Y_2O_3.It was observed that addition of Y_2O_3 enhances the densification and promotes grain growth. The effects of sintering additives on dielectric loss tangent (tanδ) of AlN ceramics were explored . tan δ decrease with Y_2O_3 best value of 0.0036 .We suggest that the effect of aluminates second phase and the micro imperfections could play an important role on the dielectric properties of sintered AlN ceramics.

Keywords: Aluminium Nitride, Y_2O_3, Sintering , SPS, Dielectric Property, Microstructure

Synthesis of Calcia-Stabilized Zirconia by Solid State Reaction Route and its Electrical Conductivity

Submitted in partial fulfillment of the requirements

of the degree of

Master of Technology

by

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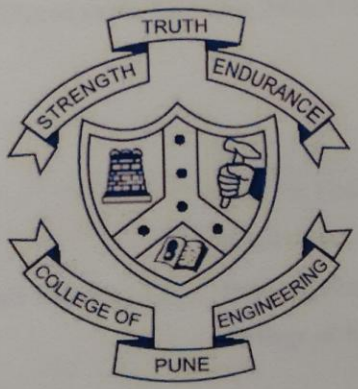

Department of Metallurgy & Materials Science

COLLEGE OF ENGINEERING PUNE

August, 2016

Abstract

Calcia stabilize zirconia (CSZ), $Ca_xZr_{1-x}O_{2-x}$, (x = 0.1 - 0.3) fine powders were synthesized using solid state reaction route. The powder pellets fabricated were sintered at high temperature under variable partial pressures of oxygen. Formation of phase pure CSZ with/without other secondary phases (ZrO_2 & $CaZrO_3$) was confirmed by X-Ray diffraction studies. Microstructural aspects were studied using scanning electron microscopy. Theoretical density (TD) was calculated using Aleksandrov model and compared with bulk density. The measured bulk density was 90-98 %TD. The electrical conductivity values of sintered samples determined in the temperature range of 400-1000°C using electrochemical impedance spectroscopy were better than those reported by other researchers in the field. Change in activation energy values at 800°C, indicated an associated phase change from cubic to tetragonal zirconia. The activation energy values for the mobility of charged particles also matched well to their reported values.

Keywords: CSZ synthesis, solid state reaction, ionic conductivity, impedance spectroscopy, activation energy etc.

A

DISSERTATION
ON

"To Improve the Machinability of CuSn alloy."

Submitted in partial fulfilment of the requirements of the degree of
Master of Technology in Physical Metallurgy

By

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Under the guidance of

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DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE
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(2016)

ABSTRACT

The aim of this work to evaluate the machinability CuSn alloy by varying tin from wt % 13.50 to wt% 14.5 and also to evaluate the effect of rotational speed of mould from 550 to 760 rpm on machinability. The machinability of investigated alloys is tested based on cutting force, tool wear, chip type and the surface roughness.The objective of the present work is to determine the effect of chemical composition and rotational speed of die on the machinability of CuSn alloy. Machinability tests results correlated with the alloy's mechanical properties and with the phases present in the microstructure. It can be anticipated that the hardness of the CuSn alloy increases when the Sn content was increased and rotational speed of the die increased due to uniform eutectoid phase formation $\alpha+(\alpha+\delta)$ in the structure. However in this work, the alloy CuSn tested for manufacturing of gears and for different parameters like machinability, hardness, and strength. The results suggested that in centrifugal casting there was a critical range for the speed of die 760 rpm,within which the produced castings exhibited best uniformity and maximum mechanical properties which helps to improve machinability of CuSn alloy. At 760 rpm casting shows fine grains and harder metal compared to the lower speed.Microstrutural evaluation of the specimen conducted using optical microscope. The Brinell and Rockwell tester was used to measure hardness of the specimen.SEM and EDS and X-Ray Diffraction technique was employed to identify phases and chemical analysis. Mechanical properties were tested by UTS machine and Chemical analysis is done by optical emission spectrometer.

Key words: CuSn alloy, Centrifugal casting, Chemical composition (wt% tin), Rotational speed of die, chip formation, Tool wear, cutting force, surface roughness. Mechanical properties, Hardness, Machinability.

A

Dissertation Report on

Effect of NbC addition in M3/2 High Speed Steel and Optimization of HPS parameters

Submitted in partial fulfillment of the requirements for the Degree of Master of Technology in Metallurgical Engineering

By

JOSHI APURV MADHAV

MIS No:-121426008

M. Tech (Physical Metallurgy)

Under the guidance of

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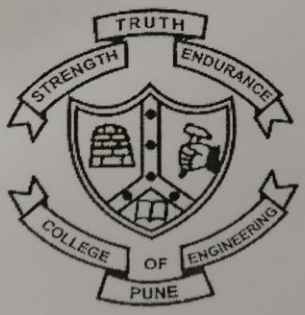
(Guide)

Prof. V. T. Thavale

(Co-guide)



Department of Metallurgy and Materials Science

College of Engineering, Pune

(An Autonomous Institute of Government of Maharashtra)

June-2016

Abstract

In the present work, the influence of Niobium Carbide impregnation (1, 3 and 5 wt. %) on the properties of M3/2 High Speed Steel prepared by powder metallurgy process containing (in wt. %) 0.93 % C, 4.05 % Cr, 5.72 % Mo, 3.04 % V, 0.36 % Si, 0.14 % Mn, 0.11 % Cu was investigated The compacts were prepared by Hot Press Sintering process with various combinations of pressure, time and temperature among which the optimized parameters on the density basis were (Temperature – 1070 °C, Time – 4 minutes and Pressure – 50 MPa). The compacts then prepared with the optimized HPS parameters were examined for various mechanical properties and also the effect of secondary hardening was analysed. The compacts with better wear resistance, hardness and density were used to fabricate the tool inserts. The machining performance of the in-house fabricated tool insert was compared with the performance of the commercially available Sandvik tool insert and High Speed Steel tool. This machining performance was evaluated by turning operation on lathe machine keeping the machining parameters constant for all tools and the comparative performance data of the three tools was obtained.

A
DISSERTATION
REPORT ON

FRICTION AND WEAR ANALYSIS OF UNTREATED AND TREATED ZINC OXIDE REINFORCED POLYMER NANOCOMPOSITES

Submitted in partial fulfilment of the requirements of the degree of
Master of Technology in Physical Metallurgy

BY

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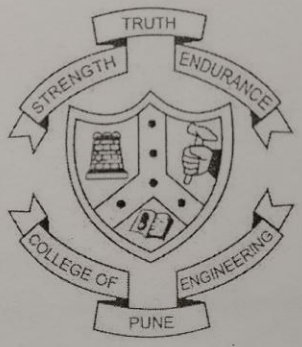

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE-05
(An autonomous institute of Govt. of Maharashtra)

(2016)

ABSTRACT

The present study discusses the tribological behaviour of polycarbonate (PC) nanocomposite containing 0-10 wt.% graphene, 0-5 wt.% zinc oxide and modified zinc oxide powders. Tribological behaviour of the nanocomposites was investigated at a sliding speed of 1.0 m/s and nominal pressure 0.2 MPa under dry sliding conditions using a pin-on-disc wear tester. The wear resistance of 3 wt.% graphene, 3 wt.% ZnO and 1 wt.% mZnO was increased approximately nine fold, tenfold and sixty three times, respectively as compared to pure PC. The improvement in wear resistance was attributed to the thin, tenacious and coherent transfer film formed between the counterface and the nanocomposite pin. The coefficient of friction of the nanocomposites was decreased at higher concentrations. In order to examine the dispersion of the interfacial filler in the matrix, fractured samples were observed using scanning electron microscopy (SEM). Thermogravimetric analysis (TGA) showed a decrease in thermal stability and no significance change in char yield on increasing the nanofiller loading in the PC matrix.

Keywords: Polycarbonate, graphene, zinc oxide, wear, friction, SEM, TGA.

A

Dissertation Report on

Forgeability of Prealloyed DB-1 and its Response to Thermal Processing

Submitted in partialfulfilment of the requirements for the Degree of **Master of Technology** in **Metallurgical Engineering**

(Physical Metallurgy)

By

KARANJIKAR OMKAR AMRUTRAO

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Under The Guidance of

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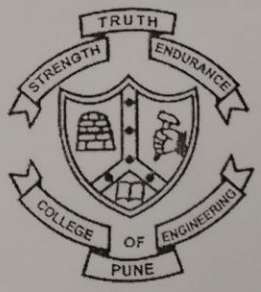
Prof. Vijay Thavale (Co-Guide)



Department of Metallurgy and Materials Science

College of Engineering, Pune

(An Autonomous Institute of Government of Maharashtra)

Year 2015-2016

Abstract

In high performance gear applications, compaction, sintering are used as primary densification process while repressing and heat treatment are secondary densification processes. To overcome this problem, forging applications as a secondary densification process was introduced by replacing repressing.

The present context, prealloyed powders DB-1 and DB-1 + 0.1 % graphite were compacted, sintered, hot forged and carbonitrided. The hot forging process conditions were optimized to 180 MPa, 0.3 per second strain rate to sintered density of 98 % ρ_{th} in DB-1 and 97 % in DB-1 + 0.4 % graphite with improved hardness and wear resistance as compared to industrially manufactured gear (90 % ρ_{th}, 84 HRB). A comparative study has been done to understand silent feature of powder forging. Study also revealed that hot forging pressure drops to 180 MPa from 1500 MPa as the hot forging temperature reduces to from 1000 °C to 800 °C respectively. In addition, dimensional shrinkage is observed in alloys of powders were varying from 0.09 to 0.199 %.

Key Word: Powder Forging, Carbonitriding, TRS, Tensile Strength, Wear, Sinter hardening, Dimensional growth.

A Dissertation REPORT

On

Chloride and carbonated induced corrosion of mild steel immersed in concrete pore solution.

Submitted in partial fulfillment of the requirements of the degree of
Master of Technology in Physical Metallurgy

by

Manoj Mahaveer Patil

(M.I.S No. 121426011)

Under the guidance of

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DEPARTMENT OF METALLURGY AND MATERIAL SCIENCE

COLLEGE OF ENGINEERING, PUNE

(An autonomous institute of Government of Maharashtra)

June 2016

Abstract:

Passive film properties of mild steel immersed in concrete pore solution have been investigated. Mild steel gets passivated after three days of immersion in standard concrete pore solution. As ratio of chloride ions to hydroxide ions exceeds critical chloride level, it becomes active. Passive film will be stable if there is no chloride ions present in pore solution and active corrosion would if threshold chloride level is reached. By the end of 10 days of immersion in non carbonated concrete pore solution having 1M sodium chloride, mild steel exhibits maximum corrosion rate 0.6 mpy. The nature curve (From Mott Schottky Plot) when passive film formed on mild steel was n-type. However, it becomes p-type at high negative potential and longer immersion time. Passive film thickness decreases with increase in immersion time, indicating disintegration of passive film as a function of time. Pitting potential gets lowered as chloride concentration is increased. It becomes minimum ie. 540 mV for 1M sodium chloride containing concrete pore solution. High HCO_3^- concentration enhances the stability of the passive film and the corrosion resistance of the steel specimen, while the low concentration of HCO_3^- ions accelerates the corrosion.

A

Dissertation Report

On

MULTIPASS HOT ROLLING OF SAE 9260 SPRING STEEL

Submitted in partial fulfilment of the requirements for the Degree of

Master of Technology in Metallurgical Engineering

By

PATIL POONAM SHIVAJI

MIS NO: 121426012

(Physical Metallurgy)

Under the Guidance of

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DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLGE OF ENGINEERING PUNE

SHIVAJINAGAR, PUNE-411005

2015 – 2016

ABSTRACT

Silicon-manganese steels are widely used for making helical coils and leaf springs. SAE 9260 grade silicon manganese steel is a medium carbon steel with approx 0.6% C with major alloying elements viz. Si (1.91%) and Mn (0.9%) and small amount of chromium and nickel. The objective of current work is to find out a processing method which can be used to enhance tensile strength and ductility together. Various type of thermomechanical processes (TMP) can be adopted to increase strength and ductility together. Thermomechanical processing is a combination of well-defined deformation and heat treatment in a single production stage to control the microstructure of the metal being worked. In order to meet the increasingly stringent requirements, controlled rolling followed by controlled cooling, as a cost-effective process, is now being used to improve the microstructure of many spring steels. Several parameters like strain, strain rate, deformation temperature, reduction ratio, cooling rates, inter-pass time etc decide the evolution of grain size and structure of deformed austenite. The parent grain size i.e. grain size of 'prior austenite' is responsible for the final microstructure and properties. If a process is rolling, a range of finishing strains and strain rates is used to clarify the effect of different rolling schedules and parameters on the phase transformation kinetics, microstructure development and mechanical properties.

In current work, multiple hot rolling of SAE 9260 spring steel is done by changing rolling speed, strain and cooling method after hot rolling. Initially the rolling process and parameters are optimized. After optimisation, actual hot rolling is done at 910°C by using the selected parameters. Hot rolling is carried out in multiple passes to get desired reduction in thickness. In between each pass of rolling, the samples were reheated to 910°C for 5 minutes. The actual rolling was done at different rolling speeds (22.5, 32, 43.16 rpm), reduction ratios (60%, 73% and 86% reduction in thickness), followed by hardening and tempering; normalising and isothermal cooling in salt bath at 350°C. The samples were characterized by using metallography, mechanical testing. The microstructure evaluation is done by optical microscopy and SEM technique. The structure achieved after various types of cooling methods, was studied and correlated with the hardness, tensile test and ductility of samples. Out of all types of cooling methods the best combination of microstructure, tensile strength and ductility are achieved in hot rolled samples at 60% reduction in thickness followed by salt bath quenching. The YS/UTS ratio was increased above 0.9 to a maximum value of 0.98 in the current work by thermomechanical processing.

A

DISSERTATION REPORT

ON

Thermal mapping and quality aspects of high pressure die casting

Submitted in partial fulfillment of the requirements

of the degree of

Master of Technology

(Physical Metallurgy)

By

PATOLE ANIKET KESHAV

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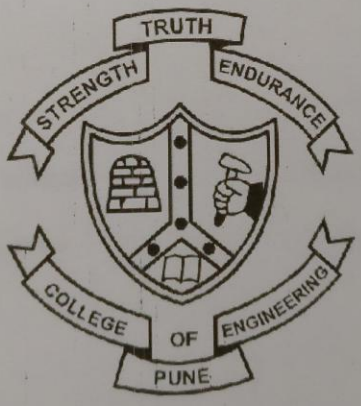
Under the Guidance of

Dr. M. J. Rathod



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

College of Engineering, Pune

(An Autonomous Institute of Govt. of Maharashtra)

2015-2016

ABSTRACT

Die casting process is for low melting point alloys of Aluminium, Zinc and Magnesium. In high pressure die casting process of aluminium, die temperature measurement and its control are an important factor affects quality of casting. Contact temperature measurement using thermocouple is possible but faced with practical limitations. Formation of porosity in the casting due to solidification, shrinkage and gas segregation mechanisms and affect its mechanical properties. The measurement of die temperature using infrared thermography in thermal camera depends on parameters such as emissivity, height from ground level, angle and distance of camera from die block. These parameters were studied and optimized in comparison with thermocouple measurement to achieve minimum error. Effect of vacuum assistance in HPDC on porosity distribution in castings was also studied. Castings conditions were selected on the basis of design of experiments using first phase velocity (V_1) second phase velocity (V_2), distance travelled by plunger in first phase S_1, injection pressure (IP), vacuum start time (Vs) and end time (Ve). It was found that with optimized parameters of thermal camera, the die temperature can be measured with minimum error. In case of vacuum assisted HPDC process combination of process parameters and vacuum parameters were optimized. By using optimized parameters, amount of porosity was reduced.

A

Dissertation Report

On

"Hot Deformation study of P91 Steel"

Submitted in partial fulfilment of the requirements

for the Degree of

Master of Technology

Metallurgical Engineering

By

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Under The Guidance of

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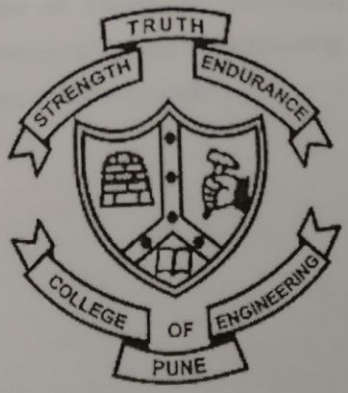

Department of Metallurgy and Materials Science

Govt. College Of Engineering, Pune

2015-2016

ABSTRACT

P91 steel containing 8-9.5% of Cr-1%Mo is mainly used in nuclear and fossil-fuelled power generation industries which operate at elevated temperatures. Grade P91 steel is cast steel has a microstructure of martensite with finely dispersed carbides. Tensile tests were carried out on heat treated P91 alloy steel, using strain rate of 0.001/s, at room temperature, 300°C, 500°C, 630°C, and 800°C to characterize the mechanical properties such as yield strength, UTS, % elongation, % area reduction and fracture toughness. The yield strength and ultimate tensile strength was found to decrease with increase in test temperature. The stress-strain curves were fitted using Holloman equation to determine the strain hardening exponent values. The strain hardening rate decreases with increase in temperature.

To understand the deformation and fracture behavior of P91 steel at various temperatures, microstructural characterization of 10% deformed samples and fracture surface is carried out. It is observed that up to 500°C strength decreases gradually and rapidly above that because of microstructural instability i.e. breakdown of ferrite matrix under thermal influence in tensile test. Deformed sample shows lot of slip bands after 10% deformation which indicates deformation due to slip mechanism. Fracture surfaces show the dimples with different sizes along with cavities under scanning electron microscope. The presence of dimple appearance of fracture surface indicates that fracture occur by ductile mechanism. The increase in size and depth of cavity with decrease in fracture toughness for increase in temperature indicates that early fracture at high temperature is because of rapid growth of cavity.

A
DISSERTATION
REPORT ON

Mechanically Alloyed and Sintered Steel-B_4C System: Heat Treatment and Mechanical Properties

Submitted in partial fulfilment of the requirements of the degree of
Master of Technology in Physical Metallurgy

BY

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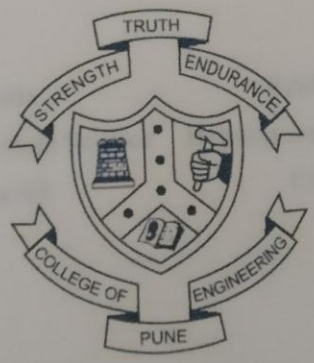

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE-05
(An autonomous institute of Govt. of Maharashtra)

(2016)

ABSTRACT

Fe-B_4C alloy was made by using powder metallurgy route comprising of homogenous mixing, mechanical alloying, compaction and sintering. The size of starting powder used were 60 μm for Medium carbon steel (MCS) and sub-micron for B_4C. Ball milling was done using steel balls with diameter of 6 mm, ethanol as medium and ball powder ratio (BPR) of 10:1. Mechanical alloying (MA) was performed in planetary ball milling with 5:1 BPR using tungsten carbide balls of 10 mm diameter at 350 rpm. MA was done for 4 h, 8 h and 16 h duration. Density of compacted samples decreases with samples milled for longer duration. Hardness increased from 112 HV to 256 HV with samples milled for longer duration as well as with increasing hardening temperature in heat treatment for respective milling time. Ferrite and Fe_2B phases were observed in XRD of sintered samples, whereas, ferrite, Fe_2B and $Fe_{23}(C,B)_6$ phases were seen in heat treated samples. SEM revealed flattening and increase in size of particle till 8 h of milling and braking of particle for 16 h milling. Compaction of as received and MA powder was done at 600 MPa followed by sintering at 1150°C temperature for 30 minutes. Hardening-Tempering was done on one batch of sintered samples. UTM machine was used to test compressive strength. Compressive strengh decreases form 3 h mixing to 8 h MA, but it increases for 16 h MA samples. It is due to drastic reduction in particle size. The compressive strengh of hardened-tempered samples is more than corresponding sintered samples. Pin-on-disc machine was used to test the wear property of sintered and heat treated samples at 2 kg and 5 kg load. The wear rate of hardened-tempered samples is marginally less for both 2 kg and 5 kg load as compared to the sintered samples. For both load the wear rate of sintered as well as hardened-tempered samples is getting reduced for the samples milled for longer duration.

Standardization of Process Parameters for Metallic Iron and its Sintering Response

Submitted in partial fulfillment of the requirements

of the degree of

Master of Technology

By

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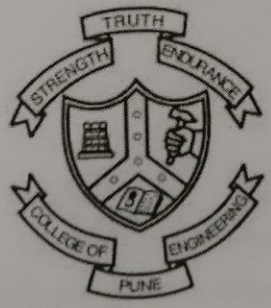
Guide:

Dr. N. B. Dhokey



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ABSTRACT

The mill scale is known for its richness in iron content approximately 72%. Still mill scale cannot be properly utilized for industrial use due to its complex chemistry. In present work, mill scale was milled and oxidized to Fe_2O_3 in specially design and fabricated in- house set up to know by hydrogen gas which results in production of reduced iron powder with higher specific surface area (about 0.69 m^2g^{-1}) was obtained. The reduced iron powder was then consolidated at different compacting pressure ranging from 600MPa to 700MPa. These compacts were sintered at 1100^{O}C in 90%N_2+10%H_2 atmosphere. Sintered compacts depicted radial shrinkage of about 2.31 % (average) and longitudinal shrinkage of about 2.22% (average). The activation energies were calculated for oxidation and reduction and were determined to be about 35.277 KJ/mol and 48.478 KJ/mol respectively.

Key words: Mill scale, Activation energy, specific surface area.

A Dissertation Report on

INFLUENCE OF PROCESS PARAMETERS ON GENERATION OF CRACKS DURING INDUCTION HARDENING OF EN8 STEEL BAR

Submitted in partial fulfillment for the requirement of the degree

of

Master of Technology

(PHYSICAL METALLURGY)

by

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Abstract

The parts undergoing induction hardening treatment are susceptible to generation of cracks. The objective of this study was to experimentally identify the effect of various process parameters on crack generation in EN8 hot rolled steel bar. For this purpose, the 'Pushrod' used in automotive engine was selected.

The parts cracked during its manufacturing process were investigated to understand the nature of crack by using various metallurgical analysis techniques like chemical analysis, hardness measurement, macro examination, metallography & SEM analysis, etc. The entire manufacturing process & their process parameters were screened using Design of Experiments by Plackett-Burman Technique to understand their contribution in generation of cracks. Total 51 experiments were conducted involving almost 500 test samples.

The experimental investigation showed that the carbon content of the bar has the most prominent effect on generation of residual stresses & formation of cracks followed by cooling time. The conclusions were verified & understood using metallography & residual stress measurement by X ray diffraction method.

Keywords : Factography, Critical stage, X ray diffraction, Intergranular cracking, MPI, SEM, Hoop stress.