A Dissertation Report

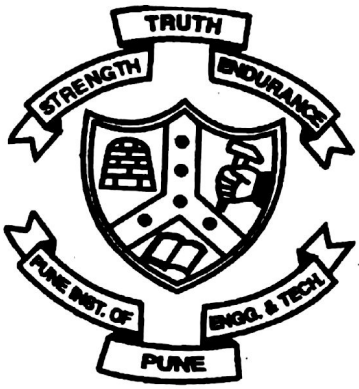
Mechanical behaviour of aluminium 7075 alloy at various deforming & ageing conditions

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

By

SADANAND R. BHAVSAR
(M.I.S No. 121327001)

Under the guidance of
Prof. S. U. DANGARIKAR



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE
COLLEGE OF ENGINEERING, PUNE
(An autonomous institute of Government of Maharashtra)
(June, 2015)

Abstract

Al 7075 alloy have high strength to low density ratio and have good fatigue strength and average machinability. It is used in aircraft, aerospace structure and rock climbing equipment. High strength age hardenable Al 7075 series alloys are difficult to process by many of the severe plastic deformation processes at room temperature. Cryorolling of Al 7075 which is one of the deformation techniques to obtain fine grained structure. There are various advantages of processing Al 7075 at very low temperature for improving various mechanical properties. Hence, Al 7075 alloy needs to process at cryogenic temperature and room temperature up to various rolling thicknesses. The Project report is on mechanical behaviour of Al 7075 alloy sheet, at room temperature rolling, high temperature rolling (at 200^{0}C) and cryotemperature (at -196^{0}C) rolling with 20% and 40% thickness reduction at different ageing temperature 110^{0}C and 160^{0}C. Along with this, mechanical behaviour of Al 7075 bar sample with and without cryotreatment at different ageing temperatures (110^{0}C and 160^{0}C) has also been compared. A cryorolling treatment has been found to be desirable for producing the ultrafine grained Al 7075 alloys with the high angle grain boundaries. The results were analyzed by using tensile testing, hardness, charpy impact testing, electrical conductivity, FESEM and XRD. It has been observed that cryorolled Al 7075 alloy samples has higher strength and hardness than that of the room temperature rolled samples while it has lower toughness as compared to as received sample. Also electrical conductivity decreased from room temperature rolled to cryorolled specimens. The improved strength and hardness of cryorolled samples may be due to the grain size effect and higher dislocation density, suppression of dynamic recovery, while decreased toughness may be due to work hardening.

A

Dissertation Report on

Forgeability of PM Compact and its Response to Thermal Processing

Submitted in partial fulfilment of the requirements for the Degree of

Master of Technology in **Metallurgical Engineering**

(Process Metallurgy)

By

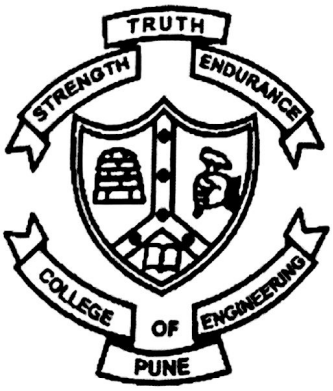
Dhokale Sagar Devchand

MIS No: 121327002

Under The Guidance of

Prof. Vijay Thavale (Guide)

Dr. N. B. Dhokey (Co- guide)



Department of Metallurgy and Materials Science

College of Engineering, Pune

(An Autonomous Institute of Government of Maharashtra)

Year 2014-2015

Abstract

In Powder metallurgy, gears are manufactured by pressing, sintering, selective densification process and hardening to get final geometrical shape. In high performance gear applications; compaction, sintering are used as primary densification process while repressing and heat treatment is the secondary densification process. During repressing, even though high working pressure is required which creates higher stresses in the gear, the final densification achieved is lower. To overcome this problem, forging application as secondary densification process was introduced by replacing repressing to get higher mechanical properties such as tensile, TRS, wear. Forging at 1000°C and 0.3 mm/s strain rate gives approximately 98% density and 90 HRB Hardness. Carbonitriding gave better hardness and wear property than carburizing. Sinter hardening is a cost effective process to get high strength part by minimizing various processing step. Powder metallurgy is near net shape technology but tolerance is affected by alloy addition and cooling rate. Astaloy Molybdenum is dimensionally stable as it showed minimum dimensional variation after heat treatment because the absence of copper.

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

A

DISSERTATION

ON

FABRICATION OF POLYPROPYLENE/IRON COMPOSITES USING TWIN SCREW EXTRUDER AND THEIR ELECTRICAL, THERMAL AND MECHANICAL PROPERTIES

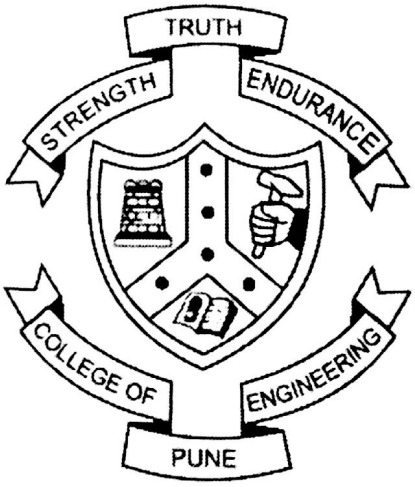
Submitted in partial fulfilment of the requirements of the degree of
Master of Technology in **Process Metallurgy**

by

CHETAN VIJAYRAO KALE
(MIS No. 121327003)

Under the Guidance of

Dr. R. K. GOYAL



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING PUNE
(An Autonomous Institute of Government of Maharashtra)

(June 2015)

ABSTRACT

This project deals with preparation of polypropylene/iron (PP/Fe) composites containing unmodified and modified-Fe powder using twin screw extruder followed by hot compaction. The content of Fe was varied from 0 to 70 wt% (21.3 vol%). Triethoxyvinylsilane was used as treating agent to modify iron particles. Composites were characterized using optical microscopy, scanning electron microscope (SEM), energy dispersive X-ray spectroscopy (EDX), impedance spectroscopy, thermo gravimetric analysis (TGA), differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA). Experimental density of the PP/Fe composites was found close to the theoretical density. SEM/OM shows that the Fe particles are uniformly dispersed in the PP matrix. The percolation threshold was obtained at 4.67 vol% (30 wt%) Fe content. The electrical conductivity of the composites with 10.3 vol. % (50 wt%) Fe increased by more than ten orders of magnitude compared to pure PP. The PP/Fe composites exhibits increase in dielectric constant and dissipation factor under wide sweep frequencies. The dielectric constant of composites measured at 1 kHz, increased significantly. TGA shows that the decomposition temperature of the composites increases by more than 90 °C compared to pure PP. DSC shows that the melting temperature decreases slightly while peak crystallization temperature increases with increasing Fe content. Both Shore-D hardness and Rockwell hardness (HRL) of the composites increases approximately 30% compared to pure PP. DMA shows that storage modulus of the composites increases with increasing Fe content in the PP matrix and it decreases with increasing temperatures. For comparison, PP/Fe composites were also prepared by using ball milling followed by hot pressing and it was found that their thermal, mechanical and electrical properties were increased with increasing Fe content. However, in this series, the dispersion of the Fe particles was not as good as in the composites prepared by extrusion. The significant improvement in thermal, electrical and mechanical properties indicates that PP/Fe composites may be useful for the applications in electromagnetic shielding (EMI), radio frequency interference (RFI) shielding and electrostatic dissipation of charges (ESD).

A Dissertation Report

Tensile behaviour of Aluminium 2014 alloy at various temperature & strain rate conditions by Arrhenius model

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

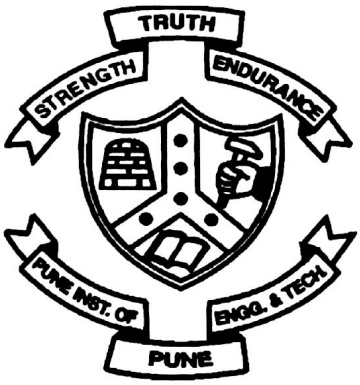
By

SHEJAL G. KASAR

(M.I.S No. 121327005)

Under the guidance of

Prof. S. U. DANGARIKAR



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE

(An autonomous institute of Government of Maharashtra)

(June, 2015)

Abstract

Due to high strength and low density property of Al 2014 alloy it is extensively used in aerospace application and structural applications. The understanding of the flow behaviours of metals and alloys at different deformation condition has a great importance for designers engaged in metal forming. In this project work, I have done the comparative study to find how Arrhenius model is reliable for prediction of flow stress behaviour of Al 2014. In this, I have done tensile test at room temperature (25^0C), high temperature (196^0C) and cryotemperature (-196^0C) with different strain rates 0.001, 0.002 and 0.004 s^{-1}. True stress-strain curve to develop the Arrhenius model and evaluate some statistical parameter, correlation coefficient (R), average absolute relative errors (AARE) for verifying the predictability of model are used. I have also studied the hardness and other properties such as conductivity, optical microstructure and fractography of high strained region of tensile sample.

A Dissertation on

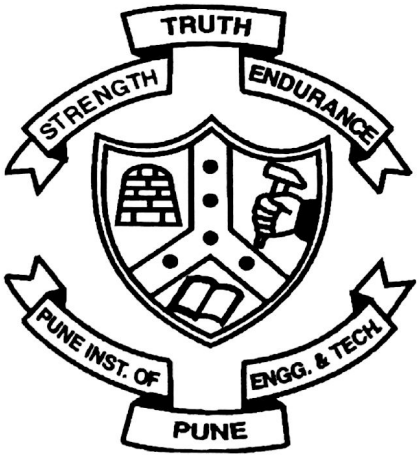
Synthesis of Yttria stabilized Zirconia Powder with 10 mol% ≤ Y_2O_3 ≤ 30 mol% by Co-precipitation method and its Electrical Characterization

Submitted in partial fulfillment for the award of the degree of
Master of Technology in Process Metallurgy in
Department of Metallurgy & Materials Science

By

UMESH VASANT KEDAR
M.I.S No. 121327006
M. Tech - Second Year
(Process Metallurgy)

Under the guidance of
Mr. Kaustubh Kambale



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE

ABSTRACT

Yttria Stabilized Zirconia (YSZ) is a ceramic in which the crystal structure of Zirconium Dioxide is made stable at room temperature by an addition of Yttria. In this experiment the cubic phase of Zirconia is made stable by addition of different mol% of Yttria viz. 10mol%, 15mol%, 20mol%, 25mol%, and 30mol%, and is confirmed from X-Ray Diffraction. The XRD patterns become sharp with increasing calcined temperature. This shows that the crystallite sizes become gradually larger. It is observed that the powders 10YSZ and 15YSZ gets cubic phase without any impurities by re-calcined powder at 750°C and for powders 20YSZ, 25YSZ, and 30YSZ by re-calcined powder at 800°C. The surface area and average particle size of precursor powders and final YSZ powders carried out by BET surface area analyzer and found that as surface area increases the average particle size decreases. The powders are then sintered at temperature 1350°C for 4hrs and observed that maximum density is achieved at 10mol%YSZ sample and found to be 72% for without sintering aid and maximum relative density is observed at 1350°C for 6hrs sintering for YSZ+5wt%Al_2O_3 for all compositions. It is observed that as Yttria content increases the relative density decreases and confirmed from Scanning Electron Microscopy (SEM) and measuring the density of sintered pellets. Higher relative density is observed at higher sintering temperature & isothermal holding time. Scanning Electron Microscopy also shows that it is a highly porous ceramic; the grain and grain boundary cannot be seen clearly as thermal energy supplied for sintering is less. The impedance spectroscopy of these samples carried out and found out that the Ionic conductivity increase with increase in temperature and frequency for given mol% of YSZ. The total activation energy of all samples calculated by Arrhenius plot and found in the range of 1.03ev to 1.22ev for different mol% of YSZ. The activation energy for Intragranular conductivity and Intergranular conductivity cannot be calculated individually as the grain and grain boundary are not developed during sintering as the thermal energy supplied for crystallization is found less. The dense electrolyte can be achieved by increasing the sintering temperature. The porous YSZ electrolyte found applications in No_x sensors as it has better sensing capability.

A Dissertation Report

on

CONDUCTING POLYANILINE-NANO ZINC OXIDE BASED PAINT COATINGS: BAND GAP AND CORROSION PROTECTION STUDIES

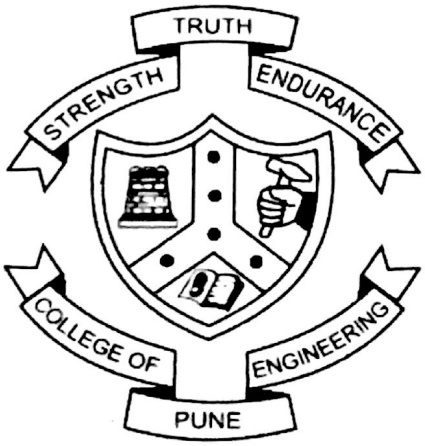
Submitted in partial fulfilment of the requirements of the degree of **Master of Technology** in **Process Metallurgy**

by

NIKLAISH RAJU RATHOD
(M.I.S. No. 121327009)

Guide

Dr. P. P. DESHPANDE



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE
(An Autonomous Institute of Govt. of Maharashtra)

(JUNE 2015)

Abstract

Conducting polyaniline- nano zinc oxide composite was synthesized by chemical method and used as a pigment for making paint. UV-Visible spectroscopy was used to find nature of polyaniline and band gap. Transmission electron microscopy was employed to determine nature of the pigment. Corrosion protection performance of the paint was studied using potentiodynamic polarization and electrochemical impedance spectroscopy. UV-Vis spectroscopy revealed peaks at 330 nm and 620 nm indicating polyaniline base formation and band gap was found to be 1.66 eV. Transmission electron microscopy conforms the formation of nano zinc oxide as a core and polyaniline as a shell around the core. Potentiodynamic polarization studies on polyaniline- nano zinc oxide based paint coated low carbon steel in 3.5 wt % NaCl solution exhibits corrosion rate 1.16 mpy , i.e. 90% reduction in corrosion rate than that of uncoated steel. Electrochemical Impedance spectroscopy reveals long term protection ability of Polyaniline-nano zinc oxide based paint coating due to the formation of passive film after 96 hours. Mott Schottky studies revels that the intact paint coating is n- type and damaged coating is both n-type and p type in nature. Polyaniline being p-type presents a barrier for electron transport while zinc oxide being n-type gives hindrance to hole transport across the interface and thereby prevents corrosion.

A

Dissertation Report

Uniaxial Deformation of AISI 9260 Steel above Upper Critical Temperature at Fixed Strain, Varying Cooling Conditions and Tempering at 350°C

Submitted in partial fulfilment of the requirements of the degree of

Master of Technology

in

Process Metallurgy

by

Surekha Gorakh Dalavi
(121327010)

Under the guidance of

Prof. V.S. Galphade

Assistant Professor

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING PUNE

(An autonomous institute of Government of Maharashtra)

(June 2015)

ABSTRACT

Over the last decades considerable efforts have been made to develop high performance spring steels, which would allow vehicles weight reduction. One way of improving steel properties is by refining its microstructure. Therefore, the aim of the current investigation was to determine the effect of uniaxial deformation of spring steel – AISI 9260 above upper critical temperature at fixed strain followed by oil and salt bath quenching and tempering at 350°C. Aim was to study the effect of refined microstructure obtained through thermomechanical processing on the mechanical and microstructural properties of spring steel. Austenitizing was performed at the temperature of 910°C for 30 minutes and these samples are uniaxially pressed on the 20 Ton hydraulic press. Before compression, plates are heated at 910°C for 20 min and deformed into 5 passes/steps with final reduction is 57%. Cooling conditions were selected such as oil quench and forced air cool and salt bath quench is conducted in a salt bath furnace at the temperature of 350°C for 3 hours. The microstructure of spring steel have been investigated using, optical and scanning electron microscopy .The structure and properties were correlated to specific thermomechanical processing done on samples. The results showed that the thermo-mechanical process showed refined microstructure and increased tensile strength and ductility of spring steel Bainitic microstructure and a good combination of strength and ductility were achieved by sal bath quench after deformation. On the other hand, continuous cooling after deformation force air cool treatment resulted in an adequate tensile strength and substantial increase in ductility.

A Dissertation Report

CORROSION PROTECTION PERFORMANCE OF NANO TITANIUM DIOXIDE INCORPORATED PHOSPHATE COATING ON LOW CARBON STEEL

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

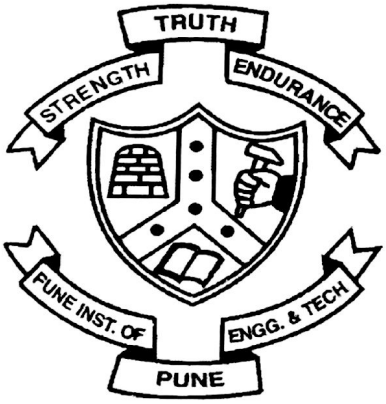
By

NILESH S. BAGAL

(M.I.S. No. 121327014)

Under the guidance of

Dr. P. P. DESHPANDE



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE

(An autonomous institute of Government of Maharashtra)

(June, 2015)

ABSTRACT

Phosphating is one of the most important chemical conversion processes for the purpose of corrosion protection and primer for painting. In the present work, nano TiO_2 incorporated phosphate coating was developed on low carbon steel by chemical and electrochemical method for achieving good paintability and corrosion resistance. Incorporation of nano TiO_2 yielded coating with greater thickness than the normal phosphate coating. The porosity of the phosphate coating obtained using the electrochemical impedance spectroscopy technique. The morphology and chemical composition of the coatings were analyzed by scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX). Results from the Electrochemical Impedance Spectroscopy and Potentiodynamic polarization study in 3.5 % NaCl solution revealed the better barrier protection characteristics and enhanced corrosion resistance of TiO_2 incorporated phosphate coatings over the normal phosphate coatings. The results showed that nano TiO_2 (2g/L) particles in the phosphating solution yielded phosphate coatings of higher coating weight, greater surface coverage and enhanced corrosion resistance than the normal zinc phosphate coatings.

A

DISSERTATION

ON

MICROSTRUCTURE EVOLUTION AND STRAIN HARDENING EFFECT ON AA1350 ALUMINIUM ALLOY DURING CONTINUOUS CASTING AND ROLLING PROCESS

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

By

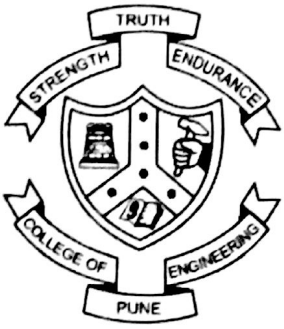
SHREYAS KHOT
(MIS No. 121327018)

Under the Guidance of

Prof. NAZIA PATEL
(College of Engineering Pune)

And

Mrs. JAYSHRI DUMBRE
(Aditya Birla Science and Technology Company Private Ltd., Taloja)



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING PUNE

(An Autonomous Institute of Government of Maharashtra)

(June 2015)

Abstract

The Continuous Casting and Rolling (CCR) technology is widely being used for production of aluminium wire rods which are used for transmission and distribution conductor applications. The work presented here focuses on microstructure evolution of AA1350 low UTS grade during various stages of manufacturing i.e. as cast (cast bar), warm rolled (wire rod) and as cold drawn (drawn wire). Optical metallurgical microscope in bright field and polarized light mode, back scattered Scanning Electron Microscopy (SEM) and image analysis was utilized to study various microstructural features. With increased degree of deformation, the mechanical properties as well as electrical conductivity in wire rod found to be increasing. The mechanical properties are further found to be increasing in cold drawn wire whereas; the electrical conductivity drops in this case. The microstructure observations conclude coarse grain structure with absence of equiaxed zone due to very high solidification rate in low UTS cast bar. The further deformation processing (warm rolling and cold drawing) reduces the grain sizes, microporosity respectively. XRD analysis reveals (220) plane orientation in longitudinal direction of wire rod. EBSD analysis further confirms the fiber texture in [111]//RD for wire rod and drawn wire samples. Reduced microporosity content and enhanced texture both might be the causes of increased conductivity after warm rolling.

Further, the high and low UTS grades of AA1350 are compared for tensile, electrical and microstructural properties. The mechanical properties are superior in case of high UTS grade whereas the electrical conductivity is inferior when compared with low UTS grade. Macro analysis of the cast bar samples show coarser grain structure in case of high UTS grade due to slower solidification rate.

The effect of cast bar temperature on strain hardening was studied by conducting few controlled experiments. The lower cast bar temperatures are found to be beneficial in getting superior tensile properties. It was estimated that, the increased tensile strength is primarily governed by strain hardening phenomenon (Zener-Hollomon parameter prediction) and not by grain boundary strengthening (Hall-Petch relationship prediction).

Microstructural study and Mechanical behavior of AA6061-AA8011 aluminum alloy sheets joined by friction stir welding

Submitted In partial fulfillment of the requirements

Of the degree of

Master of Technology

in

Process metallurgy

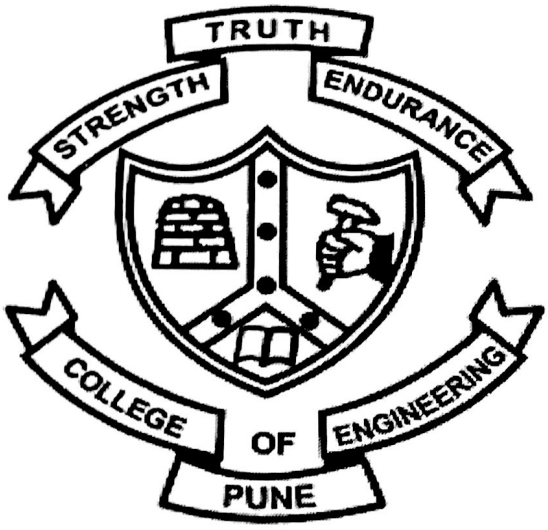
By

SWAPNIL.N. GAIKWAD (121227004)

Guide:

Mrs. Anand N R

Associate professor



Department of metallurgy and Materials science

COLLEGE OF ENGINEERING, PUNE-411005

(May 2015)

ABSTRACT

Friction Stir Welding (FSW), a fairly recent technique, invented by The Welding Institute (TWI) in 1991, utilizes a non-consumable rotating welding tool to generate frictional heat and plastic deformation at the welding location there by affecting the formation of a joint while the material is in the solid state.

In this work Friction Stir butt Welding on Al6061-Al8011 Aluminum Alloy is carried out on Vertical Milling Machine. During FSW important process parameters such as Tool Rotational speed, welding speed, tilt angle and Material placing is varied and corresponding changes are noted. These process parameters are optimized using taguchi method of design.

Experiments were performed with rotational speeds of 1000, 1300,1600 rpm at three welding speed of 70,80,90 mm/min feed rate, keeping axial load at 2.5 KN , tool tilt angle at 3 degree and changing material placing i.e., advancing and retreating sides alternatively, it was found that there is no defect concentration for tool speed of 1300 rpm ,90 mm/min feed rate and AA8011 on advancing sides.

Mechanical and Microstructural behavior of these Alloys was studied after FSW. The resultant microstructures were characterized by using optical microscope and scanning electron microscope (SEM). For evaluating mechanical properties Vickers hardness test and tensile test was performed. As a result of the experiment it had been found that maximum tensile strength of 101Mpa was obtained at welding speed of 90 mm/min, tool rotational speed 1300 rpm and placing AA8011 on advancing side.

Keywords: FSW, Aluminium alloy, Vertical milling machine, Process parameters

A

Dissertation

on

Effect of Vanadium Oxide on Densification Behaviour and Electrical Properties of Potassium Sodium Niobate.

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

By

SAMEER B. SHROFF

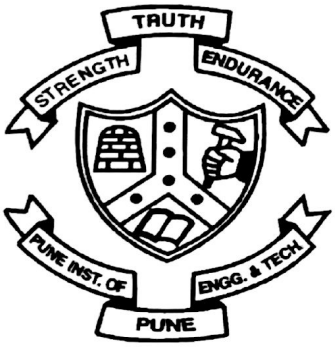
M.I.S No. 121127015

M. Tech - Second Year

(Process Metallurgy)

Under the guidance of

Mr. Kaustubh Kambale



DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

ABSTRACT

Sodium Potassium Niobate $Na_{0.5}K_{0.5}NbO_3$ **(KNN)** was prepared by the conventional solid state route. Reaction Sintering was done at 960 ^{0}C, 1050 ^{0}C, 1060 ^{0}C, but unfortunately samples were very less dense and get cracks. Again Calcination of the sample prepared through the solid state route was done at 950 ^{0}C for 6 hours. XRD of the samples was done in which a single perovskite phase was confirmed. The samples were sintered using the conventional sintering method at 1120^{0}C with a heating rate of 5/min to get the dense samples. SEM images of the samples were taken which showed dense microstructure and uniform grain size. Comparative study of dielectric and ferroelectric properties of the samples was carried out.