Final project report on UGC Major Research Project entitled

FABRICATION AND CHARACTERIZATION OF NANO Al_2O_3 REINFORCED MAGNESIUM METAL MATRIX COMPOSITES

UGC File No: 42-878/2013(SR)
Dated: 19-02-2014

ज्ञान-विज्ञान विमुक्तये

Submitted to

UNIVERSITY GRANTS COMMISSION
NEW DELHI – 110 002

Submitted by

Dr. K. Ravindra,
Professor, M. E. Dept.,

DEPARTMENT OF MECHANICAL ENGINEERING
R.V.R. & J.C.COLLEGE OF ENGINEERING
(Autonomous)
Chandramoulipuram :: Chowdavaram
GUNTUR - 522 019, ANDHRA PRADESH, INDIA.
Email: rvrjcce@hotmail.com

Annexure - IX

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002.

FINAL REPORT OF THE WORK DONE ON THE MAJOR RESEARCH PROJECT

FABRICATION AND CHARACTERIZATION OF NANO Al_2O_3 REINFORCED MAGNESIUM METAL MATRIX COMPOSITES

1. Name and address of the principal investigator

Dr.K.Ravindra
Professor & Head, M. E. Dept.,
Department of Mechanical Engineering,
R.V.R. & J.C. College of Engineering,
Chowdavarm,
Guntur-19

2. Name and address of the Institution

R.V.R. & J.C. College of Engineering,
Chowdavarm,
Guntur-19

3. UGC approval No. and date — **UGC File No: 42-878/2013(SR)**

4. Date of implementation — 01-04-2014

5. Tenure of the project — 3 Years

6. Total grant allocated — Rs. 4, 36, 000/-

7. Total grant received — NIL

8. Final expenditure — Rs. 1,33,910.88/-

9. Title of the project	**FABRICATION AND CHARACTERIZATION OF NANO Al_2O_3 REINFORCED MAGNESIUM METAL MATRIX COMPOSITES**
10. Objectives of the project	Attached as Enclosure-I
11. Whether objectives were achieved	Yes (Details Attached as Enclosure-II)
12. Achievements from the project	Attached as Enclosure-III
13. Summary of the findings	Attached as Enclosure-IV
14. Contribution to the society	Attached as Enclosure-V
15. Whether any Ph.D. enrolled/Produced out of the project	one PhD Completed and one ongoing
16. No. Of publications out of the project	5

(Dr.K.RAVINDRA)
PRINCIPAL INVESTIGATOR

(D. Sameer Kumar)
CO- INVESTIGATOR

(Dr. C.Tara Sasanka)
CO- INVESTIGATOR

(Dr.N.V.SRINIVASA RAO)
REGISTRAR

(Dr. K.SRINIVASU)
PRINICIPAL

Annexure – X

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

ASSESSMENT CERTIFICATE

It is certified that the proposal entitled" **Fabrication and Characterization of Nano Al_2O_3 Reinforced Magnesium Metal Matrix Composites"** by Dr. K. Ravindra Department of Mechanical Engineering, R.V.R & J.C College of engineering has been assessed by the Research and Development cell committee consisting the following members for submission to the University Grants Commission, New Delhi for financial support under the scheme of Major Research Projects:

Details of Expert Committee:

Name of Expert	Name of Department	Signature with Date
Dr. K. Srinivasu, Chairman	PRINCIPAL	
Dr.A.Sudhakar, Director	Dept. ECE	
Dr.K.S.Sai Ram, Member	Dept. CE	
Dr.K. Chandrasekhar, Member	Dept. EEE	
Dr. Ch.V.Subramanyam, Member	Dept. ChE	
Dr.G.Srinivasa Rao, Member	Dept. ME	
Dr.Ch.Aparna, Member	Dept. CSE	
Dr. M. Ramesh, Member	Dept. IT	
Dr.R.Srinivasa Rao, Member	Dept. M & H	
Sri.N.V.Srinivasa Rao, Member	Registrar	

The proposal is as per the guidelines.

(PRINCIPAL)

(Seal)

Annexure – XI

Final Report Assessment / Evaluation Certificate

(Two Members Expert Committee Not Belonging to the Institute of Principal Investigator)

It is certified that the proposal entitled" **Fabrication and Characterization of Nano Al_2O_3 Reinforced Magnesium Metal Matrix Composites"** by Dr. K. Ravindra Department of Mechanical Engineering, R.V.R & J.C College of engineering has been assessed by the committee consisting the following members for final submission of the report to the UGC, New Delhi under the scheme of Major Research Project.

Comments/Suggestions of the Expert Committee:-

- Considerable amount of work is done and the work is carried according to the proposal
- This work is benefitted the coinvestigator to obtain his Ph.D Degree and also provided an opportunity for another scholar to extend.
- Sufficient publications arised from the investigation and are published in referred journals.

Name & Signatures of Experts with Date:-

S. No	Name of Expert	University/ College Name	Signature with Date
1	Dr. J. Apparao	Principal, Malineni Lakshmaiah Women's Engineering College, Guntur	20/12/17 PRINCIPAL MALINENI LAKSHMAIAH WOMEN'S ENGINEERING COLLEGE PULLADIGUNTA, GUNTUR-17
2	Dr. M. Gopi Krishna	HOD, Mechanical Engineering Department, ANU college of Engineering & Technology, Acharya Nagarjuna University, Guntur	Dr. M. GOPI KRISHNA, M.E.,M.I.S.T.E.,Ph.D. ASST. PROFESSOR DEPT. OF MECHANICAL ENGINEERING University College of Engineering & Technology Acharya Nagarjuna University

It is also certified that final report, Executive summary of the report, Research documents, monograph academic papers provided under Major Research Project have been posted on the website of the University/College.

Principal
Seal

Annexure - III

UNIVERSITY GRANTS COMMISSION

BAHADUR SHAH ZAFAR MARG

NEW DELHI – 110 002

STATEMENT OF EXPENDITURE IN RESPECT OF MAJOR RESEARCH PROJECT

1. **Name of Principal Investigator** :Dr.K Ravindra
2. **Name of the Co- Investigators** : C.Tarasasanka, D.Sameer Kumar
3. **Dept. of Principal Investigator** : Mechanical Engineering Department

   University/College : R.V.R. & J.C. College of Engineering
4. **UGC approval Letter No. and Date** :UGC File No: 42-878/2013(SR)

   Dated 19-02-2014
5. **Title of the Research Project** :**FABRICATION AND CHARACTERIZATION OF NANO Al_2O_3 REINFORCED MAGNESIUM METAL MATRIX COMPOSITES**
6. **Effective date of starting the project** :01-04-2014
7. **a. Period of Expenditure** : From 01-04-2014 to Till date

   b. Details of Expenditure : **Funds not released**

S.No.	Item	Expenditure Incurred (Rs.)
i.	Books & Journals	5000.00
ii.	Equipment	
iii.	Contingency	5,000.00
iv.	Field Work/Travel (Give details in the proforma at Annexure- IV).	22,873.88
v.	Hiring Services**	74,037.00
vi.	Chemicals & Glassware	27000.00
vii.	Overhead	
viii.	Any other items (Please specify)	
	Total	**1,33,910.88**

** Enclosed as **Enclosure-I.**

c . Staff**NOT APPLICABLE**

Date of Appointment_____

S.No	Items	From	To	Amount Approved (Rs.)	Expenditure incurred (Rs.)
1.	Honorarium to PI (Retired Teachers) @ Rs. 18,000/-p.m.				
2.	**Project fellow:** i) **NET/GATE qualified**-Rs. 16,000/- p.m. for initial 2 years and Rs. 18,000/- p.m. for the third year. ii) **Non-GATE/Non-NET**- Rs. 14,000/- p.m. for initial 2 years and Rs. 16,000/- p.m. for the third year.				

1. It is certified that the appointment(s) have been made in accordance with the terms and conditions laid down by the Commission.
2. If as a result of check or audit objection some irregularly is noticed at later date, action will be taken to refund, adjust or regularize the objected amounts.
3. Payment @ revised rates shall be made with arrears on the availability of additional funds.
4. It is certified that the grant of **Rs. 4,36,000/-** (Rupees Four lakh thirty six thousand only) was **sanctioned but not received** from the University Grants Commission under the scheme of support for Major Research Project entitled **Fabrication and Characterization of Nano Al_2O_3 Reinforced Magnesium Metal Matrix Composites** vide UGC File No: 42-878/2013(SR) dated 19-02-2014 **has been done by own expenses** for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.

(Dr.K.RAVINDRA)
PRINCIPAL INVESTIGATOR

(D. Sameer Kumar)
CO- INVESTIGATOR

(Dr. C.Tara Sasanka)
CO- INVESTIGATOR

(Dr.N.V.SRINIVASA RAO)
REGISTRAR

(Dr. K.SRINIVASU)
PRINICIPAL

Enclosure-I

Hiring Services:

S.No	Item	Bill Details	Amount
1	Preparation of composites	NML, Jamshedpur, dt:7/5/15	25,281.00
2	Preparation of specimens for SEM and Mechanical Testing	M.A Engineering Works Dt: 14/5/15	8000.00
3	SEM, XRD, EDAX	Satyabhama University Dt: 3/6/15	9930.00
4	SEM, Polishing	Satyabhama University Dt:27/7/15	4460.00
5	Mechanical Testing	Hyderabad Engineering Labs Dt:26/6/15	7000.00
6	SEM, TEM & XRD	STIC, Cochin University Dt:8/3/16	14,766.00
7	Preparation of composites	NML, Jamshedpur, Dt:3/08/16	4,600.00
		TOTAL	**74,037.00**

Annexure – IV

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

STATEMENT OF EXPENDITURE INCURRED ON FIELD WORK

Name of the Principal Investigator: Dr K. Ravindra
Name of the Co- Investigators : C.Tarasasanka, D.Sameer Kumar

Name of the Place visited	Duration of the Visit		Mode of Journey	Expenditure Incurred (Rs.)
	From	To		
NML, Jamshedpur	Vishakapatnam	Tatanagar	TRAIN	2314.94
	Tatanagar	Vishakapatnam	TRAIN	2314.94
Project Review meeting	RVR & JC, Guntur	UGC, Delhi	Flight	18,224.00
			TOTAL	**22853.88**

Certified that the above expenditure is in accordance with the UGC norms for Major ResearchProjects.

(Dr.K.RAVINDRA)
PRINCIPAL INVESTIGATOR

(D. Sameer Kumar)
CO- INVESTIGATOR

(Dr. C.Tara Sasanka)
CO- INVESTIGATOR

(Dr.N.V.SRINIVASA RAO)
REGISTRAR

(Dr. K.SRINIVASU)
PRINICIPAL

Annexure - V

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG::NEW DELHI – 110 002

Utilization certificate

Name of the Institute : R.V.R. & J. C. College of Engineering, Chowdavarm, Guntur-19 (AP)
Sanction Letter : UGC File No: 42-878/2013(SR) Dated 19-02 2014

Certified that the grant of **Rs.4,36,000/-** (Rupees four lakh thirty six thousand only) was sanctioned by the University Grants Commission during the year 2013-2014 under the scheme of support for Major Research Project entitled "**Fabrication and Characterization of Nano Al_2O_3 Reinforced Magnesium Metal Matrix Composites**" vide UGC File No: 42-878/2013(SR) Dated 19.02.2014

As the grants were not received the project is completed by the Principal and Co-investigators with their own expenses.

However the project report is being submitted and the statement of expenditure is also submitted for release of the grants.

Financial Year	Amount Sanctioned (Rs)	Un Spent balance at the beginning of the financial year	Amount Released (Rs)	Interest Earned (Rs)	Amount Spent (Rs)	Interest Utilized (Rs)	Total (Rs)	Unspent balance at the end of the financial year (Rs)
2014-15	4,36,000.00	-	Nil	Nil	32000.00	Nil	32,000.00	---
2015-16	Nil	Nil	Nil	Nil	97310.88		97310..88	----
2016-17	Nil	Nil	Nil	Nil	4600.00		4600.00	----

(Dr.K.RAVINDRA)
PRINCIPAL INVESTIGATOR

(D. Sameer Kumar)
CO- INVESTIGATOR

(Dr. C.Tara Sasanka)
CO- INVESTIGATOR

(Dr.N.V.SRINIVASA RAO)
REGISTRAR

(Dr. K.SRINIVASU)
PRINICIPAL

IRCTCs e-Ticketing Service

Electronic Reservation Slip (Personal User)

IRCTC

This Ticket will be valid with an ID proof in original. Please carry original Identity Proof. If found traveling without original ID proof, Passenger will be treated as without ticket and charged as per extent Railway Rules.

At least one passenger should travel with his/her ID card in original which is indicated on the ERS/VRM. In case he/she is not travelling, all other passenger(s) booked on that ticket, if found travelling in train will be treated as travelling without ticket and charged accordingly.

Valid IDs to be presented during train journey by one of the passenger booked on an e-ticket :- Voter Identity Card / Passport / PAN Card / Driving License / Photo ID card issued by Central / State Govt / Public Sector Undertakings of State / Central Government ,District Administrations , Muncipal bodies and Panchayat Administrations which are having serial number / Student Identity Card with photograph issued by recognized School or College for their students / Nationalized Bank Passbook with photograph /Credit Cards issued by Banks with laminated photograph/Unique Identification Card "Aadhaar".

General rules/ Information for e-ticket passenger have to be studied by the customer for cancellation & refund.

PNR No: 6140287204	Train No. & Name: 08189/TATA VSKP SPL	Quota: GENERAL (GN)
Transaction ID: 100000217650264	Date & Time Of Booking: 22-Apr-2015 12:47:08 HRS	Class: THIRD AC (3A)
From: TATANAGAR JN(TATA)	Date Of Journey:08-May-2015	To:VISHAKAPATNAM(VSKP)
Boarding At: TATANAGAR JN(TATA)	Date Of Boarding:08-May-2015	Scheduled Departure:08-May-2015 13:00 *
To: VISHAKAPATNAM(VSKP)	Scheduled Arrival:09-May-2015 04:40 *	Adult:2 Child:0
Passenger Mobile No:9966431000		Distance:864 KM
Passenger Address:	2-12-15/2,stambalagaruvu,, Guntur, Andhra Pradesh - 522006	

FARE DETAILS :

Ticket Fare **	₹ 2270.0	Rupees Two Thousand Two Hundred and Seventy Only
IRCTC Service Charge (Incl. of Service Tax) #	₹ 44.94	Rupees Forty Four and Nine Four Paisa Only
Total Fare (all inclusive)	₹ 2314.94	Rupees Two Thousand Three Hundred and Fourteen and Nine Four Paisa Only

Includes of Service Tax - ₹ 82 Only

** Charges per e-ticket irrespective of number of passengers on the ticket.

PASSENGER DETAILS :

No.	Name	Age	Sex	Booking Status	Current Status
1	T TARASASANKA	32	Male	CNF/B1/64/SIDE UPPER	CNF/B1/64/SIDE UPPER
2	D SAMEER KUMAR	29	Male	CNF/B1/56/SIDE UPPER	CNF/B1/56/SIDE UPPER

Ticket is booked on a personal user ID and cannot be sold by an agent. If bought from an agent by any individual, it is at his/her own risk.

Booking Time: 22-Apr-2015 12:47:41 HRS

IMPORTANT :

For details, rules and terms & conditions of E-Ticketing services, please visit www.irctc.co.in.

New Time Table will be effective from 01-07-2015. Departure time and Arrival Time printed on this ERS/VRM is liable to change. Please Check correct departure, arrival from Railway Station Enquiry, Dial 139 or SMS RAIL to 139.

There are amendments in certain provisions of Refund Rule. Refer, Amended Refund Rules w.e.f 01-07-2013.(detail available on www.irctc.co.in under heading General Information)

The accommodation booked is not transferable and is valid only if the ORIGINAL ID card printed above is presented during the journey. The ERS/VRM along with printed ID proof in original would be verified by TTE with the name and PNR on the chart. If the passenger fail to produce/display ERS/VRM due to any eventuality (loss, damaged mobile/laptop etc.) but has the prescribed original proof of identity, a penalty of Rs.50/- per ticket as applicable to such cases will be levied. The ticket checking staff On board/Off board will give Excess Fare Ticket for the same.

Ticket cancellations are permitted through www.irctc.co.in by the user.

PNRs having fully waitlisted status will be dropped and the names of the passengers will not appear on the chart. They are not allowed to board the train. However the namesof PARTIALLY waitlisted/confirmed and RAC will appear in the chart.

Obtain certificate from the TTE/Conductor in case of (a) PARTIALLY waitlisted e-ticket when LESS NO. OF PASSENGERS travel, (b)A.C.FAILURE, (c)TRAVEL IN LOWER CLASS. This original certificate must be sent to GGM (IT), IRCTC, Internet Ticketing Centre, IRCA Building, State Entry Road, New Delhi-110055 after filing TDR online within prescribed time for claiming refund.

In case of Partial confirmed/RAC/Wait listed ticket, TDR should be filed online within prescribed time in case NO PASSENGER is travelling for

WL

IRCTCs e-Ticketing Service

Electronic Reservation Slip (Personal User)

WL

IRCTC

1. This Ticket will be valid with an ID proof in original. Please carry original Identity Proof. If found traveling without original ID proof, Passenger will be treated as without ticket and charged as per extent Railway Rules.
2. At least one passenger should travel with his/her ID card in original which is indicated on the ERS/VRM. In case he/she is not travelling, all other passenger(s) booked on that ticket, if found travelling in train will be treated as travelling without ticket and charged accordingly.
3. Valid IDs to be presented during train journey by one of the passenger booked on an e-ticket :- Voter Identity Card / Passport / PAN Card / Driving License / Photo ID card issued by Central / State Govt / Public Sector Undertakings of State / Central Government ,District Administrations , Muncipal bodies and Panchayat Administrations which are having serial number / Student Identity Card with photograph issued by recognized School or College for their students / Nationalized Bank Passbook with photograph /Credit Cards issued by Banks with laminated photograph/Unique Identification Card "Aadhaar".
4. General rules/ Information for e-ticket passenger have to be studied by the customer for cancellation & refund.

PNR No: 6740498114	Train No. & Name: 18516/VSKP TATA EXP	Quota: GENERAL (GN)
Transaction ID: 100000217650200	Date & Time Of Booking: 22-Apr-2015 12:33:26 HRS	Class: THIRD AC (3A)
From:VISHAKAPATNAM(VSKP)	Date Of Journey:03-May-2015	To:TATANAGAR JN(TATA)
Boarding At:VISHAKAPATNAM(VSKP)	Date Of Boarding:03-May-2015	Scheduled Departure:03-May-2015 17:45 *
Resv. Upto:TATANAGAR JN(TATA)	Scheduled Arrival:04-May-2015 10:45 *	Adult:2 **Child:**0
Passenger Mobile No:9966431000		Distance:864 KM
Passenger Address:	2-12-15/2,stambalagaruvu,, Guntur, Andhra Pradesh - 522006	

FARE DETAILS :

Ticket Fare **	₹ 2270.0	Rupees Two Thousand Two Hundred and Seventy Only
IRCTC Service Charge (Incl. of Service Tax) #	₹ 44.94	Rupees Forty Four and Nine Four Paisa Only
Total Fare (all inclusive)	₹ 2314.94	Rupees Two Thousand Three Hundred and Fourteen and Nine Four Paisa Only

** Inclusive of Service Tax - ₹ 82 Only

Service Charges per e-ticket irrespective of number of passengers on the ticket.

PASSENGER DETAILS :

SNo.	Name	Age	Sex	Booking Status	Current Status
1	C TARASASANKA	32	Male	WL/15	WL/4
2	D SAMEER KUMAR	29	Male	WL/16	WL/5

This ticket is booked on a personal user ID and cannot be sold by an agent. If bought from an agent by any individual, it is at his/her own risk.

Acronyms: RLWL: REMOTE LOCATION WAITLIST **PQWL:** POOLED QUOTA WAITLIST **RSWL:** ROAD-SIDE WAITLIST

Ticket Printing Time: 22-Apr-2015 12:33:44 HRS

DEPARTMENT OF MECHANICAL ENGINEERING
R.V.R. & J.C. COLLEGE OF ENGINEERING, CHOWDAVARAM, GUNTUR-522 019
(Autonomous)

DT: 03.02.2015

NOTE SUBMITTED TO THE PRINCIPAL:

Sub: Request for reimbursement of Travelling Expenses – Project Review Meeting – UGC – Reg.

****

With your kind permission, I, Dr.K.Ravindra has attended UGC funded Major Research Project Review Meeting held at UGC, New Delhi on 09-01-2015 at 10.00 a.m. In this connection, the following are the details of expenditure incurred towards T.A. & Boarding.

S. No.	Description	Amount (Rs.)
1.	To Gannavaram Airport on 08.01.2015	250.00
2.	Flight charges from Gannavaram to New Delhi (Rs.13198 / 2)	6,599.00
3.	Lodging charges (2219/- per day x 2 days) 4438 /2	2,219.00
4.	Local transport at New Delhi	250.00
5.	Flight charges from New Delhi to Hyderabad (14682 / 2)	7,341.00
6.	Train charges from Hyderabad to Guntur PNR No.4403386652 (920 / 2)	460.00
7.	Meals (for 3 days @ Rs.375/- per day)	1,125.00
	Total	**18,244.00**
	Amount to be sanctioned by the College as per college rules	**15,000.00**

Hence, I request you to kindly sanction and reimburse the said sum of Rs.15,000/- (Rupees fifteen thousand only).

(Dr.K.Ravindra)
Prof., & HOD, ME

Submitted
may be reimbursed.

04/02/2015

PAID THROUGH
Cheque No. 226507
Dated 06/02/2015

No. Date....3/2/.....20 1

RECEIVED with thanks from **R.V.R. & J.C.** College of Engineering, Chandramoulipuram, **CHOWDAVARAM,** G U N T U R - 522 019

the sum of Rupees.....Two hundred and fifty only.....

towards.....Local Travel Charges for new admn

Rs. 250/-

Signature.

No. Date.....20

RECEIVED with thanks from **R.V.R. & J.C.** College of Engineering, Chandramoulipuram, **CHOWDAVARAM,** G U N T U R - 522 019

the sum of Rupees.....Fifteen thousand only.....

Ch.No: 226507 dt. 6.2.2015, A.B.....

towards.....Reimbursement of Travelling expenses.....

Rs. 15000/-

Signature.

No. Date...3/2/.....20 5

RECEIVED with thanks from **R.V.R. & J.C.** College of Engineering, Chandramoulipuram, **CHOWDAVARAM,** G U N T U R - 522 019

the sum of Rupees.....Two hundred and fifty only.....

towards.....Travel to Bommavaram & Dist Travelling charges

Rs. 250/-

Signature.

Gmail

Ravindra Kommineni <ravindra.kom@gmail.com>

Confirmation Email

message

yatra.com <donotreply@yatra.com>
Reply-To: bookings@yatra.com
To: ravindra.kom@gmail.com

Thu, Dec 4, 2014 at 6:09 PM

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Customer Support
955 5800 800
support@yatra.com

Dear Ravindra Kommineni,

Congratulations! Your flight booking is confirmed.

Booking Reference Number - 04121451103

Please find your e-ticket attached with this email.

Flight Details

SpiceJet SG - 1002	**Vijayawada** Thu, 8 Jan, 2015| 09:30 Vijayawada Airport,	**Hyderabad** Thu, 8 Jan, 2015 | 10:25 Shamshabad Rajiv Gandhi Airport ,	Airline PNR **P1U36L** Duration: 00:55

Economy | Baggage: 15 kg (Free) | Non-Refundable

SpiceJet SG - 108	**Hyderabad** Thu, 8 Jan, 2015| 13:15 Shamshabad Rajiv Gandhi Airport,	**New Delhi** Thu, 8 Jan, 2015 | 15:35 Indira Gandhi Airport , T-1D	Airline PNR **P1U36L** Duration: 02:20

Economy | Baggage: 15 kg (Free) | Non-Refundable

Passenger Details

Mr Ravindra Kommineni (Adult)

Mr Srinivas Kolla (Adult)

Payment Details

Total Flight Price	Rs. 12838
Online Processing Fee	Rs. 360
You Paid Payment Mode : Debit Card	**Rs. 13198**

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To know your cancellation/rescheduling charges please SMS: **ytinfo <yatra reference number>** to **56161**.

Your eCash Account

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(+) eCash Earned	(+) Rs. 39
Available Balance	**Rs. 39**

Confirmation details have also been sent to: SMS: ++91 9849660254

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Facebook Twitter Google+

CASH / BILL

SOUTHERN GUEST HOUSE

(RESIDENTIAL HOTEL)

18/1, Arya Samaj Road, W.E.A., Karol Bagh, New Delhi - 110 005.
...es : 5722210 (10 Lines), 5739508, 5726724, Fax : 011-575-1308, website : southerntravelsindia.com

ADVANCE DETAILS

100 Check-in-No. ______ R.No. ______ Rs. ______
MR. K. RAVINDRA R.No. ______ Rs. ______
...ss: R.No. ______ Rs. ______
8|1|15 At 18:00 Departure On 9|1|15 At 7:30 A

Lodging		Boarding		Local Calls		Others		Daily Total	
		Tariff						1890	00
		L. Tax		10%				189	00
		S. Tax		7.42%				140	40

...words Two thousand two hundred nineteen only 2219.40

E. & O.E.

Less Advance	
Net Amount	2219.40
Signature	

...eques are not accepted.
...bills are payable on presentation.
...ease don't forget to hand over the room key at our Reception
...efore you leave the hotel.
...heck out time 8 a.m.

...ank you for your patronage & we hope to serve you again.

...ignature of the Guest ______

Gmail

Ravindra Kommineni <ravindra.kom@gmail.com>

Confirmation Email
Inbox

.com <donotreply@yatra.com>
To: bookings@yatra.com
ravindra.kom@gmail.com

Thu, Dec 18, 2014 at 8:39 PM

yatra.com
creating happy travellers

Customer Support
955 5800 800
support@yatra.com

Dear Ravindra Kommineni,

Congratulations! Your flight booking is confirmed.

Booking Reference Number - 18121458820

Please find your e-ticket attached with this email.

Flight Details

Airindia AI - 542	**New Delhi** Sat, 10 Jan, 2015| 09:50 Indira Gandhi Airport, T-3	**Hyderabad** Sat, 10 Jan, 2015 | 12:00 Shamshabad Rajiv Gandhi Airport ,	Airline PNR **JH9X3** Duration: 02:10

Economy | Baggage: 15 Kg (Free) | Refundable

Passenger Details

Mr **Ravindra Kommineni** (Adult)

Mr **Srinivas Kolla** (Adult)

Payment Details

Total Flight Price	Rs. 14322
Online Processing Fee	Rs. 360
You Paid Payment Mode : Debit Card	**Rs. 14682**

1/30/2015 11:23 AM

Ravindra Kommineni <ravindra.kom@gmail.com>

Confirmation on IRCTC, Train: 12748, 10-Jan-2015, CC, SC - GNT

irctc.co.in <ticketadmin@irctc.co.in>
@gmail.com Thu, Dec 18, 2014 at 10:27 PM

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Confirmation

IRCTC

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Take a printout of the Electronic Reservation Slip (ERS)/a screenshot of ERS i.e. Virtual Reservation Message OF YOUR TICKET FROM YOUR Booked Tickets History page .You have to carry this printout/VRM along with any of the listed identity cards (Voter Identity Card / Passport / PAN Card / Driving License / Photo ID card issued by State Govt / Student Identity Card with photograph issued by recognized School or College for their students / Pass Bank Passbook with photograph / Credit Cards issued by Banks with laminated photograph) during train journey. Both these will be examined by ticket checking staff on stations/trains for verification purpose.

Details

Transaction ID :	100000138086787	PNR No. :	4403386652	Train No. & Name :	12748 / PALNADU EXP
Date of Booking :	18-Dec-2014	Class :	CHAIR CAR	Quota :	GENERAL
Date of Journey :	10-Jan-2015	From :	SC	To :	GNT
Boarding At :	SC	Date Of Boarding :	10-Jan-2015	Reservation Upto :	GNT

Passenger Details

Name	Age	Gender	Status	Coach	Seat / Berth / WL No
RAVINDRA K	52	Male	WL		7
SRINVAS K	50	Male	WL		8

Fare Details

Distance :	282 KM
Ticket Fare :	Rs. 920
IRCTC Charge :	Rs. 22.47
Total Fare :	Rs. 942.47 *

* Convenience/Gateway charges as applicable.

For cancellation of your ticket, please log in to your account, select the PNR you wish to cancel and cancel your ticket online. Cancellation of your e-Ticket is possible only on the website www.irctc.co.in, and is NOT possible on PRS counters.

11:23 AM

No. Date 3/12/20 15

RECEIVED with thanks from **R.V.R. & J.C.** College of Engineering, Chandramoulipuram, **CHOWDAVARAM,** G U N T U R - 522 019

the sum of Rupees [illegible]

towards [illegible]

Rs. 1125/-

Signature.

CSIR-NATIONAL METALLURGICAL LABORATORY

(Council of Scientific & Industrial Research),

Jamshedpur-831 007

Proforma-Invoice for Investigation Charges

Proforma Invoice No.:-0067 Date : 7-May-2015

PARTY		REFERENCES	
Name	M/s. R.V.R & J.C.College of Engineering	Your Ref.	
Address	Department of Mechanical Engineering	Date	
	Chowdavaram	Our Ref.	NML/BDM/2015-16
	Guntur- 522 019	Date	07-05-2015
	Andhra Pradesh		
	Kind attn.: Mr. D. Sameer Kumar, Asst. Professor		

	Description Of Works	Cost (in Rs.)
Project Details	Charges for Melting of Magnesium alloys and composite for 05 Nos. of samples @ Rs 4500.00/- per sample	22,500.00
	Add: S.Tax @12%	2,700.00
	Add: E.Cess @ 2% of S.Tax	54.00
	Add: S&H E.Cess @1% of S.Tax	27.00
	Total Cost	25,281.00
	Less Advance	
	Grand Total	25,281.00

S.T.Regn. No AAATC2716RST009

S.T.Category 112- Scientific &Technical Consultancy Services/JSR-1/2001

PAN No. : AAATC2716R

Note: CSIR-NML is exempted from TDS u/s. 10(23C) of the I.T.Act. 1961

Head-BDM

CASH BILL

Cell : 9553806884

M.A. Engineering Works

All Types Of Turning, Milling & Cylindrical Grinding works

Plot No.23, Rajiva Gandhi Nagar,
Prasanth Nagar, Kukatpally, Hyderabad - 500 072.

No. 390

Date : 14/5/15

M/s. R.V.R & J.C College of Engineering

S.No.	Particulars	Qty.	Rate	Amount Rs.	Ps.
1	Sample preparation 120 x 15			8000	/-
2	Samples 15 x 15				
			TOTAL	8000	/-

Receiver's Signature

For *M.A. Engineering Works*

Personnel Copy

SATHYABAMA UNIVERSITY
Jeppiaar Nagar, Rajiv Gandhi Road,
Chennai – 600 119.

Centre for Nanoscience & Nanotechnology

Consultancy fee Receipt

No. 170 Date: 3/6/15

We received with thanks from Dr. K. Ravindra Professor & HOD of R.V.R. & J.C. College of Engineering, Guntur, A.P a sum of Rs. 9930 (In Words Nine thousand nine hundred thirty only) towards analyzing the samples **XRD/ EDAX/FESEM/AFM/Epi.Mic./SONICATOR/Coatings/ High Temp. Furnace (DRS/Specular)/UV-Visible Spectroscopy/Pellet Press/Thickness Measurement (Thickness/ (Thickness+Stress)/(Thickness+Stress+Roughness)** at Centre for Nanoscience and Technology, Sathyabama University, Chennai -119

No. of Samples: 6

Rs. 9930/-

(including service tax)

3/6/15

Signature of the Dean

Personnel Copy

SATHYABAMA UNIVERSITY
Jeppiaar Nagar, Rajiv Gandhi Road,
Chennai – 600 119.

Centre for Nanoscience & Nanotechnology

Consultancy fee Receipt

No. 236 Date: 27/7/15

We received with thanks from Dr. K. Ravindran
of Department of Mech., R.V.R & J.C.C.E, Guntur A.P
a sum of Rs. 4460 (In Words four thousand four hundred sixty only) towards analyzing the samples **XRD/ EDAX/FESEM/AFM / Epi.Mic./SONICATOR/Coatings/High. Tem. Furnace (DRS/Specular)/UV-Vis. Spectroscopy/ Pellet Press/PLD/Thickness Measurement (Thickness/(Thickness+ Stress)/ (Thickness+ Stress Roughness)** at Centre for Nanoscience and Technology, Sathyabama University, Chennai -119

No. of Samples: Sem 2, Polishing 4

Rs. 4460/-

27/7/15

Signature of the Dean

Huderabad Engineering Labs

NABL ACCREDITED LAB, AN ISO 9001 : 2008 & OHSAS 18001-2007

5-9-16/10, Prashanthi Nagar, I.E., Kukatpally, Hyderabad - 72.
Ph: 040-65277870 / 23078538. TEL FAX: 040-23075850
E-Mail: sbkydlabs@gmail.com / sbkhel_2@yahoo.com
Website: www.hyderabadlabs.net

Customer : M/s. R.V.R & J.C College of engineering

Date : 26-6-15

Your D.C. No. :

Date :

Sl. No.	PARTICULARS OF TESTING	Area / Length	Unit	Rate Rs.	Rate Ps.	Amount Rs.	Amount Ps.
1)	mechanical & Impact Test Charges	-	-	7000	00	7000	00
				TOTAL		7000	00

Rupees (in words) : Seven thousand rupees Only

For **Hyderabad Engineering Labs**

Of Mech Engg,
JC College of Engineering,
avaram,Guntur,

Invoice No : 17517
Invoice Date : 8-Mar-2016
Our Ref : SAIF/TM/160308A
Category : CATEGORY 3

Particulars

Analysis	No.of Samples	Hrs or Elements	Rate	Amount
SEM	12		450.00	5400.00
PXRD / PXRD HIGH TEMP	3		300.00	900.00
TEM	6		750.00	4500.00
			Sub Total	**10800.00**
Swachh Bharath Cess@0.5%				*54.00*
Service Tax@14% (14% ST +EC @ 0% on ST-HEC @ 0 on ST)				*1512.00*
Cost of Consumables				
TEM (Consumables)	6		400.00	2400.00

Total Rs. 14,766.00

Fourteen Thousand Seven Hundred Sixty Six Only

E&OE

Tax,EC-Education Cess,HEC-Higher Edu.Cess

hour with a minimum of charge applicable)

the following

Director

राष्ट्रीय
धातुकर्म
प्रयोगशाला
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)
जमशेदपुर - 831 007, भारत

National
Metallurgical
Laboratory
(Council of Scientific & Industrial Research)
Jamshedpur - 831 007, INDIA

ISO 9001 : 2008

INVOICE

Invoice No. : 1334

Date : 3-Aug-2016

PARTY		REFERENCES	
Name Address	M/s. R.V.R & J.C.College of Engineering Department of Mechanical Engineering Chowdavaram Guntur- 522 019 Andhra Pradesh Kind attn.:-Mr. D. Sameer Kumar, Asst. Professor	Your Ref. Date Our Ref. Date	 NML/BDM/2016-17 03-08-2016
	Description of Works		**Cost (in Rs.)**
Project Details	Charges for melting of magnesium alloys and composites in a batch of 2kg @ Rs. 2000/- per batch		4,000.00
	Add: Service Tax @ 14%		560.00
	Swachh Bharat Cess @ 0.5%		20.00
	Krishi Kalyan Cess @ 0.5%		20.00
	Total Cost		4,600.00
	Less Advance:		
		Grand Total	4,600.00

Regn. No. :AAATC2716RST009

Category.:112- Scientific &Technical Consultancy Services/JSR-1/2001

PAN. :AAATC2716R

Note: CSIR-NML is exempted from TDS u/s. 10(23C) of the I.T.Act. 1961

Head
Business Development
& Monitoring Division

NML-RTGS Details : Beneficiary's Bank Name Address : State Bank of India, NML Branch, Jamshedpur - 831 007, Jharkhand
Bank Code : 3329 Account No. 30271713826 MICR Code : 831002013, IFSC Code : SBIN 0003329 Swift Code : SBININBB164

MONEY RECEIPT

EXCLUSIVE MAGNESIUM PVT. LTD.
5-9-7/3, Saifabad, Hyderabad - 500 004.
Tel: (O) 234995 (W) 3095886 Fax: 3227697

No. 1143/2014-15 Date 8/5/14

Thankfully received from D. Sameer Kumar & Dr. K. Ravindra.

a sum of Rupees Twenty Seven thousand only

by Cash/Cheque No. ✓ Dated

Drawn on

on account of AZ91E Mg alloy

For EXCLUSIVE MAGNESIUM PVT. LTD.

Rs. 27,000/-

Payee's Signature

Enclosure-I

Objectives of the Project

Enclosure-I

Objectives of the Project:

Over the past decades there has been a considerable increase in the automotive sector with the effective usage of resources which is the key parameter for the growth of any country. It is focused to improve the standards of the vehicle by use of alternate materials which is the simplest and cost effective among the others. Magnesium, the light weight structural material can play a prominent role in the automotive industry with an advantage of fuel economy with reduced CO_2 emissions.

The main objectives of the project are

- To prepare the metal matrix composite of magnesium alloy reinforced with different volume fractions of Al_2O_3.
- Characterization of the proposed composite.
- Evaluating hardness and tensile behavior of the composites.

Enclosure-II

Detailed Report of Work done

Abstract:

Over the past decades there has been a considerable increase in the automotive sector with the effective usage of resources which is the key parameter for the growth of any country. It is focused to improve the standards of the vehicle by use of alternate materials which is the simplest and cost effective among the others. Magnesium, the light weight structural material can play a prominent role in the automotive industry with an advantage of fuel economy with reduced CO2 emissions.

Among various Mg based alloys still it is a question to select the suitable alloy. To resolve this, MADM methods are widely used among which VIKOR method is applied for the selection of good material by comparing the properties of Mg based alloys. It is found that AZ91 is a good choice material in view of properties.

Semi Solid stir casting technique is adopted for the fabrication of the composite with base material as Magnesium alloy (AZ91E) and Nano Al2O3 (an average size of 50nm) as reinforcement with different weight fractions ranging between 1-3% with an increment of 0.5%.

The metallurgical aspects of the study is presented and discussed with reference to optical microscopy, SEM and XRD. The microscopic analysis has shown the uniform distribution of particles in the composite. The density of the cast composites is measured to know the effectiveness of casting in terms of porosity. Characterization of composites for Hardness (Micro as well as Macro) and tensile behavior is done as per ASTM standards (ASTM B557) for all the reinforcements and the effect of change in weight fractions of reinforcements on the mechanical properties is also reported. It is observed that 2 wt % reinforced composite has shown superior properties than the other composites.

1. Selection of material using VIKOR Method

Successful implementation of VIKOR method for choosing the best material among various alloys of Magnesium used for automotive applications. A survey has been made on different Mg alloys in automotive industries and its properties among which eight Magnesium alloys with ten important properties are considered. With the implementation

VIKOR formulas and Different weighing criterions, the performance scores were calculated. Based on performance scores it is evident that the first material i.e. AZ91 is having best performance score in all weightage methods employed and is a good choice among the materials compared.

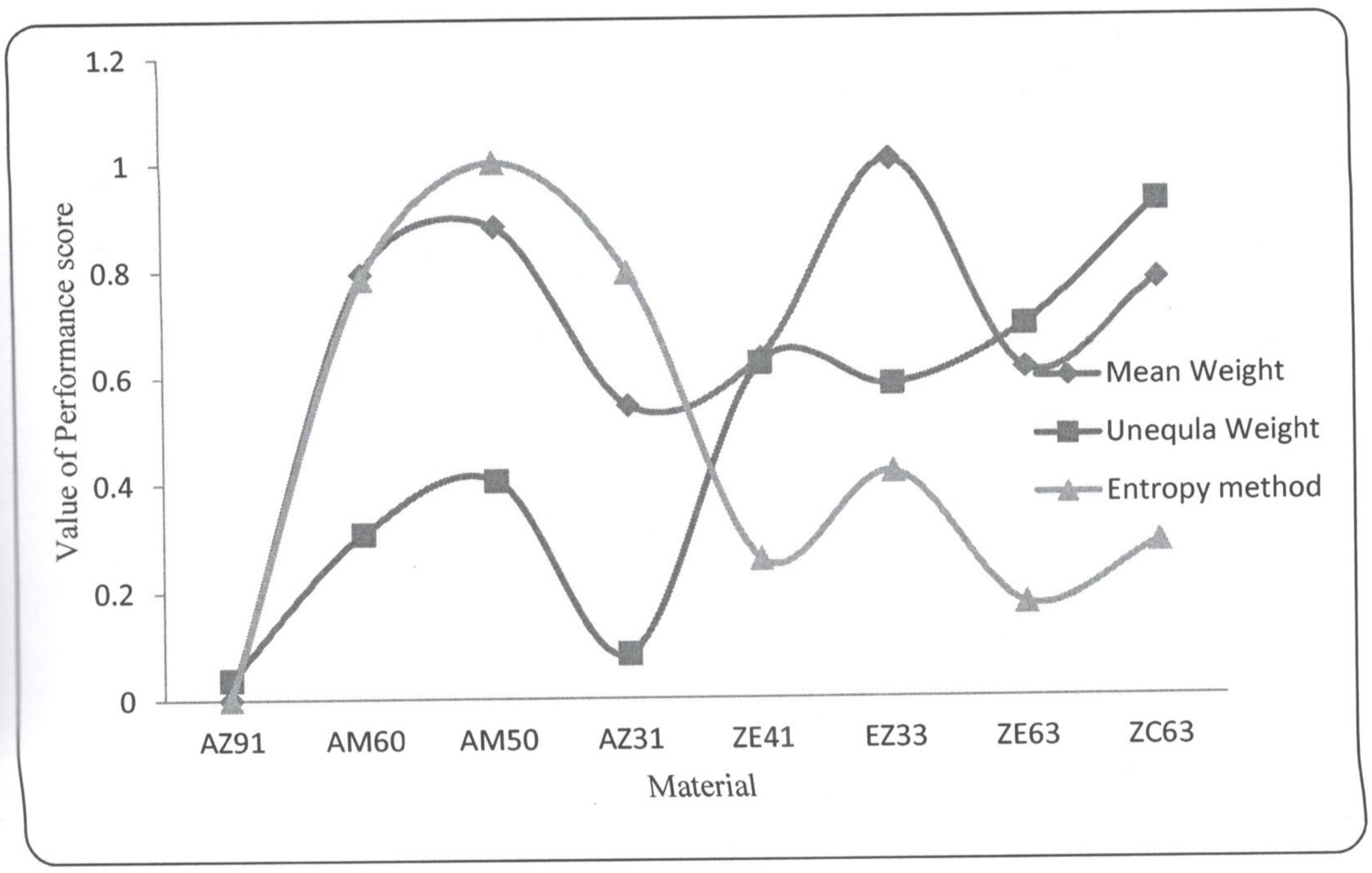


Figure: Comparison of Performance scores for different weightage methods used in VIKOR

2. Preparation of Composite Specimen:

The preparation of composite was carried out in a mild steel crucible kept in a resistance furnace under a cover of flux (20% KCl, 50% MgCl2, 15% MgO, 15% CaF2, wt.%) and with a high purity (99.98%) argon gas (IOLAR-1) supplied by Linde India Limited, Jamshedpur. The properly cleaned mould was given a graphite coat and preheated to 250°C in a heating oven for 1 h just before the casting. The raw materials, moulds, flux were preheated to avoid the casting defects. After the crucible reached the red hot condition, the preheated ingots were charged in to the crucible. The Temperature of the furnace was then raised to 7000C and the melt was homogenized for about 20 Minutes. The liquidus and the solidus temperature of the AZ91 alloy are found to be 5960C and 4680C. So, the melt was slowly cooled down to 5900C to keep the material in the semi solid condition. The preheated Al2O3 particulates (Avg. size 50 nm) wrapped in an aluminum foil were submerged beneath the melt, in corresponding wt%.

Afterwards the mixture was stirred using a four blade mechanical stirrer with a rotation speed of 450 rpm for 5 minutes in presence of argon gas and poured into a permanent steel mould to form the ingots of 15mm diameter with 150 mm length.

3. Results & Discussion

3.1 Density and Porosity :

The density and porosity of the composites was calculated. It was observed that the density and porosity of the composites increased with increase in the reinforcement content. The low porosity indicates effective casting. Increase in wt% of nanoparticles as reinforcements may enhance the porosity due to the presence of interstitial voids in clusters and discontinuity during stirring and in pouring into the moulds as gasses entrapment.

Table: Porosity Results of AZ91E Alloy and Processed Composite

Material	Porosity (%)
AZ91E	0.22
AZ 91E + 1wt% Nano Al2O3	0.58
AZ 91E + 1.5wt% Nano Al2O3	0.66
AZ 91E + 2wt% Nano Al2O3	1.05
AZ 91E + 2.5wt% Nano Al2O3	1.28
AZ 91E + 3wt% Nano Al2O3	1.51

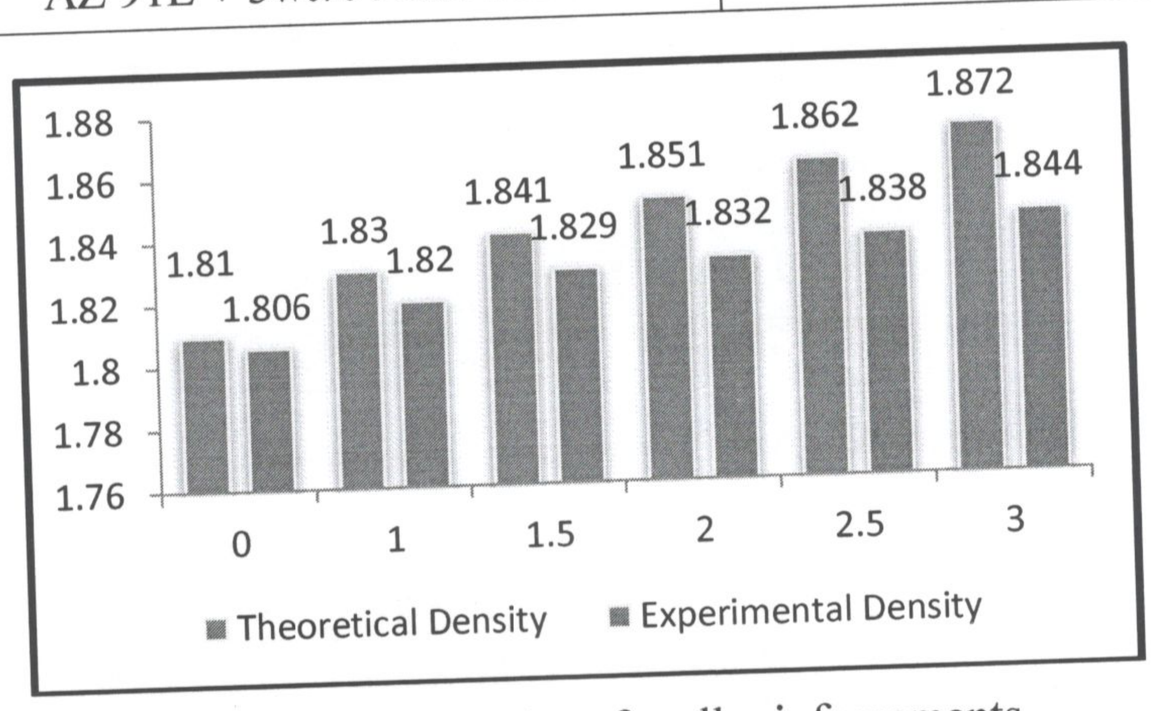


Figure: Density Values for all reinforcements

3.2 Microstructural Studies:

Interpretation of microstructural studies reveal that in base Mg alloy there are dendritic structures which shows the formation of Mg17Al12 intermetallic compound which will be helpful in improving the strength of Mg alloys. 2% and 3% reinforced Mg

composite shows the presence of Al2O3 particles, at 2% Al2O3 the dendritic structure was refined and shows the uniform distribution of Al2O3.

The Surface morphology of cast as well as composites is discussed. A closer observation by SEM combined with EDS showed that the microstructure consisted of primary α-Mg with divorced intermetallic eutectic phase ß-Mg17Al12. The precipitates were hard and brittle which had certain contribution to the hardness of the alloy

SEM analysis indicates that by increasing the reinforcement percentage, wettability of particles in the molten matrix has been decreased. It has been found that the distribution of particles in the different composite samples is uniform and the un-uniformity increases by increasing the reinforcement percentage above 2%. Particle clustering and agglomerates are observed when the percentage of reinforcement is at 3%.

It is also noticed that there is uniform distribution of Al2O3 particles and also the refinement of dendritic structures (Figure 2) which may result in better improvement of properties. The EDS analysis of the spectrum for composite with 2wt % of reinforcement shows the presence of elements present in the composite. Peaks of Mg, Al, Zn and O of magnesium matrix composite are observed(Figure 3). X- Ray Diffraction of composite sample was applied to detect the presence of Al2O3 particles.

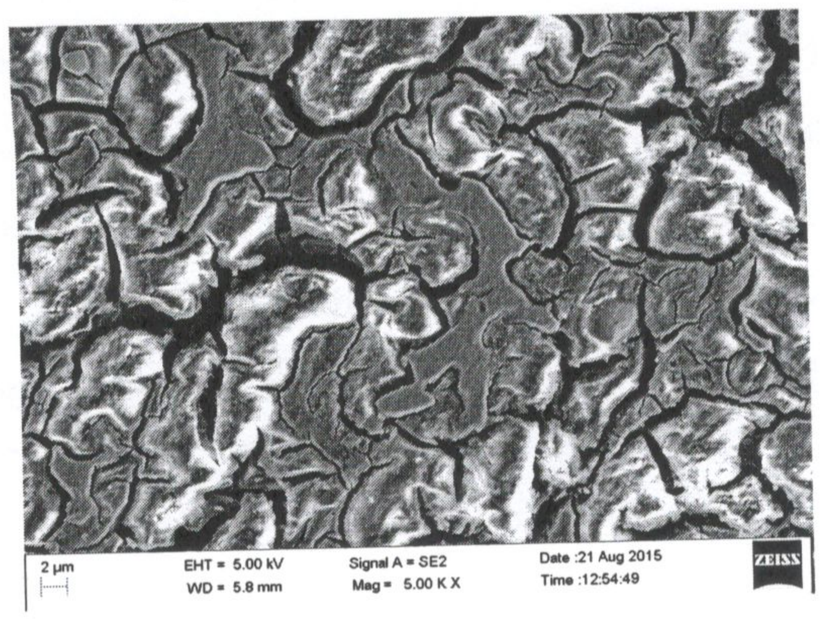
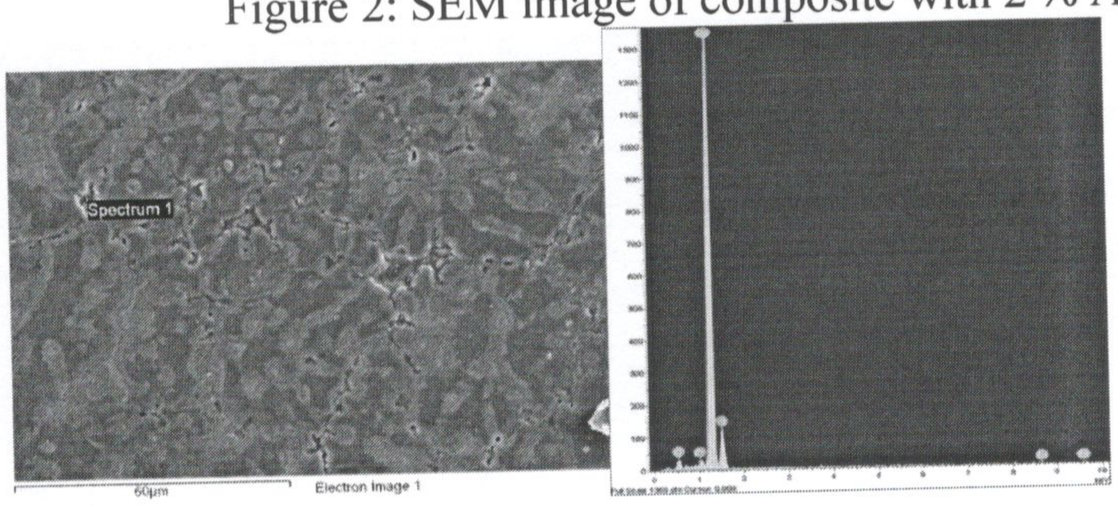


Figure 2: SEM image of composite with 2 % Al2O3 reinforcement



Element	Weight%	Atomic%
O K	5.78	8.77
Mg K	77.69	77.57
Al K	15.73	13.21
Zn L	0.8	0.45
Totals	100.00	

Figure : SEM and EDS image for elemental composition

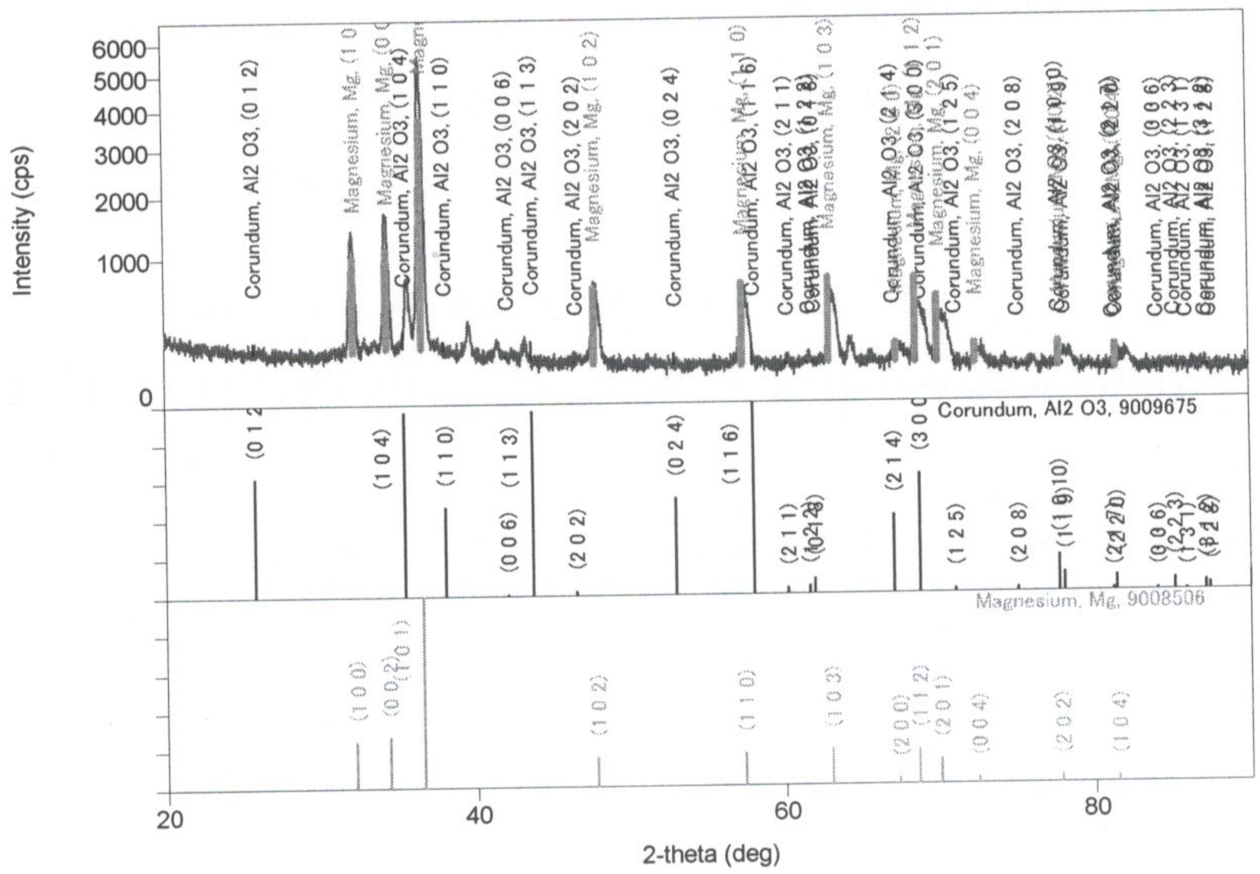


Fig: XRD Analysis

3.3 **Hardness**:

It elucidates that both the macro and micro hardness value increases along with percentage of reinforcement when compared with base alloy. Hardness value of pure AZ91 alloy was 80.87 VHN. Composites reinforced with Al2O3 particles at 3wt % shown the lowest hardness value (82.14 VHN) while composites reinforced with Al2O3 particles at 2wt% shows the highest hardness (99.038 VHN). The maximum observed increase in hardness of composites compared to unreinforced magnesium alloy was 22.45%. The micro hardness was increased by 19.5% as compared with base material.

Table Results of harness measurement

% of Reinforcement	Macro hardness HV: 10Kg	Micro hardness HV: 100gf
0	80.878±5	64.946±3
1	89.724±3	72.116±1
1.5	92.318±2	73.61±2
2	99.038±2	77.618±3
2.5	94.077±4	75.45±3
3	82.141±4	73.774±2

3.4 Tensile Behavior:

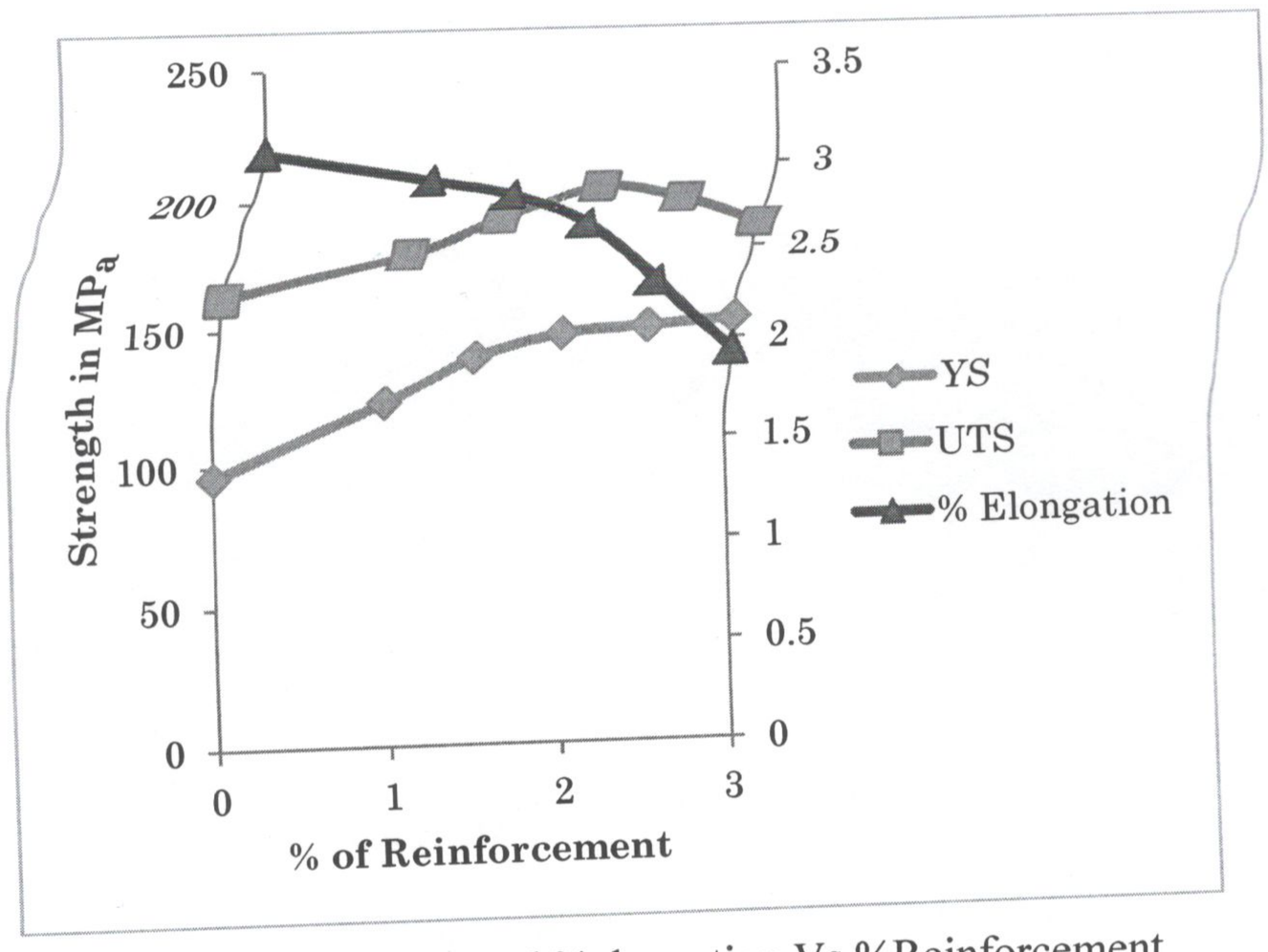
3.4.1 Yield Strength:

Yield strength of the composites is observed to be increasing with the increase in weight percentage of hard Al2O3 ceramic particles in magnesium alloy (AZ91E)

composite. The strength of the composite is always depends upon the size of the particle and the interfacial bond between the matrix and the reinforcement.

3.4.2 Tensile strength and ductility :

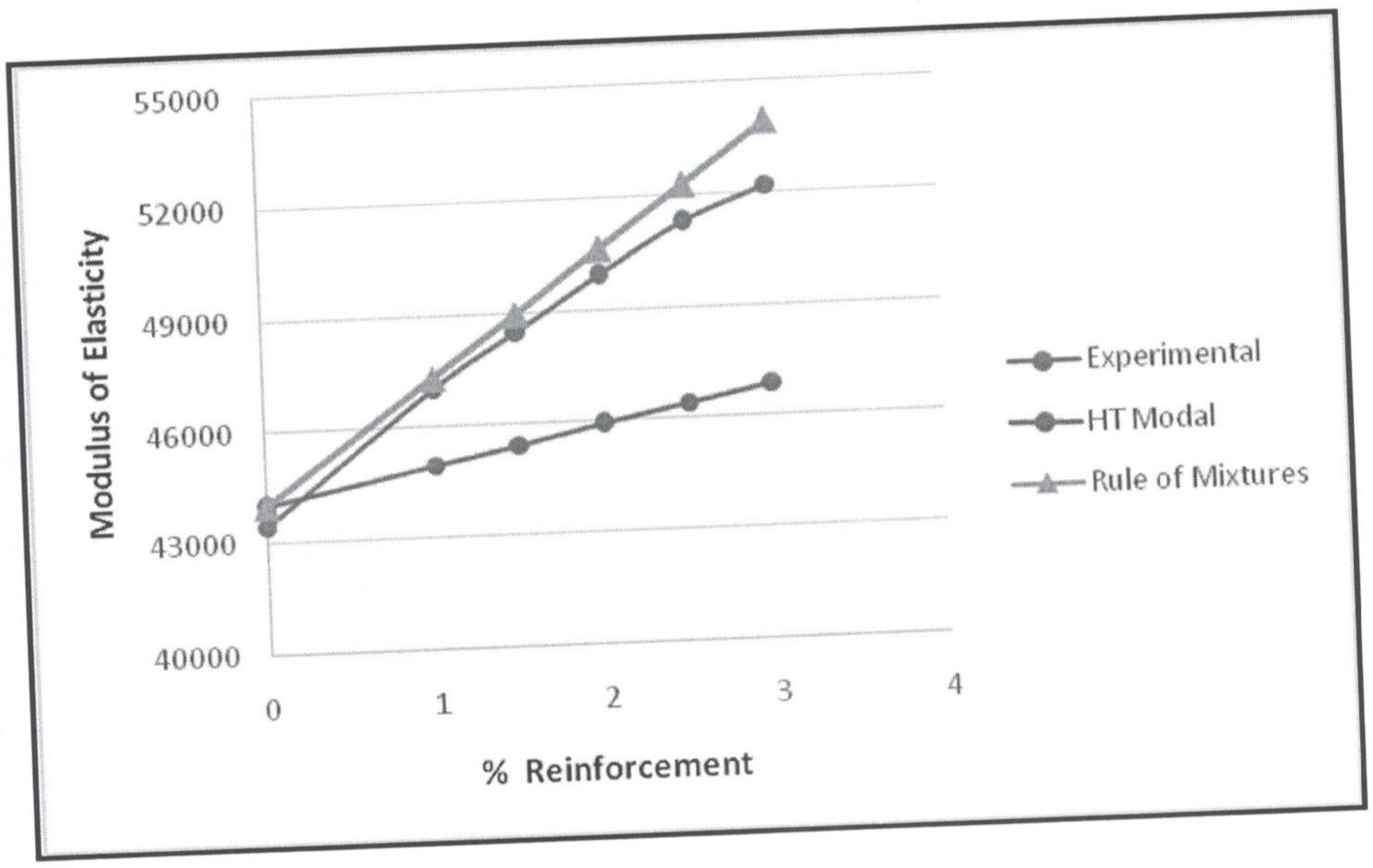
The tensile strength of casted AZ91E is 162 MPa while for 2% reinforcement it was 205 MPa and decreased to 188 MPa for 3% reinforcement. It is clear that tensile strength of composites is greater when compared to as cast AZ91. This improvement in mechanical properties is because of Al2O3 particles, which increases the strain required to accommodate any plastic deformation in the composites, which in turn increases the dislocation density and reduces grain size. The % of elongation is decreased from 3.08 to 1.94.



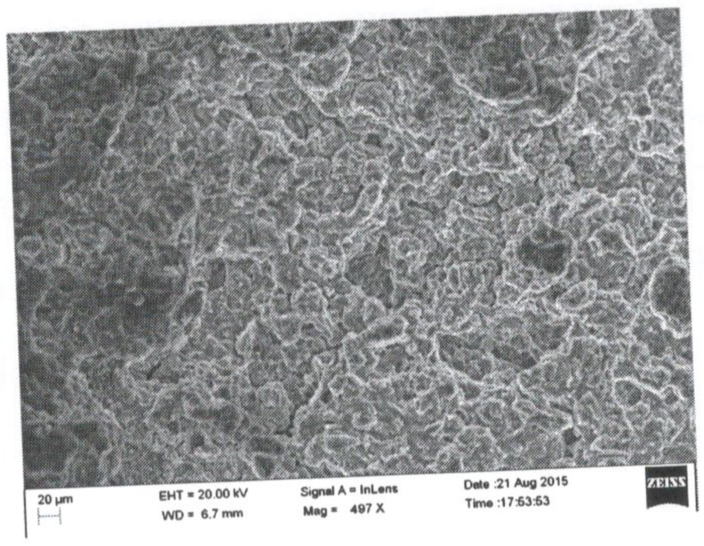
Variation of strength and %elongation Vs %Reinforcement

3.4.3 Elastic Modulus :

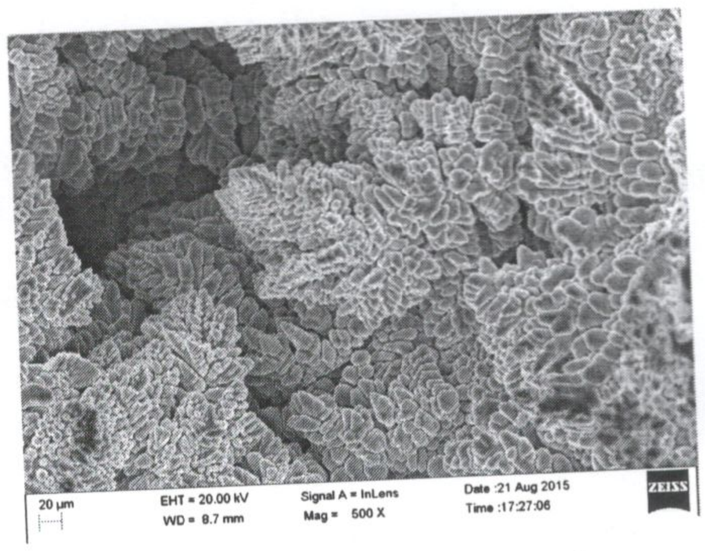
The Rule of mixtures is simple and considers only volume fraction and Elastic modulus while Halpin - Tsai considers aspect ratio of the reinforcement particle also. The modulus of elasticity was calculated by the both methods for all the reinforcements. The difference in both practical and calculated values is also attributed to the uncertainty in the appropriate value for the modulus of the particle reinforcement.



3.5 Fractography of Tensile specimens:



(a) AZ91E alloy



(b) AZ91E+2 wt% Al2O3 Reinforcement

It is clear that the AZ91E magnesium alloy shown the ductile type of fracture because of low matrix strength. The addition of hard Al2O3 particles to the matrix increases the strength of the composite reducing the ductility. The composite with 2 wt % has mixed mode of shear and brittle fracture.

4. Simulation of experimental work performed on composite specimen using ANSYS

This chapter deals about the computer simulation to identify the stress and strain distribution on the tensile specimen by applying gradual load and are compared with experimental results. The analysis is completed when the load reaches a maximum of 9.9 to 12.3 KN for different specimens. From table 7.1 it shows that the experimental results and ANSYS results are in good correlation with each other.

Table 7.1 Comparison of Stress and strain values for both experimental and ANSYS Results

% of Reinforcement	Stress MPa (Experimental)	Stress MPa (ANSYS)	Error %	Strain (Experimental)	Strain (ANSYS)	Error %
0	162.77	170.3	4.63	0.0229	0.023	0.44
1	180.86	188.98	4.49	0.0229	0.023	0.44
1.5	190.72	199.82	4.77	0.0251	0.0267	6.37
2	202.23	213.33	5.49	0.0223	0.0231	3.58
2.5	199.77	207.95	4.09	0.0186	0.0193	3.76
3	197.3	202.57	2.67	0.0171	0.0179	4.68

5. CONCLUSIONS

In the present work, AZ91E/nano-Al2O3 Mg-MMCs were prepared by the semi solid stir casting process and the effect of Al2O3 particulate on mechanical and dry sliding wear properties were investigated. The following are the conclusions observed from present investigation

- For choosing the best material among various alloys of magnesium, VIKOR method is used and it is observed that AZ91 ranked high.
- Magnesium matrix composites reinforced with nano Al2O3 particles are prepared by semi solid stir casting process with different weight percentages.
- It is observed that the density and porosity increases with increase in the wt% of reinforcements.
- Micro structural examination revealed that at 2% Al2O3 the dendritic structure is equally shaped and shows the uniform distribution of Al2O3.
- It is observed that hardness, yield and tensile strengths of the composites are increased with increase in nano Al2O3 up to 2% and then decreased with the addition of nanoparticles.
- The 2 wt% Al2O3 reinforced AZ91E composite has good mechanical properties than other reinforcements mentioned with an increment of 22.5% Macro hardness and 26.54 % in Tensile Strength.
- The % of elongation is decreased from 3.08 to 1.94. The increased amount of reinforcement can cause void nucleation and may be the reason for the decrease in ductility.

- It is understood from the fractographs that the unreinforced AZ91E alloy exhibits the ductile type of fracture, whereas the composites shown a mixed mode of shear and brittle.

Enclosure-III

Achievements from the project

Enclosure-III

Achievements from the project

Ph. D.

1. C.Tara Sasanka, Co-investigator has awarded Doctor of Philosophy (PhD), from Acharya Nagarjuna University, Guntur, Andhra Pradesh.
2. D.Sameer Kumar, Co-investigator has pursuing Doctor of Philosophy (PhD), from Andhra University, Vishakapatnam, Andhra Pradesh.

Publication of results:

1. **D.Sameer Kumar , C. Tara Sasanka , K. Ravindra,** KNS Suman, " *Magnesium and Its Alloys in Automotive Applications – A Review*", American Journal of Materials Science and Technology, , 2015, Vol.4,No.1, pp. 12 – 30. **[Journal *Publication by Columbia International Publishing , Columbia]***
2. **C. Tara Sasanka** and **K. Ravindra**, "Implementation of VIKOR Method for Selection of Magnesium Alloy to Suit Automotive Applications", **International Journal of Advanced Science and Technology** Vol.83 (2015), pp.49-58.
3. **C. Tarasasanka., K. Ravindra**, et al., "*Microstructure, mechanical response and fractography of AZ91E/Al_2O_3 (p) nano composite fabricated by semi solid stir casting method*", Journal of Magnesium and Alloys, Volume 5, Issue 1,March 2017, Pages 48–55. **[An ELSEVIER Publication , Scopus Indexed]**
4. **C. Tara Sasanka , K. Ravindra, D. Sameer Kumar,** K.N.S. Suman and Palash Poddar, "*Microstructure and Hardness Evaluation of AZ91–Al2O3 Nano-Composites Fabricated by Semi Solid Stir Casting*", Proceedings of 6th International & 27th All India Manufacturing Technology Design and Research (AIMTDR-2016) Conference organized by College of Engineering , Pune ,Maharashtra during 16-18 December, 2016. Pp:949-952 ; ISBN: 978-93-86256-27-0. **[AIMTDR Conference Poster Presentation]**
5. **C. Tara Sasanka and K. Ravindra**, "Analysis and Characterization of Tensile Property of Mg MMC using ANSYS", Trends in Mechanical Engineering & Technology (TMET), Vol.7 No.1 (2017), pp:1-5.

Book Chapter Published:

- **D. Sameer Kumar** and **C. Tara Sasanka** contributed chapter 10 on "*Magnesium and its Alloys*", in the book, *Lightweight and Sustainable Materials for Automotive Applications,* CRC press, Taylor and Francis Group, 2017. pp: 329–368 ISBN 9781498756877 - CAT# K27551

Enclosure -IV

Summary of the findings

Enclosure –IV

Summary of the findings

In the present work, AZ91E/nano-Al2O3 Mg-MMCs were prepared by the semi solid stir casting process and the effect of Al2O3 particulate on mechanical and dry sliding wear properties were investigated. The following are the conclusions observed from present investigation

- For choosing the best material among various alloys of magnesium, VIKOR method is used and it is observed that AZ91 ranked high.
- Magnesium matrix composites reinforced with nano Al2O3 particles are prepared by semi solid stir casting process with different weight percentages.
- It is observed that the density and porosity increases with increase in the wt% of reinforcements.
- Micro structural examination revealed that at 2% Al2O3 the dendritic structure is equally shaped and shows the uniform distribution of Al2O3.
- It is observed that hardness, yield and tensile strengths of the composites are increased with increase in nano Al2O3 up to 2% and then decreased with the addition of nanoparticles.
- The 2 wt% Al2O3 reinforced AZ91E composite has good mechanical properties than other reinforcements mentioned with an increment of 22.5% Macro hardness and 26.54 % in Tensile Strength.
- The % of elongation is decreased from 3.08 to 1.94. The increased amount of reinforcement can cause void nucleation and may be the reason for the decrease in ductility.
- It is understood from the fractographs that the unreinforced AZ91E alloy exhibits the ductile type of fracture, whereas the composites shown a mixed mode of shear and brittle.

Enclosure-V

Contribution to the society

Enclosure-V

Contribution to the society

i. Developed a new material which is an alternate to many conventional materials in the automotive industry.
ii. The structural results of the proposed material are promising and can be applied to various automotive components in terms of better strength to weight ratios

Enclosure-VI

Publications out of the project

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Review

Magnesium and Its Alloys in Automotive Applications – A Review

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Abstract

Magnesium is very attractive material as it has the combination of good strength, low weight and good quality. The usage of magnesium and its alloys has considerably increased over the past ten years. In structural applications, where weight plays a major role, magnesium is a good choice. Its recyclability property also gives an edge. The use of magnesium and its alloys in automotive components was limited in the early sixties and seventies but today the awareness on fuel savings and environmental protection through reduced CO_2 emissions makes this material attractive. This paper reviews the benefits due to Mg, its alloy materials, manufacturing methods and applications in automotive sector. It also summarizes directions for the development of new magnesium alloys based on properties.

Keywords: Magnesium; Magnesium alloys; Manufacturing methods of Magnesium; Automobile applications

1. Introduction

The name magnesium has originated from the greek word for a district in thessaly called Magnesia. It was first discovered by Sir Humphrey Davy in 1808. And in metallic form by Antoine Bussy in 1831. Davy's first suggestion was magnium, but later it became magnesium (George et al. 2007, information from http://metals.about.com).

Magnesium is found to be the 8th most-abundant element in the earth's crust by mass, 9th abundant element in the universe as a whole. It occupies the 4th position among the elements that contribute earth mass as a whole followed by iron, oxygen and silicon. It is ranked 3rd most-abundant element dissolved in seawater (George et al. 2007, Guillen 2008). Magnesium is also needed by the human body as a mineral.

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Implementation of VIKOR Method for Selection of Magnesium Alloy to Suit Automotive Applications

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Abstract

Because of its lower density and plenty of availability, Magnesium alloy is a good choice material in automobile and aerospace industry. There are more and more materials available in the market to serve the common sake. Material selection plays an important role in the process of designing any physical product. A better methodology is required to help the organizations for selecting the best material. Multi Criterion Decision Making (MCDM) methods provide a ranking of the available alternatives thereby, decision of critical thinking become easier. A branch of MCDM methods named Vlse Kriterijumska Optimizacija I Kompromisno Resenje in Serbian (VIKOR) is used in the present work. The work presents the selection of a Magnesium alloy material, where eight materials and ten properties are considered to identify the best material. The influence of weightage factors by three different methods was also discussed.

Keywords: *Magnesium Alloy, MCDM methods, Material Selection, VIKOR, Entropy Method*

1. Introduction

India is one of the largest automotive industries in the world and one of the fastest growing countries. Now all automakers are concentrating on India for the promising growth in the sector and also the competition in this industry is very high. Hence the development of the product needs to be started from conceptual design with low cost, high performance and quality [1]. It is clear that reducing the mass of automobiles is a critical technology objective for vehicle performance, carbon dioxide (CO_2) emissions, and fuel economy. Vehicle mass-reduction technology offers the potential to reduce the mass of vehicles without compromising other vehicle attributes, like acceleration, size, cargo capacity, or structural integrity [2].

Power train components contribute a considerable portion of vehicle weight. There are several possibilities for resolving this problem, which include the use of alternative fuel sources, power train enhancements, aerodynamic improvements *etc*. However, lightweight construction seems to be the best cost effective solution for significant decrease of fuel consumption and CO_2 emissions. So there is a large scope for reducing the mass of wheel. Weight reduction of vehicles is a key step to reducing fuel consumption, so the industry is actively looking at replacing steel with lighter materials [3].

The abundance of Magnesium on the earth is considered to be 4th highest following iron, oxygen and silicon. The density of magnesium is approximately two thirds of that of aluminum, one quarter of zinc, and one fifth of steel. Accordingly, magnesium casting production has experienced an annual growth of between 10 and 20% over the past decades and is expected to continue at this rate [4].

Obtaining a solution, simultaneously satisfying all criteria is difficult task in any multi-criteria analysis [5]. Instead, a compromise solution can provide acceptable answers [6].

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Microstructure and Hardness Evaluation of AZ91–Al_2O_3 Nano-Composites Fabricated by Semi Solid Stir Casting

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ABSTRACT

The present study confers to the fabrication and characterization of Magnesium alloy (AZ91E) based nano composites with Nano Al2O3 particulate as reinforcements. A novel semi solid stir casting technique was adopted for the fabrication of the composites. An average particle size of 50nm was dispersed as reinforcement in AZ91E matrix. The effect of change in weight fraction of reinforcements on the distribution of particles and hardness were reported. The microscopic analysis has shown the uniform distribution of particles in the composite. The hardness of reinforced and unreinforced composite were evaluated and presented.

1. Introduction

For the past decade, the research on alternate materials in automotive and aerospace sector has been considerably grown as it seems cost effective solution. The selection of material plays a prominent role in terms of functionality. The Magnesium as an alternate to cast iron, aluminum and other materials has been observed with significant favorable results [1-4].

Magnesium offers good strength with low density. But pure magnesium is highly reactive [5]. AZ91 alloy (Combination of Mg-Al and Zinc) is a modern alloy with good mechanical properties at room temperature [6]. The thermal stability of the material can be enhanced by incorporating stronger reinforcement particles [5]. SiC, Al_2O_3 reinforcements are good choice in Magnesium based composites [13]. SiC Particles as reinforcements in Magnesium alloy matrix and its effect on mechanical properties [9-12] was investigated and observed the composites contains highly brittle nature. On the other hand, an Al2O3 particle promises both strength and ductility in magnesium composites [15]. But the research on Al_2O_3 particles as reinforcement in Mg composites is observed to be limited. So an attempt is made to fabricate the composite with Al_2O_3 particles as reinforcement in Mg based composites.

Mg based Particulate reinforced composites are prepared by different methods, such as stir casting [9-11], powder metallurgy [14], Microwave Sintering and Die Castings [4,10,16]. Among which, the experimentation with stir casting is simple because of low cost. The efficiency of the process mainly depends on stirring and stirring temperature as it leads to porosity, and high oxide inclusions. So an improved stir casting method called Semi Solid Stir Casting was suggested to reduce the defects. [10, 17]. Good wettability of the composite was achieved as the stirring was done in semi solid state.

This paper aims on the fabrication of Mg metal matrix composite with high purity grade AZ91 Mg alloy as matrix and with Nano Al_2O_3 particles as reinforcements. Semi solid stir casting method was adopted to fabricate the composite. Hardness and microstructure of processed composites with changes in weight fractions were addressed in the following sections.

2. Experimentation

2.1 Sample preparation

AZ91E alloy was supplied by M/s Exclusive Magnesium Pvt. Ltd. Hyderabad. The alloy was undergone wet analysis and observed the chemical composition as given in Table 1.

Table 1
chemical composition of AZ91E alloy

Alloy	AZ91E
Al %	8.97%
Zn %	0.86%
Mn %	0.25%
Cu %	< 0.001%
Si %	0.12%
Fe %	< 0.001%
Mg %	Remaining

The preparation of composite was carried out in a mild steel crucible kept in a resistance furnace under a cover of flux and in argon gas environment as shown in Fig 1a. 10 wt% Excess material is considered to compensate Oxidation losses and 1wt% flux was added. The mould and the materials were preheated. The AZ91 alloy was placed in the furnace and temperature of the furnace was set to 700°c. The liquidus and the solidus temperature of the AZ91 alloy are found to be 5960C and 468°C [17]. So, the melt was slowly cooled down to 590°C to bring the material to the semi solid condition. The

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Full Length Article

Microstructure, mechanical response and fractography of AZ91E/Al_2O_3 (p) nano composite fabricated by semi solid stir casting method

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Abstract

The present study confers to the fabrication and its characterization of magnesium alloy (AZ91E) based nano composites with nano Al_2O_3 particulate reinforcements. A novel Semi Solid stir casting technique was adopted for the fabrication of the composite. An average particle size 50 nm was used as reinforcement to disperse in matrix. The effects of change in weight fraction of reinforcements on the distribution of particles, particle–matrix interfacial reactions, physical as well as mechanical properties were reported. The SEM and EDS analysis has shown the uniform distribution of particles in the composite along with the presence of elements. The mechanical properties of reinforced and unreinforced composite were evaluated and presented. Fractography of tensile specimens was also discussed.

Keywords: Magnesium alloys; Nano composites; Semi solid stir casting; Al_2O_3 particle

Introduction

In the recent years, the research on product development for improved vehicle performance in automotive and aerospace sector has been considerably increased. The use of alternative materials is the best cost effective solution. The selection of material to the particular application should focus on functionality, cost and environmental impact. The research on magnesium as a substitute to cast iron, aluminum and polymers is going on at rapid pace [1–4,22].

Magnesium offers good strength with low density. The recyclability with reduced CO_2 emissions has also an added attraction for magnesium. But pure magnesium is rarely used due to its poor mechanical properties and high reactivity [5]. The addition of zinc and aluminum to magnesium as alloying elements overcomes the demerits. AZ91 is popular commercial alloy with good cast ability and with wide range mechanical properties at room temperature [6] but does not retain the same properties at elevated temperatures >120 °C [7]. Preparing composites by magnesium alloys appears to be a good alternative for improving their thermal stability [5].

Reinforcement particles should be stronger and stiffer than the matrix material, so as to produce the expected strengthening effect. However, the selection of material, type, size and volume fraction of the reinforcements as well as its interactions with matrix is essential to get desirable properties. With good thermal stability, ceramic particles as reinforcements are the most desirable due to high hardness, strength and melting point [8]. With due considerations on cost and applications are on mind SiC, Al_2O_3 reinforcements are popular in magnesium composites [9]. A number of research reports are available on SiC particle reinforced magnesium MMC. The composites are observed to be highly brittle in nature because of SiC particles [8,11,12,23]. On the other hand Al_2O_3 particles have the advantages of low cost, exhibit high specific stiffness and excellent oxidation resistance [9]. Al_2O_3 particles can exist in many crystalline phases and produces the most stable hexagonal alpha

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Analysis and Characterization of Tensile Property of Mg MMC using ANSYS

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Abstract

The objective of the this research paper is to predict the stress and strain values of magnesium metal matrix composites using finite element analysis (FEA) and compare with the universal testing machine (UTM) results through the tensile load. The composites were prepared by semi solid stir casting process. Tensile specimens with ASTM B557 standard dimensions were prepared from the composites. These specimens were subjected to uni-axial tension under the 10 t capacity UTM. The specimen's FEA models were created using ANSYS 16 and the stress strain values were obtained. The actual results were compared with the predicted values obtained from the FEA. It was ensured that the FEA results had well agreement with the original deformation length with in the acceptable error margin.

Keywords: *Mg MMC, FEA, tensile strength*

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INTRODUCTION

The rapid, significant development evolved necessity to search for new multipurpose full developed technology in the manufacturing quality of product, not only at the minimization of dimensions and mass but also growth in its reliability and dimensional stability in working conditions. As the present technology intends for light vehicle constructions as possible and expects for low fuel consumption by using magnesium alloys as a material in case of car wheels, engine pistons, gearbox and clutch housings, framing of doors, pedals, manifolds, housings of propeller shafts, differential gears, brackets, radiators and others.

Alloys can produce qualitative products where as they are parallelly expensive. Even then the customers prefer to the purchase of alloy materials. Usually magnesium and its alloys are used in motor industry and machine building. In fact, they also go with applications in helicopter production, planes, air navigation, chemical and nuclear power industries [1].

Actually, aluminium and zirconium are main alloying elements of magnesium alloys. AM and AZ series of Mg-Al based alloys provide great stiffness and strength at room temperature and are not suitable for service at temperatures of 150–200°C since they exhibit low creep strength. Many alloying elements have an influence of mechanical, physical and chemical properties. For example, aluminium maintains significant tensile strength.

Due to fast developments in computer technology, the complexity in determining the responses for composite analysis can be made easy by using finite element methods. The FEM is used worldwide to simulate the composite materials processes and has become a reliable numerical simulation technology. There are many FEM packages such as (MSC/NASTRAN, SUPERFORGE, ABAQUS, ALGOR, DIEKA, and ANSYS) [2, 3]. This paper presents the outcomes of the tensile properties investigations of an experimental and numerical investigation of composites.

MATERIALS

AZ91E alloy that has a nominal composition (in weight percent) of 9 Al, 1 Zn, 0.25 Mn and balancing Mg was used as matrix material. 1 to 3 wt% of alumina (Al_2O_3) powder having an average particle size of 50 nm was used as reinforcement.

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10 Magnesium and Its Alloys

D. Sameer Kumar and C. Tara Sasanka

CONTENTS

10.1 INTRODUCTION TO MAGNESIUM

The name magnesium originated from the Greek word for a district in Thessaly called Magnesia. It was first discovered by Sir Humphrey Davy in 1808 and in metallic form by Antoine Bussy in 1831. Davy's first suggestion was magnium, but later it became magnesium [1]. Its chemical symbol is Mg.

Magnesium is found to be the eighth most-abundant element in the Earth's crust by mass and the ninth most-abundant element in the universe as a whole. It occupies the fourth position among the elements that contribute to earth's mass as a whole followed by iron, oxygen and silicon. It is ranked the third most-abundant element dissolved in seawater [1,2].

Magnesium is an alkaline earth metal having atomic number 12 with oxidation number +2. It has a hexagonal close packed (HCP) crystalline structure. The free element (metal) is not found naturally on earth, as it is highly reactive. Magnesium is a light, strong metal that gives a white brilliant light when exposed to the atmosphere.

Magnesium is a silvery white metal that is similar in appearance to aluminum but weighs one-third less. With a density of only 1.738 g per cubic centimeter, it is the lightest structural metal known. Because of its low density, many companies prefer magnesium as a potential substitute to conventional materials in weight-critical applications.

Magnesium is tougher than plastic and has better damping capacity as compared to cast iron and aluminum. It has good electro-magnetic interference (EMI) shielding and higher heat dissipation than that of plastics. Magnesium absorbs vibration energy effectively. Recyclability also makes magnesium a frontrunner. According to the combination of specific Young's modulus and high specific strength, magnesium alloys show similar or even better values than aluminum and many commercial steels [3]. The properties of magnesium are given in the following section.

10.1.1 Properties of Pure Magnesium

Magnesium can be used in both its pure form and as an alloy. Depending on the composition of the alloys, there can be remarkable differences in many properties. The following data is primarily regard pure magnesium [4,5]. However, several common alloys and their properties are also mentioned in the later parts of the study.