ज्ञान-विज्ञान विमुक्तये

Annexure - IV

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

Consolidated Utilization Certificate

Certified that the total amount of Rs. **10,28,000/-** (Rupees **Ten Lakh Twenty Eight Thousand** only) received from the University Grant Commission in two installments under the scheme of support for Major Research Project entitled **"Mechanoluminescence Studies of Ultravoilet Irradiated Rare Earth Doped Strantium Aluminate Nanophosphors"** vide **UGC file No. 42-759/2013(SR)** dated **14 – 3 -2013** has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grant Commission.

PRINCIPAL INVESTIGATOR

DR. RAVI SHARMA
PRINCIPAL INVESTIGATOR
MAJOR REASEARCH PROJECT
U.G.C. F.NO.- 42-759/2013(SR)
DT. - 11 MARCH 2014

PRINCIPAL

Principal
Govt. Arts and Commerce Girls College
Devendra Nagar, Raipur (C.G.)

STAUTORY AUDITOR

19/3/14

Shyam Gattani & Associates
Chartered Accountants

ज्ञान-विज्ञान विमुक्तये

Annexure III

UNIVERSITY GRANTS COMMISSION
BAHADURSHAH ZAFAR MARG
NEW DELHI- 11O OO2

FINAL STATEMENT OF EXPENDITURE IN RESPECT OF MAJOR RESEARCH PROJECT

1.	UGC Reference No. & Date	UGC Letter No. **42-759/2013 (SR)** dated **14-3-2013**
2.	Name of the Principal investigator	**Dr. Ravi Sharma**
3.	Department and University/ College where the project has undertaken	Department of Physics, Govt. Arts &Commerce Girls Collage, Devendra Nagar, Raipur, (C.G.)
4.	Title of the Project	Mechanoluminescence Studies of Ultravoilet Irradiated Rare Earth Doped Strontium Aluminate Nanophosphors
5.	Effective date of starting the project	1st April
6.	Tenure of the project	April 2013 to March 2016 extended for an year
7.	Grant Sanctioned	10,28,000/-
7.	Grants Received	1st installment : 9,08,000/- 2nd installment : 1,04,000/-
8	**Grant yet to be Received**	**24000/-**

Expenditure incurred:

S. No.	**Item**	**Amount approved**	**Expenditure incurred so far**
1.	Books & Journal	20,000/-	20,000/-
2.	Equipment	7,50,000/-	7,50,000/-
3.	Honorarium	nil	nil
4.	Project Fellow	nil	nil
5.	HRA	nil	nil
4.	Chemicals and Glassware	90,000/-	90,000/-
5.	Contingency	90,000/-	90,000/-
6.	Travel / Field work	60,000/-	60,000/-

7.	Hiring Services	Nil	Nil
8.	Overhead	18000/-	18000/-
9.	Additional Grant	Nil	Nil
10.	**Total**	10,28,000/-	10,28,000/-

It is certified that the grant of Rs.**10, 28, 000/-** (Rupees **Ten lakhs Twenty eight thousand only**) received from the University Grants Commission under the Scheme of support for Major Research Project entitled **Mechanoluminescence Studies of Ultravoilet Irradiated Rare Earth Doped Strontium Aluminate Nanophosphors** vide UGC Letter No. **42-759/2013 (SR)** dated **14-3-2013** has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.

(SIGNATURES WITH SEAL)

PRINCIPAL INVESTIGATOR

PRINCIPAL INVESTIGATOR
MAJOR REASEARCH PROJECT
U.G.C. F.NO.- 42-759/2013(SR)
DT. - 11 MARCH 2014
DR. RAVI SHARMA
PRINCIPAL INVESTIGATOR
MAJOR REASEARCH PROJECT
U.G.C. F.NO.- 42-759/2013(SR)
DT. - 11 MARCH 2014

PRINCIPAL

Principal
Govt. Arts and Commerce Girls Colleg
Devendra Nagar, Raipur (C.

Shyam Gallani & Associates
Chartered Accountants

STAUTORY AUDITOR

Annexure – XI

Final Report Assessment / Evaluation Certificate

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

(to be submitted with the final report)

It is certified that the final report of Major Research Project entitled **"Mechanoluminescence Studies of Ultravoilet Irradiated Rare Earth Doped Strantium Aluminate Nanophosphors"** by **Dr. Ravi Sharma** Dept. of Physics, Govt. Arts and Commerce Girls College Devendra Nagar Raipur 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:-

The work has been satisfactorily carried out with six outstanding publications. The prepared material has potential application for mercury free fluorescence lamp. The work has potential to apply for new modified proposal also.

Name & Signatures of Experts with Date:-

Name of Expert	University/College name	Signature with Date
1. Prof. N. Brahme	**SOS Physics& Astrophysics Pt. R. S. U. Raipur (C. G.)**	Nameet 25/03/2021
2. Dr. B. G. Sharma	**Dept. of Physics Govt. Nagarjuna P. G. College of Science Raipur (C. G.)**	

It is certified that the final report has been uploaded on UGC-MRP portal on ....30/3/21....

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.

* One copy of the project/project report is being kept in the college library.

P.I.

DR. RAVI SHARMA
PRINCIPAL INVESTIGATOR
MAJOR REASEARCH PROJECT
U.G.C. F.NO.- 42-759/2013(SR)
DT. - 11 MARCH 2014

(Principal)

Seal

Principal
Govt. Arts and Commerce Girls College
Devendra Nagar, Raipur (C.G.)

Annexure – VIII

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

PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF SENDING THE FINAL REPORT OF THE WORK DONE ON THE PROJECT

1. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR→ **Dr. Ravi Sharma**

2. NAME AND ADDRESS OF THE INSTITUTION→ **Govt. Arts & Commerce Girls College Devendra Nagar Raipur (C. G.)**

3. UGC APPROVAL NO. AND DATE→ **UGC file No. 42-759/2013(SR) dated 14 – 3 -2013**

4. DATE OF IMPLEMENTATION→ **1st April 2013**

5. TENURE OF THE PROJECT→ **4 years**

6. TOTAL GRANT ALLOCATED→ **10 lakh 28 thousand**

7. TOTAL GRANT RECEIVED → **10 lakh 04 thousand**

8. FINAL EXPENDITURE→ **10 lakh 28 thousand**

9. TITLE OF THE PROJECT→ **Mechanoluminescence Studies of Ultravoilet Irradiated Rare Earth Doped Strantium Aluminate Nanophosphors**

10. OBJECTIVES OF THE PROJECT → **Attached I**

11. WHETHER OBJECTIVES WERE ACHIEVED→ **Yes, Attached IA**
(GIVE DETAILS)

12. ACHIEVEMENTS FROM THE PROJECT→ **Attached IB**

13. SUMMARY OF THE FINDINGS→ **Attached II**
(IN 500 WORDS)

14. CONTRIBUTION TO THE SOCIETY→ **Attached III**
(GIVE DETAILS)

15. WHETHER ANY PH.D. ENROLLED/PRODUCED → **No**
OUT OF THE PROJECT

16. NO. OF PUBLICATIONS OUT OF THE PROJECT→ **06 Attached IV**
(PLEASE ATTACH RE-PRINTS)

(PRINCIPAL INVESTIGATOR)

DR. RAVI SHARMA
PRINCIPAL INVESTIGATOR
MAJOR REASEARCH PROJECT
U.G.C. F.NO.- 42-759/2013(SR)
DT. - 11 MARCH 2014

(CO-INVESTIGATOR)

22.3.17

(REGISTRAR/PRINCIPAL)

I/C PRINCIPAL
GOVT. ARTS & COM. GIRLS COLLEGE
DEVENDRA NAGAR, RAIPUR (C.G.)

24.5.18

I/C PRINCIPAL
GOVT. ARTS & COM. GIRLS COLLEGE
DEVENDRA NAGAR, RAIPUR (C.G.)

Annexure -III

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

Final Report of the work done on the Major Research Project

1. Project report	**Final**
2. UGC Reference No.	**42-759/2013 (SR)** dated **14-3-2013**
3. Period of report: from	**April 2013** to **March 2017**
4. Title of research project	**Mechanoluminescence Studies of Ultravoilet Irradiated Rare Earth Doped Strontium Aluminate Nanophosphors**
5. (a) Name of the Principal Investigator	**Dr. Ravi Sharma**
(b) Deptt. and College where work has progressed	**Department of Physics, Govt. Arts & Commerce Girls Collage, Devendra Nagar, Raipur, (C.G.)**
6. Effective date of starting of the project	**1st April 2013**
7. Grant approved and expenditure incurred during the period of the report:	**96,000/-**
a. Total amount approved Rs.	**10, 28000/-**
b. Total expenditure Rs.	**10, 28000/-**
c. Report of the work done: (Please attach a separate sheet)	
i. Brief objective of the project	**Attached separately I**
ii. Work done so far and results achieved and publications. if any, resulting from the work (Give details of the papers and names of the journals in which it has been published or accepted for publication	**Attached separately IB & IV**
iii. Has the progress been according to original plan of work and towards achieving the objective. if not, state reasons	**Yes**
iv. Please indicate the difficulties. if any. experienced in implementing the project.	**No**
v. If project has not been completed, please indicate the approximate time by which it is likely to be completed. A summary of the work done for the period (Annual basis) may please be sent to the Commission on a	**Completed**

24.5.18

I/C PRINCIPAL
GOVT. ARTS & COM. GIRLS COLLEGE
DEVENDRA NAGAR, RAIPUR (C.G.)

separate sheet

vi. If the project has been completed, please enclose a summary of the findings of the study. Two bound copies of the final report of work done may also be sent to the Commission — **Attached**

vii. Any other information which would help in evaluation of work done on the project. At the completion of the project, the first report should indicate the output, such as (a) Manpower trained (b) Ph. D. awarded (c) Publication of results (d) other impact, if any — **NIL**

SAUS 29.3.17

SIGNATURE OF THE PRINCIPAL INVESTIGATOR

PRINCIPAL INVESTIGATOR
MAJOR RESEARCH PROJECT
U.G.C. F.NO. - 42-
DT. - 11 MARCH 2014

REGISTRAR/PRINCIPAL

I/C PRINCIPAL
GOVT. ARTS & COM. GIRLS COLLEGE
DEVENDRA NAGAR, RAIPUR (C.G.)

SIGNATURE OF THE COINVESTIGATOR

SAUS 24.5.18

I/C PRINCIPAL
GOVT. ARTS & COM. GIRLS COLLEGE
DEVENDRA NAGAR, RAIPUR (C.G.)

OBJECTIVES OF THE PROJECT I

Nanophosphors have been extensively investigated during the last decade due to their potential applications for various high performances and novel displays devices. Rare earth doped alkaline earth aluminates particularly rare earth doped $SrAl_2O_4$ nanophosphor exhibits very bright and long lasting phosphorescence. Conventional synthesis of strontium aluminate phosphors is the solid-state reaction method, which requires extremely high temperature and a long period of sintering time. As a result, the size of the particles is relatively large and it is difficult to crush the hard phosphor blocks into small particles, which decreases the luminescence intensity. However, preparations of aluminates by combustion synthesis are less common. Therefore, we have synthesized rare earth doped $SrAl_2O_4$ material by a low-temperature initiated combustion process. The effect of this method on the particle size was also the aim. In recent years, some rare earth doped $SrAl_2O_4$ materials have been developed whose ML emission could be seen in the day light with naked eye. Previously the mechanoluminescent materials used were giving very weak intense signals, so, the ML dosimetry was not possible. But now with the development of very bright and long lasting mechanoluminescent materials it is expected that there is possibility of ML dosimetry by these materials.

The objective of the present project was to synthesize nanophase rare earth doped $SrAl_2O_4$ phosphor by combustion technique. The synthesized samples were to be characterized by XRD, SEM/TEM for structural and nanophase characterization. The mechanoluminescent and photoluminescent properties were to be studied. The possible application of the material in ML Dosimetry was also planned to be studied.

The studies of ML have been made with respect to following points.

(i) Dependence of ML intensity on UV- irradiation dose given to the phosphor.

(ii) Dependence of ML intensity on applied load.

(iii) Effect of concentration variation of rare earth doping on the ML intensity.

The studies on photoluminescence (PL) includes

(i) Effect of concentration variation of rare earth doping on the ML intensity.

(ii) The effect of the particle size on the pholuminescence emission spectra.

(iii) Dependence of PL intensity on UV- irradiation dose given to the phosphor.

Objectives Achieved IA

The $SrAl_2O_4:Eu^{2+}$ phosphor, $SrAl_2O_4:Dy^{3+}$ phosphor and $SrAl_2O_4:Eu^{2+}$, Dy^{3+} were successfully synthesized by the combustion method using H_3BO_3 as the flux. The phase structure of the phosphor was found consistent with standard tetragonal crystallography and was in well accordance with the JCPDS files. From the XRD and TEM analysis, average particle size of $SrAl_2O_4$: RE phosphor were in nanometer. The results showed that the doping process does not made significant changes to the morphology and size of the nanostructures. Under the ultra-violet excitation, the prepared $SrAl_2O_4:Eu^{2+}$ phosphor emitted green light with peak at 515 nm, which was confirmed from the calculated CIE coordinates which were found to be very close to standard green light for human eyes for Eu and Eu,Dy doped samples whereas the trivalent dysprosium showed two intense fluorescence peaks in the blue and in the yellow-orange wavelength region. Brighter ML peak was recorded for the sample having H_3BO_3 as compared to the sample without H_3BO_3. Increase in the ML intensity was found with increasing concentration of Dy and the maximum intensity was found for the sample with 3% of Dy. The ML intensity of $SrAl_2O_4$:RE nanophosphors were found to increase with increasing stress or the applied pressure close to linearity, so, the stress or the pressure can be determined using the ML intensity. Hence ML of $SrAl_2O_4$: RE could be used as stress sensor or pressure sensor or pressure indicator. It has been found that the ML intensity can be recovered with the exposure of sample to UV. Therefore ML Dosimetry may be possible in this material. The spectroscopic property of the Dy doped sample in the visible emission range is suitable for fabrication of white light lamp excited by 365nm UV light. Therefore, the sample has potential application for mercury free fluorescence lamp.

ACHIEVEMENTS FROM THE PROJECT IB

Strontium aluminates have generally been synthesized by the solid state route, requiring high calcination temperatures. We have achieved to synthesize the rare earth doped $SrAl_2O_4$ nanophosphors with high brightness and long persistent luminescence at a lower temperature by combustion synthesis method. The present work achieved to determine the exact role of fluxing agent H_3BO_3 on the phosphorescence characteristics of rare earth doped $SrAl_2O_4$ nanophosphors. This project was on nanoparticles, which itself is an interdisciplinary field of research. It gave a chance to collaborate with other scientific community. It enhanced the scientific knowledge about the nature of the material and the effect of particle size on the luminescence properties of rare earth doped $SrAl_2O_4$ nanophosphors. A man power was trained for this project. The effect of UV radiation on the mechanoluminescence of strontium aluminates nanophosphors was very firstly done by us to best of our knowledge. A major instrument to measure the photoluminescence of the materials was purchased, which is an asset to the college. Six papers in the reputed international journal were achieved during this project.

CONTRIBUTION TO THE SOCIETY III

The effect of UV radiation on the human society and environment is a great matter of concern in recent days. In recent years the investigation of mechanoluminescent materials exhibiting intense ML intensity during their deformation has attracted the attention of a large number of workers. As ML emission is associated with stress, fracture and damage of solids, so such inherent behavior of ML material could be used to fabricate mechanoluminescent stress, fracture and damage sensors. The intense mechanoluminescent materials have been reported to be suitable for the real-time sensing of the strength and location of damages caused by the dynamic events in an object. Rare earth doped strontium aluminate phosphors have been found useful in the real-time visualization of stress distribution in solids. This ML materials show promising application to stress sensing techniques. The stress sensing using UV irradiation is a new dimension to it. The ML materials have also been found useful in the fuse system for army warhead. The present study has relevance and importance for the society because, rare earth ions are good activator for preparation of sensors based on mechanoluminescence for example,

detecting earthquakes, damage detection in airplanes or cars as ML sensors are employed to detect environmental stress by means of emitted light. The spectroscopic property of these rare earth ions (Eu, Dy and Eu Dy) in the visible emission range is suitable for fabrication of white light lamp excited by 365nm UV light. Therefore, they have potential application for mercury free fluorescence lamp.

SUMMARY II

Mechanoluminescence (ML) is a type of luminescence induced by mechanical deformation and fractures of solids, involve the generation, transport and recombination of free charge carriers followed by radiative and non-radiative decay of excited gas molecules and luminescence centres in solids as well as during the electrons-hole recombination. The light emissions induced by elastic deformation, plastic deformation and fracture of solids are called elastico ML(EML), plastico ML(PML) and fracto ML(FML), respectively. ML can by excited by grinding, cutting, cleaving, rubbing, shaking, scratching, compressing, loading, crushing or impulsive deformation of solids. It can also be excited by thermal shocks caused by drastic cooling or heating of materials or by the shock-waves produced during exposure of samples to laser pulses or ultrasonic waves. ML also appears during the deformation caused by the phase-transition or growth of certain crystals as well as during separation of two solids in contact.

The development of materials with strong ML intensity is an important goal in exploring applications of ML in stress indicators and other mechano-optical devices. In the recent past, systematic materials research has been done and it has resulted in producing a variety of materials that emit an intensive and repeatable ML during deformation. The examples of mechanoluminescent materials are: coloured alkali halide crystals, ZnS: Mn, $SrAl_2O_4$: Eu, $ZnGa_2O_4$: Mn, $MgGa_2O_4$: Mn, $BaAl_2SiO_8$: rare earth element, $Ca_2Al_2SiO_7$: Ce and few polymers etc. Strontium aluminates has particular properties such as high quantum efficiency, long persistence of phosphorescence and good stability hence they can be used for luminous paints in high way, airport, buildings and ceramic products.

In the present work the $SrAl_2O_4:Eu^{2+}$ phosphor, $SrAl_2O_4:Dy^{3+}$ phosphor and $SrAl_2O_4:Eu^{2+}$, Dy^{3+} were successfully synthesized by the combustion method using H_3BO_3 as the flux. The phase structure of the $SrAl_2O_4:Eu^{2+}$ phosphor is consistent with standard tetragonal crystallography. The XRD graph of the prepared sample was in well accordance with the JCPDS files. From the XRD and TEM analysis, average particle size of $SrAl_2O_4$: RE phosphor were in nanometer. The results showed that the doping process does not made significant changes to the morphology and size of the nanostructures. The radius of Eu^{2+} (1.12 Å) are very close to that of

Sr^{2+} (1.12 Å) rather than Al^{3+} (0.57 Å). Therefore, the Eu^{2+} ions are expected to occupy the Sr^{2+} sites in the $SrAl_2O_4$ host. Under the ultra-violet excitation, the prepared $SrAl_2O_4:Eu^{2+}$ phosphor would emit green light with peak at 515 nm corresponds to the transitions of $^4F_{9/2} \rightarrow {}^6H_{15/2}$, $^4F_{9/2} \rightarrow {}^6H_{13/2}$ and $^4F_{9/2} \rightarrow {}^6H_{11/2}$ respectively. The PL emission exhibited a green light which was confirmed from the calculated CIE coordinates which were found to be very close to standard green light for human eyes for Eu and Eu,Dy doped samples whereas the trivalent dysprosium showed two intense fluorescence peaks in the blue and in the yellow-orange wavelength region. The maximum PL intensity as well as ML intensity was recorded for the sample with 3% of Dy. It is worthy to note that the dependence between ML intensity of $SrAl_2O_4:Eu^{2+}$ phosphor and the load is close to linearity. For $SrAl_2O_4$: Dy^{3+} sample the ML intensity – time graph showed two peaks. Brighter ML peak was recorded for the sample having H_3BO_3 as compared to the sample without H_3BO_3. Increase in the ML intensity was found with increasing concentration of Dy and the maximum intensity was found for the sample with 3% of Dy. Based on the above analysis this phosphors could also be used as sensors to detect the stress on an object. Thus, the combustion synthesis method furnishes a simple method for preparing aluminate based phosphor The ML intensity of $SrAl_2O_4$:RE nanophosphors were found to increase with increasing stress or the applied pressure, the stress or the pressure can be determined using the ML intensity. Hence ML of $SrAl_2O_4$: RE could be used as stress sensor or pressure sensor or pressure indicator. It has been found that the ML intensity can be recovered with the exposure of sample to UV. Therefore ML dosimetry may be possible in this material. The spectroscopic property of the Dy doped sample in the visible emission range is suitable for fabrication of white light lamp excited by 365nm UV light. Therefore, the sample has potential application for mercury free fluorescence lamp.