

# Final Report

of the work done on the

## UGC Major Research Project

titled,

**"Crystal Engineering and Characterization of  
[MX<sub>4</sub>]<sup>-</sup> [R]<sup>+</sup> Inorganic-Organic Hybrid Materials"**

**Project/File No. 42/777 of 2013 of UGC**

*submitted to*



**UNIVERSITY GRANTS COMMISSION,  
BAHADUR SHAH ZAFAR MARG,  
NEW DELHI - 110 002**

**for acceptance  
by**

**Dr. Sanjay Kumar Verma**  
Associate Prof. in Physics  
Co-Investigator

**Dr. Dinesh Jasrotia**  
Assistant Prof. in Physics  
Principal Investigator



**Department of Physics,  
Govt. Gandhi Memorial Science College,  
Jammu 180006, Jammu & Kashmir.**

**Final Report of the work done on the Major Research Project  
titled, "Crystal Engineering and Characterization of [MX<sub>4</sub>]<sup>-</sup> [R]<sup>+</sup>  
Inorganic-Organic Hybrid Materials"  
No. 42/777 of 2013 of UGC**

**Name of the Principal Investigator** : Dr. Dinesh Jasrotia

**Name of the Co- Investigator** : Dr. Sanjay Kumar Verma

**Department** : Department of Physics

**University/College where work has progressed** : Govt. Gandhi Memorial Science College,  
Jammu 180006, Jammu & Kashmir.  
[Affiliated to: University of Jammu & Constituent College of Cluster University, Jammu]

**Major Outcomes of the Research Project.**

1. Installation of an equipment for **Solution Growth through Slow Cooling technique** the Materials Science Research Laboratory, Govt. Gandhi Memorial Science College, Jammu.
2. The Project Fellow of the project has been registered as Ph.D. Student and submitted his doctorate thesis for the award of Ph.D. degree during 2017.
3. Fifteen research papers have been published in national/international journals having good impact factor.
4. Fifteen research papers were presented in International/ National Conferences and the research work has been presented in the form of conference proceedings/abstract booklets.
5. The materials prepared/synthesized under this research project have important optical applications as reported in the published research papers.

UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI - 110002

Annual/ Final Report of the work done on the Major Research Project.  
( Report to be submitted within 6 weeks after completion of each year)

1. Project report No. : Final
2. UGC Reference No. F. : 42-777/2013
3. Period of Report : 26-02-2014 [Grant received on this day] [UGC sanction letter mentioned the tenure from 01-04-2013 to 31-03-2017]
4. Title of research project : Crystal Engineering and Characterization of  $[MX_4][R]^+$  Inorganic-Organic Hybrid Materials
5. (a) Name of the principal Investigator : Dr. Dinesh Jasrotia  
(b) Department : Department of Physics  
(c) University/College where work has progressed : Govt. G.M. Science College, Jammu (J&K) (Aff. University of Jammu)
6. Effective Date of Starting of the project : 26-02-2014
7. Grant approved and expenditure incurred during the period of the report :
  - a. Total amount approved : Rs. 794,882/-
  - b. Total expenditure Rs. : Rs. 747,331/-
  - c. Report of the work done : (please attach the separate sheet)
    - i. Brief objective of the project : Please see Appendix - I
    - ii. Work done so far and result 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 : Please see Appendix - II
    - iii. Has the progress been according to original plan of work and towards achieving the objective, if not, state reasons : Yes, the work has been done as per the objectives of the research proposal.

**iv. Please indicate the difficulties, if any, experienced in implementing the project:**

The biggest hindrance in implementing the research project at College Level under J&K Higher Education Department was the transfer of Co-PI and then PI during the project tenure from the institution where the research project has been sanctioned by the UGC.

**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 separate sheet:**

Project has been completed as per the proposed Objectives.

**vi. If the project has been completed, please enclose a summary of the findings of the study. One bound copy of the final report of the work done may also be sent to University Grants Commission:**

Please see Appendix – III

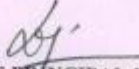
**vii. Any other information which would help in evaluation of work done on the project. At the completion of the project, the first report should indicate the output, such as (a) Manpower trained (b) Ph.D. awarded (c) Publication of the results (d) other impact, if any:**


(a) Two Research students, Mr. Ajit Kumar, Project Fellow and Mr. Bikram Singh have been trained in this area of research.

(b) Project Fellow, Mr. Ajit Kumar has been perusing his Ph. D. programme in physics at Banasthali University, Rajasthan under the joint supervision of Dr. Parvez Ahmed Alvi, Banasthali University, Rajasthan and Dr. Dinesh Jasrotia, Govt. G.M. Science College Jammu since August 2014.


(c) Seven Research Paper have been published in journals of international repute under this research project.

(d) Ten research papers presented in the Conference Proceedings at National and International Level.

  
SIGNATURE OF THE PRINCIPAL INVESTIGATOR

  
SIGNATURE OF THE CO- INVESTIGATOR

Phy. Deptt. 1  
GGM Science College Jammu

  
REGISTRAR/PRINCIPAL  
(Seal)

Principal  
G.G.M. Science College  
Jammu



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

1. **TITLE OF THE PROJECT** : "Crystal Engineering and Characterization of  $[MX_4]^{2-}$   
 $[R]^{2+}$  Inorganic-Organic Hybrid Materials"
2. **NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR** : Dr. Dinesh Jasrotia,  
Residential Address : H.No. 87, Sector 2A-Extention, Trikuta Nagar, Jammu
3. **NAME AND ADDRESS OF THE INSTITUTION**: Govt. Gandhi Memorial Science College,  
Canal Road, Jammu, J&K
4. **UGC APPROVAL LETTER NO. AND DATE** : 42-777 of 2013, dated: 26-02-2014
5. **DATE OF IMPLEMENTATION** : 26-02-2014 [grant received on this date] [UGC Sanction  
letter mentioned the tenure from : 01- 04 - 2013 to 31 - 03 - 2017]
6. **TENURE OF THE PROJECT** : 4 Years from 1<sup>st</sup> April, 2013 to 31<sup>st</sup> March, 2017
7. **TOTAL GRANT ALLOCATED** : Rs. 946,800/-
8. **TOTAL GRANT RECEIVED** : Rs. 794,882/-
9. **FINAL EXPENDITURE** : Rs. 747,331/-
10. **TITLE OF THE PROJECT** : "Crystal Engineering and Characterization of  $[MX_4]^{2-}$   
 $[R]^{2+}$  Inorganic-Organic Hybrid Materials"
11. **OBJECTIVES OF THE PROJECT** : Please see Appendix - I
12. **WHETHER OBJECTIVES WERE ACHIEVED** : Yes, achieved as per research plan
13. **ACHIEVEMENTS FROM THE PROJECT** : Please see Appendix - II
14. **SUMMARY OF THE FINDINGS** : Please see Appendix - III
15. **CONTRIBUTION TO THE SOCIETY** : Please see Appendix - IV
16. **WHETHER ANY PH.D. ENROLLED/PRODUCED OUT OF THE PROJECT**:  
Yes, Project Fellow Mr. Ajit Kumar has been enrolled for Ph.D. in 2014 and he is going to submit  
his Ph.D. thesis in 2017.
17. **NO. OF PUBLICATIONS OUT OF THE PROJECT** : Please see Appendix - V

(PRINCIPAL INVESTIGATOR & CO. INVESTIGATOR)

Associate Professor  
Phy. Deptt. I  
GGM Science College Jammu

(REGISTRAR/PRINCIPAL)

Principal  
G.G.M. Science College  
Jammu



UNIVERSITY GRANT COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

FD Diary No. 10311

Dated : 27.11.2015

GEN

Dated: December, 2015

F.No.42-777/2013 (SR)

The Under Secretary (FD-III)  
University Grants Commission  
Bahadur Shah Zafar Marg  
New Delhi - 110002

2 DEC 2015

Sub: Release of Grant-in aid to Govt. Gandhi Memorial Science College, Jammu- 180006 J & K for the year 2015-16 under plan in respect of Major Research Project entitled "Crystal materials" awarded to Dr. Dinesh Jasrotia, Department of Physics, tenure of project from 01.4.2013 to 31.3.2016.

Sir,  
I am directed to convey the sanction of the University Grants Commission for payment of grant of Rs. 1,66,963/- (Rupees One lakh sixty six thousand nine hundred sixty three only) as 2<sup>nd</sup> installment for the year 2015-16 towards Major Research Project to The Principal, Govt. Gandhi Memorial Science College, Jammu- 180006 J & K for the plan expenditure to be incurred during 2015-16.

Name of the Item	Amount Allocated	Head of Account	Grant now Being Sanctioned	Grant already Released	Total Grant
Books & Journal	50,000/-	3.A(49)(a).35	.....	50,000/-	50,000/
Equipment	1,50,000/-		.....	1,50,000/-	1,50,000/
Honorarium	.....	3.A(49)(a).31	.....	.....	.....
Project fellow	3,43,484/-		45,136/-	2,64,000/-	3,09,136/
HRA	68,697/-		61,827/-	.....	61,827/
Chemicals	50,000/-		20,000/-	25,000/-	45,000
Contingency	50,000/-		20,000/-	25,000/-	45,000
Hiring Services	.....		.....	.....	.....
Travel/field work	50,000/-		20,000/-	25,000/-	45,000
Overhead Charges	62,800/-		.....	62,800/-	62,800
Additional Grant	.....		.....	.....	.....
Total	8,24,981/-		.....	1,66,963/-	6,01,800/-

- The sanctioned amount is debit able to Major Research Project head Sector 3.A(49)(a).31 and is valid for payment during the financial year 2015-16 only.





FD Diary No. 2996  
Dated : 23.12.2013

UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

26 FEB 2014

F.No.42-777/2013(SR)

Dated:-

The Under Secretary (FD-III)  
University Grants Commission  
Bahadur Shah Zafar Marg  
New Delhi - 110002

Subject: Release of Grant-in-aid to Govt. Gandhi Memorial Science College, Jammu-180006, J&K, for the year 2013-14 under plan in respect of Major Research Project entitled "Crystal.....materials" awarded to Dr. Dinesh, Dept of Physics, tenure of the project from 01.04.2013 to 31.03.2016.

Sir,

I am directed to convey the sanction of the University Grants Commission for payment of grant of Rs 6,01,800/- (Rupees Six lakh one thousand eight hundred only) as 1<sup>st</sup> instalment for the year 2013-14 towards Major Research Project to The Principal, Govt. Gandhi Memorial Science College, Jammu-180006, J&K, for the plan expenditure to be incurred during 2013-14.

Name of the Item	Amount Allocated	Head of Account	BE/ RE for 2013 - 2014	Grant now Being Sanctioned	Grant already Released	Total Grant
Books & Journals	50,000/-	5(vii)a(35)	21.14 Crore	50,000/-	.....	50,000/-
Equipment (Data Requisition System with software and Temperature Controller & Hot Plate)	1,50,000/-			1,50,000/-	.....	1,50,000/-
Honorarium to Retd. P.I	.....	5(vii)a(31)	32.06 Crore	.....	.....	.....
Project Fellow	5,28,000/-			2,64,000/-	.....	2,64,000/-
HRA	.....			.....	.....	.....
Chemical	50,000/-			25,000/-	.....	25,000/-
Hiring Services	.....			.....	.....	.....
Contingency	50,000/-			25,000/-	.....	25,000/-
Travel/Fieldwork	50,000/-			25,000/-	.....	25,000/-
Overhead Charges	62,800/-			62,800/-	.....	62,800/-
Total	9,40,800/-		53.20 Crore	6,01,800/-	.....	6,01,800/-

## Appendix – V

*(List of Research Publications out of the project)*

### *List of papers published in Journals under UGC-MRP-42-777/2013*

#### Year: 2018

1. **Dinesh Jasrotia, Sanjay K. Verma**, B. Sridhar, P.A. Alvi and Ajit Kumar  
“3D-2D lattice dimensionality, optical Eg and PL energy variations due to organic variant in two  $[\text{ZnCl}_4]^{2-}$  based hybrid materials”  
Materials Chemistry and Physics Vol. 207 (1) (2018) 98-104.  
[Impact Factor = 2.14 & ISSN No. 0254-0584]
2. **Dinesh Jasrotia**, Ajit Kumar, Bikram Singh, Mukesh Kumar, Ashok Kumar, B. Sridhar, P.A. Alvi and **Sanjay K. Verma**  
“Nanoporous inorganic-organic hybrid material with structural and electro-optical properties of  $[\text{HgCl}_4]^{2-} [\text{R}]^{2+}$ ”  
ISST Journal of Applied Physics, Vol. 9(1) (2018) 39-42.  
[UGC Approved Journal with ISSN No. 0976-903X]
3. Bikram Singh, **Sanjay K. Verma**, Mukesh Kumar and **Dinesh Jasrotia**  
“Structural-Stability-Relationship in a series of  $[\text{ZnX}_4]$  inorganic organic hybrid material”  
Journal of Atomic, Molecular , Condensate & Nano Physics, Vol. 5(1) (2018) 1-17.  
[UGC Approved Journal with ISSN No. 2349-2716]
4. Bikram Singh, **Dinesh Jasrotia** and **Sanjay K. Verma**  
“Structure-Stability-Relationship in a series of  $[\text{CdBr}_4]$  inorganic organic hybrid material”  
International Journal of Advance Research in Science and Engineering, Vol. 7(4) (2018) 1587.  
[UGC Approved Journal with ISSN No. 2319-8354]
5. Ajit Kumar, **Dinesh Jasrotia**, Bikram Singh, **Sanjay K. Verma**, P.A. Alvi and Mukesh Kumar,  
“Structural-Spectroscopic-Relationship in a series of  $[\text{MX}_4]^- [\text{R}]^+$  metal organic material”  
Journal of Basic and Applied Engineering Research, Vol. 5(2) (2018) 74-76.  
[UGC Approved Journal with ISSN No. 2350-0077]

#### Year: 2017

6. Bikram Singh, Atul Thakur, Mukesh Kumar, Sanjay K. Verma and **Dinesh Jasrotia**  
“Structural and Optical Properties of Inorganic-Organic Hybrid Material of Acetanilide Tetrachloromercurate(II)”



Journal of Materials Science: Materials in Electronics, Vol. 28(14) (2017) 10007-100011.  
[Impact Factor = 2.34 & ISSN No. 0957-4522]

7. Bikram Singh, Atul Thakur, Mukesh Kumar, Sanjay K. Verma and **Dinesh Jasrotia**  
“Metallophilic interactions in structure stability relationship with secondary interactions in [ZnX<sub>4</sub>] based hybrid derivatives.”  
Materials Physics and Chemistry, 196 (2017) 52-61.  
[Impact Factor = 2.14 & ISSN No. 0254-0584]
8. **Dinesh Jasrotia**, Bikram Singh, Ajit Kumar, Mukesh Kumar, Sanjay K. Verma and P.A. Alvi  
“Nanoporous MOF of [HgX<sub>4</sub>]<sup>2-</sup>[R]<sup>2+</sup> with structural and Opto-electrical applications”  
International J. of Current Res. and Modern Edu., 2(2) (2017) 345-351.  
[UGC Approved Journal with ISSN No. 2455-5428]
9. **Dinesh Jasrotia**,  
“Structure-property-relationship in [ZnX<sub>4</sub>] IO-Materials”  
Modern Appl. BioEquivalence & Bioavailability (MABB). Vol. 1(4) (2017) 001-003.  
[ISSN No. 2577-2856]

**Year: 2016**

10. Ajit Kumar, Sanjay K. Verma, P.A. Alvi and **Dinesh Jasrotia**,  
“Nano-spatial parameters from 3D to 2D lattice dimensionality by organic variant in [ZnCl<sub>4</sub>]<sup>-</sup> [R]<sup>+</sup> hybrid materials: Structure, architecture-lattice dimensionality, microscopy, optical Eg and PL correlations”  
*American Institute of Physics Proc.* **1724**, 020004 (2016); doi: 10.1063/1.4945124  
[UGC Approved Journal with ISSN No. 0094-243X]

**Year: 2015**

11. Mukesh Kumar, Sanjay K. Verma, Bikram Singh, Atul Thakur, Ajit Kumar and **Dinesh Jasrotia**,  
“2D Interwoven Metal-Organic Framework in Tetrachloromercurate(II) based Hybrid Material”, *Chem Sci Trans.*, 2015, 4(2) pp. 629-637.  
[ISSN No. 2278-3458]
12. Ajit Kumar, M. Kumar, Sanjay K. Verma, P.A. Alvi and **Dinesh Jasrotia**  
“Single Crystal Growth, X-ray Structure Analysis, Optical Band Gap, Raman Spectra, Strain Tensor and Photoluminescence properties in [HgCl<sub>4</sub>]<sup>-</sup> [R]<sup>+</sup> and [ZnCl<sub>4</sub>]<sup>-</sup> [R]<sup>+</sup> Hybrid Materials”  
*J. Fundamental and Applied Sciences* 7(3) [2015] 422.  
[ISSN No. 1112-9867]
13. Ajit Kumar, Sanjay K. Verma, P.A. Alvi and **Dinesh Jasrotia**,

“Single crystal growth, structural, morphological and Raman Tensor Studies of ZnCl<sub>2</sub> based hybrid material.

*American Institute of Physics Proc.* **1675**, 020041 (2015); doi: 10.1063/1.4929199

[UGC Approved Journal with ISSN No. 0094-243X]

**Year: 2014**

14. **Dinesh Jasrotia**, Mukesh Kumar and S Dalela.  
“Structure-property-relationship of p-toluidinium tetrachloromercurate (II)”  
*American Institute of Physics proc.*, 1591 (2014)1247-1249.  
[UGC Approved Journal with ISSN No. 0094-243X]

**Year: 2013**

15. **J. Dinesh**,  
Analysis of secondary interactions and structure-activity-relationship of two benzoic acids  
*Acta Physica Polonica A*, 123 (3) (2013) 704-708.  
[Impact Factor = 0.54 & ISSN No. 0587-4246]

***List of research publications in National and International conferences***

1. Attended and presented research paper in International Conference on “Science: Emerging Scenario and Future Challenges (SESFC-2018)” held at National Institute of Technology (NIT), Hamirpur, Himachal Pradesh (H.P), India during 8-9 September, 2018.
2. **Principal Investigator of this research project has acted as Advisor** in National Conference on “Skill Enhancement Courses and Employment Generation” held at Department of Chemistry, Govt. Degree College, Kathua J&K on 19<sup>th</sup> December, 2017.
3. Attended and presented research paper in International Conference on “Innovative Trends in Applied Physical Sciences and Emerging Energy Technology for Sustainable Development” held at Jawaharlal Nehru University (JNU), New Delhi on 8<sup>th</sup> July, 2017.
4. Attended International Conference on “Recent Advances in Materials Science & Energy Technology” held at Jawaharlal Nehru University (J.N.U.), New Delhi held on March 5, 2017.
5. **Principal Investigator** of this research project has delivered **an Invited Talk** in 3<sup>rd</sup> **National Conference** on Multifunctional Advanced Materials organized by Centre for Excellence in Nanotechnology and School of Physics and Materials Science, **Shoolini University, Solan, H.P.** during May 11-13, 2015.
6. Presented Research Paper during **3<sup>rd</sup> Indo-Italian Workshop** on Energy and Health (IIWec) held at **University of Delhi, Delhi** during 3-4<sup>th</sup> July, 2015.
7. Research publication in ECCG5 - Fifth European **Conference on Crystal Growth**, held at the CNR Research Area in **Bologna, ITALY** on 9-11<sup>th</sup> September, 2015.
8. Presented Research Paper during International Conference on Research Innovations in Science Engineering and Technology held at YCET, Jammu during 20-21<sup>st</sup> Nov., 2015.

9. Presented research paper in **10<sup>th</sup> JK Science Congress** held at University of Jammu, Jammu during March 14-16, 2015.
10. Presented research paper in **2<sup>nd</sup> National Conference** on Interdisciplinary Sciences” held at Govt. G.M. Science College, Jammu during February 27-28, 2015.
11. **Best Poster Presentation Award** to the Project Fellow of this research project in UGC sponsored **National Conference** on “Recent Advances in Materials Science and Technology” held at **M.L.V. Govt. College, Bhilwara, Rajasthan** during December 22-23, 2014.
12. **Principal Investigator of this research project has delivered an Invited Talk** in **2<sup>nd</sup> National Conference** on Multifunctional Advanced Materials organized by Centre for Excellence in Nanotechnology and School of Physics and Materials Science, **Shoolini University, Solan, H.P.** during June 11-12, 2014.