Rational Strategies to Build Nano-magnets

Project Completion Report
of

SERB Project No.SB/FT/CS-069/2012 funded under the
Fast Track Scheme for Young Scientists

Principal Investigator

Dr. Nayanmoni Gogoi
Assistant Professor
Department of Chemical Sciences
Tezpur University

PROJECT COMPLETION REPORT

1. Project Title: **Rational Strategies to Build Nano-magnets**	DST No. **SB/FT/CS-069/2012**
2. PI (Name & Address): Dr. NAYANMONI GOGOI Department of Chemical Sciences Tezpur University Napaam 784028 Email: ngogoi@tezu.ernet.in Phone: 03712 27 5065	Date of Birth: 04 September 1979
3. Implementing Institution: TEZPUR UNIVERSITY, NAPAAM, SONITPUR, ASSAM	
4. Date of commencement: 20 November 2013	
5. Planned date of completion: 19 November 2016	
6. Actual date of completion: 19 November 2016	
7. Objectives as stated in the Project Proposal: (i) Synthesis of several families of already known and novel pentagonal bipyramidal 3d complexes. (ii) Accurate investigation/analysis of the magnetic anisotropy will be undertaken in order to select the 3d building blocks with large negative D parameter and thereby chose the best candidates for building ferrimagnets in the next step. (iii) Assembling hetero-bimetallic {3d-4d/5d} ferrimagnetic systems employing the most promising 3d building blocks and interconnecting them using 4d/5d bridging metallo-ligands. (iv) Characterization of the ferrimagnetic systems using analytical and structural tools. Detailed investigation of the magnetic behaviours shall be carried out.	
8. Deviations made from original objectives if any, while implementing the project and reasons thereof: NOT APPLICABLE	

9. Experimental work giving full details of experimental set up, methods adopted, data collected supported by necessary table, charts, diagrams & photographs:

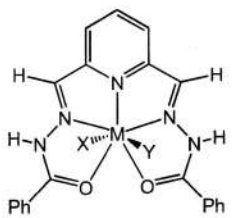
9.1. Methodology: The methodology to be adopted for the execution of this project can be broadly divided into three well defined and complementary tasks:

Synthesis of pentagonal bipyramidal 3d complexes and investigation of their zero field splitting parameters: Several classes of pentagonal bipyramidal transition metal complexes with labile axial ligand shall be prepared. The magnetic anisotropy of these complexes shall be evaluated from magnetization measurements.

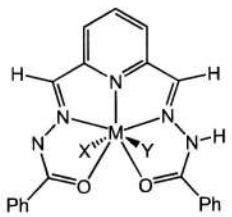
Assembling hetero-bimetallic 3d-4d/5d ferrimagnetic systems: Those pentagonal bipyramidal complexes which possess strong uniaxial anisotropy shall be utilized to charge assisted self-assembly with paramagnetic metalloligands. The resulting heteronuclear species shall be ferrimagnetic in nature.

Structural and magnetic characterization of the ferrimagnetic systems: Conventional physical characterizations- IR, elemental analysis and Single crystal X-ray diffraction measurements shall be performed in order to elucidate the solid state structure of the resulting hetero-nuclear assemblies.

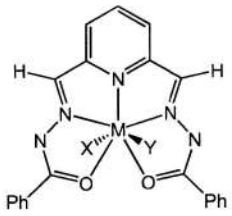
9.1.1. *Synthesis of seven coordinate complexes*: Several new pentagonal bipyramidalMn^{2+}, Co^{2+} and Ni^{2+} complexes (**1-11**) are prepared by using 2,6-diacetylpyridine (bishydrazone) (L) based planer pentadentate ligand (Chart I). All new compounds have been characterized with the aid of analytical and spectroscopic studies. The structure of all the compounds have been unambiguously determined by single crystal X-ray diffraction studies. In all cases the central metal ion is in pentagonal bipyramidal coordination environment.



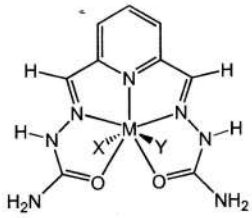
$M = Mn^{2+}$; X= NCS, Y=NCS (**1**)
$M = Co^{2+}$; X= NCS, Y=NCS (**2**)
$M = Ni^{2+}$; X= NCS, Y=NCS (**3**)
$M = Co^{2+}$; X=H_2O, Y=H_2O (**4**)



$M = Co^{2+}$; X=SCN, Y=H_2O (**5**)
$M = Ni^{2+}$; X=SCN, Y=H_2O (**6**)
$M = Mn^{2+}$; X=Cl, Y=H_2O (**7**)
$M = Mn^{2+}$; X=Y=H_2O (**8**)



$M = Co^{2+}$; X=Y=H_2O (**9**)
$M = Mn^{2+}$; X=Y=H_2O (**10**)



$M = Ni^{2+}$; X=Y=imidazole (**11**)

*Chart 1: Pentagonal bipyramidal Mn^{2+}, Co^{2+} and Ni^{2+} complexes (**1-11**) prepared. Counter anions of complex **4**, **7** and **8** are not shown.*

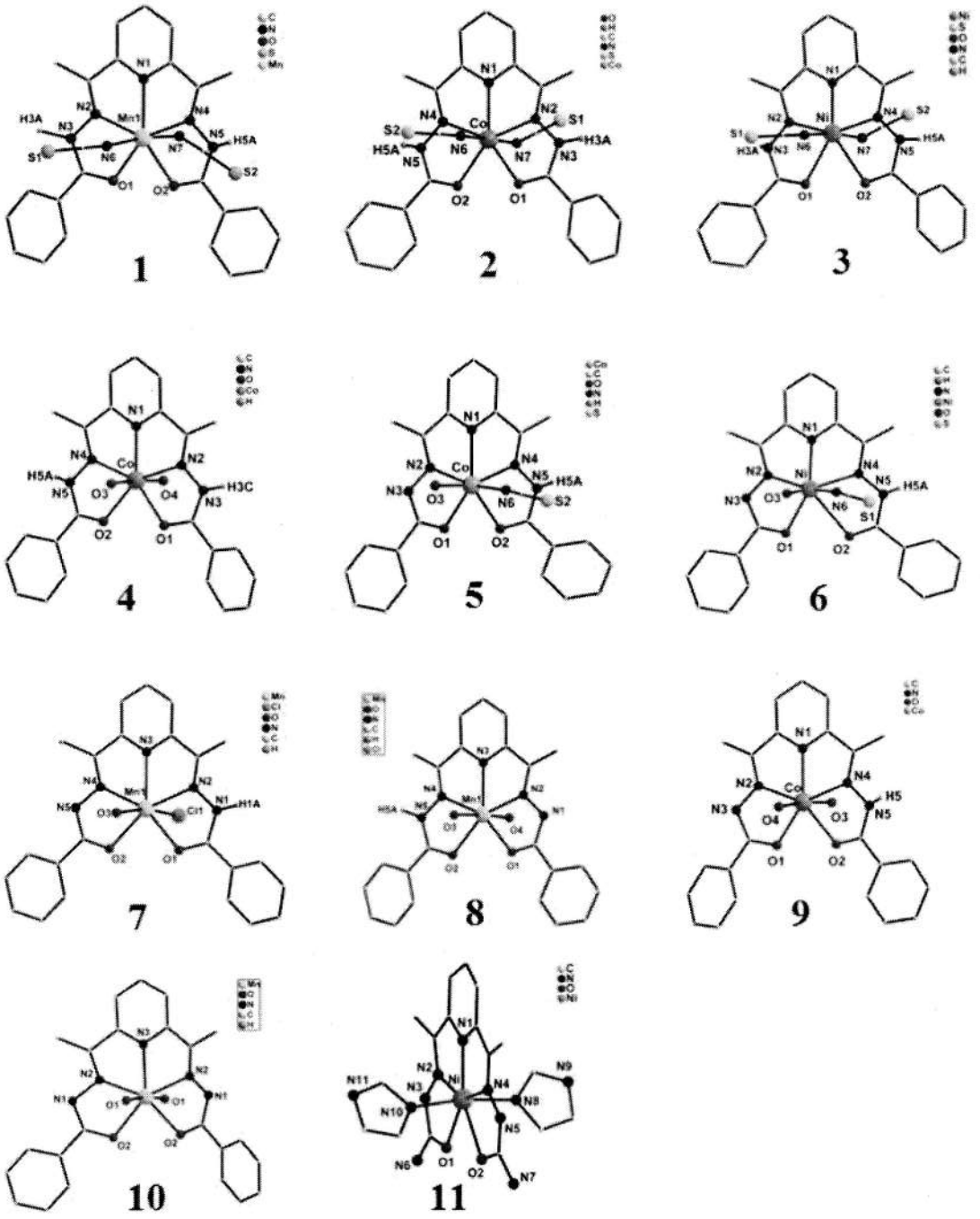


*Figure 1: Single crystal X-ray structures of **1-11**. Aromatic/aliphatic hydrogen atoms and counter ion are omitted for clarity.*

9.1.2. *Magnetic properties of seven coordinate complexes*: In order to probe the magnetic anisotropy of the pentagonal bipyramidal complexes synthesized during this study, their magnetization behavior was measured at several temperatures below 10K. The axial zero field splitting parameter (D) of **1-9** have been determined by fitting the field dependence of magnetization behavior using PHI software. Further, the D parameters of all the complexes have been theoretically estimated by carrying out DFT calculations using ORCA software. The experimental (D_{exp}) and theoretically (D_{calc}) determined D parameters of **1-10** are listed in Table 1. Several pentagonal bipyramidal complexes prepared during this study show large zero field splitting parameters. Further, due to the systematic study carried out during the course of this project, the parameters which govern the magnitude and sign of D parameters are better understood.

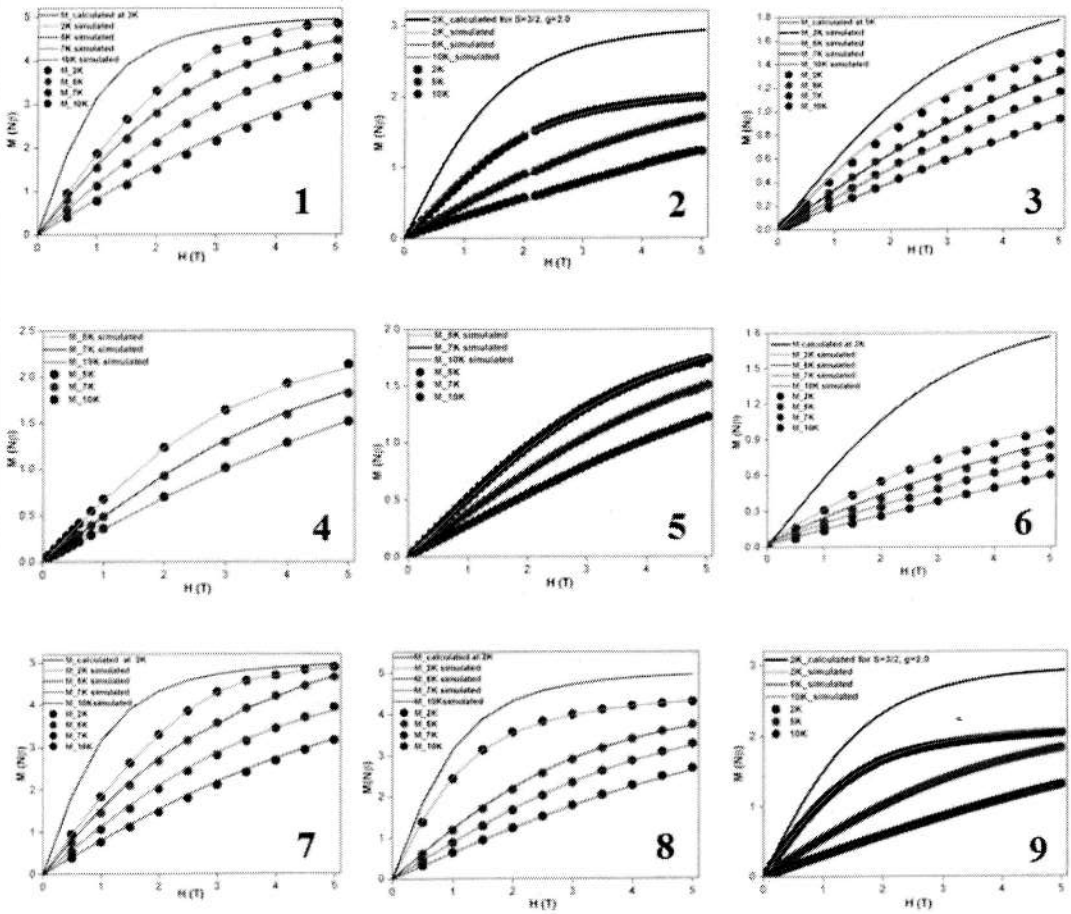


*Figure 2: Isothermal field dependence of magnetization plots of **1-9** carried out between 0-5 Tesla at different temperatures along with calculated values for isotropic systems. The circles represent experimental data while the solid lines represent the best fit obtained by using PHI program.*

*Table 1: Experimental and theoretical zero field splitting parameters of **1-10**.*

Complex	D_{exp}	D_{calc}	E/D	Dssc	D_{SOC}	α→α	β→β	α→β	β→α
1	0.60	0.506	0.162	0.003	0.503	-0.092	0.005	0.587	0.003
2	15.9	14.663	0.009	2.320	12.353	0.039	9.132	3.228	-0.047
3	-15.6	-	-	-	-	-	-	-	-
4	15.6	9.73	0.003	2.00	7.729	0.026	4.378	3.329	-0.004
5	7.1	8.0	0.039	1.7	6.3	0.080	3.068	3.234	-0.030
7	0.20	0.192	0.081	0.009	0.183	0.067	0.026	0.119	-0.029
8	0.002	-0.071	0.232	-0.025	-0.046	-0.001	-0.024	-0.028	0.008
9	13.1	12.486	0.092	2.235	10.251	1.196	5.981	4.203	-1.128
10	-	-0.746	0.320	-0.076	-0.670	0.089	-0.004	-0.231	-0.524

9.1.3. *Synthesis of heterometallic systems*: Several heterometallic species have been prepared by using seven coordinate complexes prepared above as the building block and cyanometallates as linker. First, three heterometallic, Mn(II)-Fe(II) complexes, $[Mn(L)(H_2O)_2][Fe(CN)_5(NO)].H_2O$ (**12**), $[\{Mn(L)\}\{Fe(CN)_5(NO)\}]$ (**13**), $[\{Mn(L)\}\{Fe(CN)_5(NO)\}\cdot(H_2O)_{0.75}]_n$ (**14**) were prepared by reaction of pentagonal bipyramidalMn(II) precursors with nitroprusside ion. Further, two more Mn(II)-Fe(III) heterometallic species, $[\{Mn(L)(H_2O)\}_2\{Mn(L)\}\{Fe(CN)_6\}_2].9H_2O$ (**15**) and $[Mn(L)(H_2O)_2][\{Mn(L)(H_2O)\}_2\{Fe(CN)_4(H_2O)_2\}][\{Mn(L)\}_2\{Fe(CN)_6\}_3].15H_2O$ (**16**)were prepared by using $[Fe(CN)_6]^{3-}$ as the linker. Crystal structures of all the compounds have been determined to establish their identity unambiguously. In all the cases the cyanometallate linker coordinates to the apical positions of the pentagonal bipyramidal precursors. Crystal structure of complex **15** is shown in Figure 1 as a representative example.

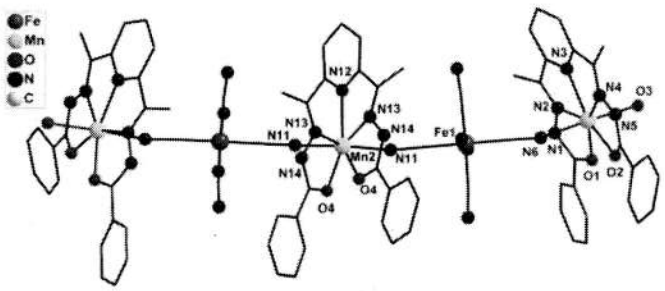


*Figure 1: Crystal structure of complex **15**. H atoms are omitted for clarity.*

9.1.4. *Magnetic properties of heterometallic species*: Magnetization studies on polycrystalline samples of **12-16** were performed under a constant static field of 1000 Oe between 2-300 K. Due to the diamagnetic character of the nitroprusside

linker in **12-14**, these complexes show paramagnetic behaviour until upto 10 K as indicated by the $\chi_M T$ behaviour. Below 10K, a sharp decrease in the $\chi_M T$ product is observed and this can be attributed to intermolecular antiferromagnetic coupling mediated through diamagnetic nitroprusside groups. $\chi_M T$ behaviour of **15-16** show that both of these two compounds have irregular spin-state structure due to the antiferromagnetic interaction mediated by ferricyanide groups. The magnitude of the antiferromagnetic exchange interactions were evaluated by fitting the $\chi_M T$behaviour of these complexes with the help of PHI software.

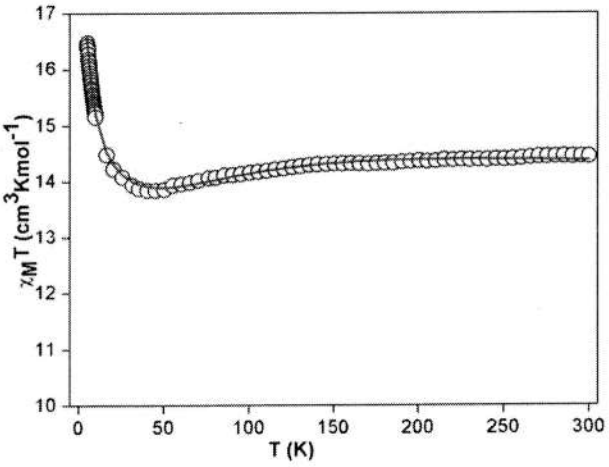


Figure 2. Temperature dependence of $\chi_M T$ for compound **15**. Circles represent experimental data and the solid line indicates best fit obtained by using PHI program.

10. Detailed analysis of the results indicating contributions made towards increasing the state of knowledge in the subject:

Temperature dependence of magnetization studies carried out under static dc field of 1000 Oe revealed that all the Mn(II), Co(II) and Ni(II) PBP complexes are paramagnetic in nature. Moreover, the sharp decrease in $\chi_M T$ product in low temperature region was attributed to ZFS. Nevertheless, isothermal field dependence of magnetization studies was performed for all these PBP complexes. Inspection of the reduced magnetization plots revealed the presence of weak but non-zero magnetic anisotropy in the Mn(II) complexes while significantly large magnetic anisotropy are present in Co(II) and Ni(II) complexes. Fitting of the field dependence of magnetization plots at different temperatures were performed to determine the value of ZFS values parameter for all the complexes. DFT calculations based on the coupled perturbed method was also

performed for Mn(II) and Co(II) PBP complexes to evaluate D values and in all the cases good agreement of the calculated D values with the experimentally determined D values were observed. Correlation of the ZFS values for the PBP Mn(II) complexes reveal that complexes containing stronger σ-donor axial ligands have large positive D values while stronger equatorial ligand field led to negative D values.

Similarly for the PBP Co(II) complexes, increasing both the axial and equatorial ligand field strength led to lowering of the large positive D values generally observed in reported D_{5h} Co(II) system. The deviation of the ZFS parameter in PBP Co(II) complexes from the reported D values of D_{5h} Co(II) system can be easily rationalized with help of theoretical calculations performed earlier. Moreover, significant lowering of ZFS values of PBP Co(II) complexes were observed upon deviation of the local coordination geometry around the Co(II) center from ideal D_{5h} geometry. Lowering of symmetry quenches the orbital angular momentum of the excited states involved in SOC and thereby reduces the D value significantly. However, in case of PBP Ni(II) complexes, no significant deviation in axial ZFS parameter was observed even when strong σ-donor axial ligands are used. Careful analysis of the excited states involved in out-of-state SOC revealed that energy of one of the excited state increases while that of another excited state decreases under the influence of stronger axial ligand field. Due to these two opposing effects, overall there is no appreciable deviation in D parameter on changing the axial ligand field.

The presence of labile axial ligands on the PBP complexes synthesized herein provided us an appealing opportunity to develop heterometallic species by replacing the axial sites with suitable metalloligands. In view of the fascinating array of intriguing magnetic properties displayed by cyano bridged polymetallic aggregates we employed cyanometallate bridging groups to interlink PBP species. Previous studies have established that the self-assembling process between cyanometallate anion and cationic 3d building block is primarily governed by the charge on both species. Based on the principle of electroneutrality, a range of structural motifs have been isolated by varying the charge on the motifs. Results presented herein show that intricate control over the self-assembly process can be achieved by proper choice of reaction medium. Excess water present in the reaction medium impedes isolation of an ionic compound **12** but lead to the crystallization of a neutral bimetallic species **13**. Moreover, presence of an additional anion with coordinating ability can overwhelmingly influence the self-assembly

process. Results described here suggest that presence of KSCN as well as $NaClO_4$ can avert formation of polymeric structure. The magnetic features of the heterometallic species were investigated by using low temperature magnetization studies and the extent of magnetic exchange interaction was also deduced by fitting the magnetization plots.

Thus, results obtained during the course of this project clearly establish that pentagonal bipyramidalcoordination geometry is an efficient environment to induce strong magnetic anisotropy in transition metal ions which are otherwise considered to be magnetically isotropic in O_h environment. Moreover,systematic analysis of the zero field splitting parameters in complexes with subtle differences in coordination environment have furnished crucial parameters which govern magnetic anisotropy in these complexes.

11. Conclusions summarizing the achievements and indication of scope for future work:

11.1. Salient Research Achievements: The following important milestones have been achieved during the course of this project:

A. Several new seven coordinated Mn^{2+}, Co^{2+} and Ni^{2+} complexes have been prepared by using an acyclic planer pentadentate ligand based on 2,6-diacetylpyridine (bis-hydrazone).

B. Analytical and structural characterizations of the new seven coordinated complexes were carried out to unambiguously establish the structure of these complexes.

C. Low temperature magnetization studies on several seven coordinate Co^{2+} and Ni^{2+} complexes were carried out to assess their magnetically anisotropies. The zero field splitting parameter of the complexes were determined by fitting the low temperature magnetization behavior using PHI software. Moreover, DFT level calculations were carried out to extract the zero field splitting parameters for different seven coordinate complexes.

D. Several cyano bridged hetermetallic species have been prepared by using seven coordinate Mn^{2+} complexes as the building block and cyanometallates as linkers. Analytical, spectroscopic, structural and magnetic characterization of these heterometallic species were carried out.

11.2 Future Scope:

Increase in the blocking temperature, even by a few Kelvin's can tremendously contribute to the development of much denser electronic storage media. Moreover

based upon the result obtained and experience gained from this project we expect to develop magnetic materials for application in information storage, sensor etc. Transition metal ions which display large magnetic anisotropy in pentagonal bipyramidal geometry have been identified during the course of this project. Moreover, this study has paved way for intricate control over magnetic anisotropy and based on this it is now possible to design transition metal species with large magnetic anisotropy. We anticipate that assembling these anisotropic building blocks with 4d/5d cyanometallates shall result in nano-magnets with better characteristics. Due the enhanced 3d-4d/5d exchange interaction and large anisotropy from the 3d building blocks, we anticipate to increase the energy barrier of magnetization reversal $U = -DS^2$ in the proposed hetero-nuclear assemblies.

12. S & T Benefits

(i) List of Publications from this Project (including title, author(s), journals & year (s)

(1) Modulation of the coordination environment: a convenient approach to tailor magnetic anisotropy in seven coordinate Co(II) complexes. Dey, M.; Dutta, S.; Sarma, B.; Deka, R. C.; Gogoi, N.*Chemical Communication*s, **2016**, 52, 753-756.

(2) Auto-reusable receptors for selective colorimetric recognition of fluoride. Borah, S.; Konwar, G.; Borborah, A.; Gogoi, N.*RSC Advances*, **2015**, 5, 101701-101706.

(3) Phenolic oxime based receptors for selective detection of fluoride. Borah, S.; Das, B. P.; Konwar, G.; Mahanta, S. P.; Gogoi, N.*RSC Advances***2015**, *5*, 75187-75194.

(4) Coligand Promoted Controlled Assembly of Hierarchical Heterobimetallic Nitroprusside Based Aggregates. Dey, M.; Sarma, B.; Gogoi, N.*Z. Anorg. Allg. Chem.* **2014**, 640, 2962-2967.

(5) Single Crystal X-ray Structure of Zinc Tert-butylphosphonate. Borah, S.; Kalita, A.; Gogoi, N.*Z. Anorg. Allg. Chem.***2014**,*640*, 1789-1792.

(ii) Manpower trained on the project

(a) Research Scientists or Research Associates: NIL

(b) No. of Ph.D. produced: NIL

(c) Other Technical Personnel Trained: 01

(iii) Patents filed/to be filed: NIL

13. Financial Position

Sl. No	Budget Heads	Funds Sanctioned	Expenditure	% of Total cost
1	Manpower costs	4,09,597.00	4,09,131.00	99.88
2	Consumables	7,59,536.00	7,59,530.00	99.99
3	Travel	42,108.00	32,818.00	77.93
4	Contingencies	60,000.00	59,998.00	99.99
5	Equipment	6,50,000.00	6,46,924.00	99.52
6	Overhead	2,78,759.00	2,78,697.00	99.97
7	Others	NIL	NIL	NIL
8	Total	22,00,000.00	21,87,098.00	99.41

14. Procurement/Usage of Equipment

A.

Sl. No	Name of Equipment	Make/ Model	Cost (₹ in Lakhs)	Date of installation	Utilization rate (%)	Remarks regarding maintenance
1	Rotary evaporator	BUCHI RV10	4.49	07/03/2014	100%	Working
2	Analytical balance	DENVER TP214DE	0.73	17/01/2014	100%	Working
3	Magnetic Stirrer	REMI 2MLH	0.35	05/03/2014	100%	Working
4	Vacuum pump	HHV FD-6	0.435	20/05/2014	100%	Working
5	Electric oven	Relitech UO-216D	0.28	27/08/2014	100%	Working

B. Plans for utilizing the equipment facilities in future:

All the equipment's procured under the project are being actively used in our laboratory and assisting us to perform research work pertaining to two currently ongoing research projects funded by SERB and CSIR. Therefore, we plan to continue using all the equipment's procured under this project in our laboratory.

Name of Principal Investigator: Dr. NAYANMONI GOGOI

Signature:

Date: 15/06/2017

Annexure-II

UP-TO-DATE STATEMENT OF EXPENDITURE

1. SERB Sanction Order No and date : SERB/F/4373/2013-14 dated 08/10/2013
2. Name of the PI : Dr. NAYANMONI GOGOI
3. Total Project Cost : 24,50,800.00
4. Revised Project Cost (if applicable) : NA
5. Date of Commencement : 20 NOVEMBER 2013
6. Statement of Expenditure
   (month wise expenditure incurred during current financial year)

Month & year	Expenditure incurred/committed
April 2016	NIL
May 2016	18,638.00
June 2016	17,000.00
July 2016	21,710.00
August 2016	14,000.00
September 2016	14,000.00
October 2016	33,422.00
November 2016	2,09,081.00
December 2016	NOT APPLICABLE
January 2017	NOT APPLICABLE
February 2017	NOT APPLICABLE
March 2017	NOT APPLICABLE
Total Expenditure during F. Y. 2016-2017	**3,27,851.00**

7. Grant received in each year
   a. 1st Year : ₹ 12,00,000.00
   b. 2nd Year : ₹ 3,00,000.00
   c. 3rd Year : ₹ 5,00,000.00
   d. 4th Year : ₹ 2,00,000.00
   e. Interest, if any: ₹ 16,154.00
   f. Total (a+b+c+d+e): ₹ 22,16,154.00

Annexure-II

Statement of Expenditure

For the period 20th November 2013 to 19th November 2016

Sr No (I)	Sanctioned Heads (II)	Total Fund Allocated (Sanctioned) (III) In ₹	Expenditure Incurred				Total Expenditure till 19th November 2016 (VIII = IV + V+ VI+VII) In ₹	Balance as on 19th November 2016 (IX = III – VIII) In ₹	Requirement of Funds upto 31st March 2017 In ₹	Remarks (if any)
			1st Year (IV) In ₹	2nd Year (V) In ₹	3rd Year (VI) In ₹	4th Year (VII) In ₹				
1.	Manpower costs	4,09,597.00	44, 258.00	90,006.00	1,68,000.00	1,06,867.00	4,09,131.00	466.00	NIL	NIL
2.	Consumables	7,59,536.00	1,94,991.00	1,90,092.00	1,96,034.00	1,78,413.00	7,59,530.00	6.00	NIL	NIL
3.	Travel	42,108.00	9,923.00	9,000.00	3,185.00	10,710.00	32,818.00	9,290.00	NIL	NIL
4.	Contingencies	60,000.00	14,138.00	19,849.00	15,350.00	10,661.00	59,998.00	2.00	NIL	NIL
5.	Others, if any	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
6.	Equipment	6,50,000.00	5,75,132.00	71,792.00	NIL	NIL	6,46,924.00	3,076.00	NIL	NIL
7.	Overhead	2,78,759.00	62,500.00	33,759.00	1,61,238.00	21,200.00	2,78,697.00	62.00	NIL	NIL
8.	Total	22,00,000.00	9,00,942.00	4,14,498.00	5,43,807.00	3,27,851.00	21,87,098.00	12,902.00	NIL	NIL

Name of Principal Investigator: **Dr. NAYANMONI GOGOI**

Signature of PI:

Date: 10/04/2017

18/5/17

Signature of competent financial authority: _____

(with seal) Date: _____

Finance Officer
Tezpur University

UTILISATION CERTIFICATE

FOR THE FINANCIAL YEAR –ENDING **31ST MARCH 2017**

U.C. pertains to √ appropriate box

First Release	Second Release	Third Release	Fourth Release	Final Release

Is the UC provisional : NO

1.	Title of the Project/Scheme	: Rational Strategies to Build Nano-Magnets
2.	Name of Principal Investigator	: Dr. NAYANMONI GOGOI
3.	Implementing Institution	: TEZPUR UNIVERSITY, NAPAAM, SONITPUR, ASSAM-784028
4.	SERB sanction order No. & date	: SERB/F/4373/2013-14 dated 08/10/2013
5.	Amount brought forward from the previous financial year quoting SERB letter number and date in which the authority to carry forward the said amount was given	: Amount- ₹ 1,37,677.00 : Letter/Order No. SERB/F/3901/2016-17 : Date: 10-09-2016
6.	(a) Amount received during the financial year (Please give SERB letter/order no. and date for the amount)	: Amount: ₹ 2,00,000.00 : Letter/Order No. SERB/F/3901/2016-17 : Date: 10-09-2016
	(b) Interest earned, if any	: ₹ 16,154.00
7.	Total amount that was available for expenditure ₹ (excluding commitments) during the financial year (Sr. No. 5+6a+6b)	: ₹ 3,53,831.00
8.	Actual Expenditure (excluding commitments incurred during the financial year (upto 31st March)	: ₹ 3,27,851.00
9.	Balance amount avaialable at the end of the financial year (8-9): OR/Negative balance (If expenditure incurred is more than the funds released)	₹ 25,980.00
10.	Unspent balance, if any, refunded to SERB (give details of cheque/DD No. etc.)	₹ 25,980.00 DD 049392 (SBI)
11.	Amount to be carried forward to the next financial year (if any)	NIL

UC for Recurring Grants

UILISATION CERTIFICATE

Certified that out of ₹ 2,00,000.00 (Rupees Two Lakhs Only) of Recurring grants-in-aid sanctioned during the year 2016-2017 in favor of Dr. NAYANMONI GOGOI under SERB letter/order No. SERB/F/3901/2016-17 dated 10-09-2016 and ₹ 1,37,677.00 (Rupees One Lakh Thirty Seven Thousands Six Hundred and Seventy Seven Only) on account of unspent balance of the previous year, a sum of ₹ 3,27,851.00 (Rupees Three Lakhs Twenty Seven Thousands Eight Hundred and Fifty One Only) has been utilized for the purpose for which it was sanctioned and that the balance of ₹ 25,980.00 (Rupees Twenty Five Thousands Nine Hundred Eighty Only) remaining unutilized at the end of the year has been refunded to SERB (vide Cheque/DD No. 049392 (SBI) dated 25/05/2015).

Certified that we have satisfied ourselves that the conditions on which the grants-in-aid was sanctioned have been fulfilled/are being fulfilled and that we have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned.

Kinds of checks exercised:

1.

2.

Signature of PI	Signature of Finance Officer	Signature of Head of Institution
Date: 10/04/2017	Date: 18/5/17	Date:
	Finance Officer *Tezpur University*	*Registrar* *Tezpur University*

UTILISATION CERTIFICATE

FOR THE FINANCIAL YEAR –ENDING **31ST MARCH 2017**

U.C. pertains to √ appropriate box

First Release	Second Release	Third Release	Fourth Release	Final Release

Is the UC provisional : NO

1.	Title of the Project/Scheme	:	Rational Strategies to Build Nano-Magnets
2.	Name of Principal Investigator	:	Dr. NAYANMONI GOGOI
3.	Implementing Institution	:	TEZPUR UNIVERSITY, NAPAAM, SONITPUR, ASSAM-784028
4.	SERB sanction order No. & date	:	SERB/F/4373/2013-14 dated 08/10/2013
5.	Amount brought forward from the previous financial year quoting SERB letter number and date in which the authority to carry forward the said amount was given	:	Amount: ₹ 3076.00
		:	Letter/Order No. SERB/F/3901/2016-2017
		:	Date: 10-09-2016
6.	Amount received during the financial year (Please give SERB letter/order no. and date for the amount)	:	Amount- NIL
		:	Letter/Order No. NOT APPLICABLE
		:	Date: NOT APLLICABLE
7.	Interest earned, if any	:	
8.	Total amount that was available for expenditure ₹ (excluding commitments) during the financial year (Sr. No. 5+6a+6b)	:	₹ 3076.00
9.	Actual Expenditure (excluding commitments incurred during the financial year (upto 31st March)	:	NIL
10.	Balance amount avaialable at the end of the financial year (8-9): OR/Negative balance (If expenditure incurred is more than the funds released)		₹ 3076.00
11.	Unspent balance, if any, refunded to SERB (give details of cheque/DD No. etc.)		₹ 3076.00 SBI DD 049392
12.	Amount to be carried forward to the next financial year (if any)		NIL

UC for Non-Recurring Grants

UILISATION CERTIFICATE

Certified that out of ₹ **NIL** of Non-Recurring grants-in-aid sanctioned during the year 2016-2017 in favor of **Dr. NAYANMONI GOGOI** under SERB letter/order No. **NOT APPLICABLE** dated **NOT APPLICABLE** and ₹ **3076.00** (Three Thousands and Seventy Six Only) on account of unspent balance of the previous year, a sum of ₹ **NIL** has been utilized for the purpose for which it was sanctioned and that the balance of ₹ **3076.00** (Three Thousands and Seventy Six Only) remaining unutilized at the end of the year has been refunded to SERB (vide Cheque/DD No. 049392 (SBI) dated 25/05/2017).

Certified that we have satisfied ourselves that the conditions on which the grants-in-aid was sanctioned have been fulfilled/are being fulfilled and that we have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned.

Kinds of checks exercised:

1.

2.

Signature of PI	Signature of Finance Officer	Signature of Head of Institution
Date: 10/04/2017	Date: 18/5/17	Date:
	Finance Officer Tezpur University	Registrar Tezpur University