NON-RECURRING
GFR 12 – A [(See Rule 238 (1))]
UTILIZATION CERTIFICATE (UC) FOR THE YEAR 2022-2023
in respect of *NON-RECURRING*
as on 11.09.2022 to be submitted to SERB
Is the UC ……*(Provisional/Audited)*
(To be given separately for each financial year ending on 31st March)

1. Name of the grant receiving Organization: **Tezpur University**
2. Name of Principal Investigator (PI): **Shyamal Kumar Das**
3. SERB Sanction order no. & date: **FILE NO. CRG/2018/000263** Dated 09.03.2019
4. Title of the Project: Identification of electroactive materials for high energy and high power rechargeable aluminum-ion battery
5. Name of the SERB Scheme : **CRG**
6. Whether recurring or non-recurring grants : **Non-Recurring grant**
7. Grants position at the beginning of the Financial year (Grants released by SERB)
   (i) Cash In Hand/Bank /Carry forward from previous financial year: Rs. 1,07,214/-
   (ii) Others, If any : NIL
   (iii) Total : Rs. 1,07,214/-
8. Details of grants received, expenditure incurred and closing balances: (Actuals)

Unspent Balance of Grants received previous years figure as at Sl. No. 7(iii)]	Interest Earned thereon	Interest deposited back to the SERB	Grants received during the year In ₹			Total Available funds (1+2-3+4) In ₹	Expenditure incurred In ₹	Closing Balances (5-6) In ₹
1	2	3	4			5	6	7
			Sanction No. (i)	Date (ii)	Amount (iii) In ₹			
1,07,214/-	1948/-	3,914/-	Diary No. SERB/F/1290/2022-2023	9-6-2022	NIL	1,05,248/-	NIL	1,05,248/-

Component wise utilization of grants:

Grant-in-aid-creation for capital assets	Total In ₹
	NIL

Details of grants position at the end of the year
(i) Cash in Hand/Bank : Rs. 1,05,248/-
(ii) Refunds to SERB, If any : NIL
(iii) Balance (***To be refunded to SERB as unspent balance***) : Rs. 1,05,248/-

Signature of PI	Signature with Seal Name: Chief Finance Officer (Head of Finance)	Signature with Seal Name: Head of Organisation
	Finance Officer Tezpur University	Registrar Tezpur University

NON-RECURRING
GFR 12 – A [(See Rule 238 (1))]
UTILIZATION CERTIFICATE (UC) FOR THE YEAR 2022-2023
in respect of *NON-RECURRING*
as on 11.09.2022 to be submitted to SERB
Is the UC ……*(Provisional/Audited)*
(To be given separately for each financial year ending on 31st March)

Certified that I have satisfied that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:

(i) The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.

(ii) There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.

(iii) To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.

(iv) The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.

(v) The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.

(vi) The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.

(vii) It has been ensured that the physical and financial performance under **CRG** (Name of the scheme has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure – I duly enclosed.

(viii) The utilization of the fund resulted in outcomes given at Annexure – II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications.)

(ix) Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure –II (to be formulated by the Ministry/Department concerned as per their requirements/specifications).

Date: 06/12/22
Place: Tezpur University

Signature of PI	Signature with Seal 06/12/2022 Name: Chief Finance Officer (Head of Finance)	Signature with Seal Name: Head of Organisation

Finance Officer
Tezpur University

Registrar
Tezpur University

RECURRING

GFR 12 – A [(See Rule 238 (1))]

UTILIZATION CERTIFICATE (UC) FOR THE YEAR 2022-2023

in respect of *RECURRING*

as on 11.09.2022 to be submitted to SERB

Is the UC ……*(Provisional/Audited)*

(To be given separately for each financial year ending on 31st March)

1. Name of the grant receiving Organization: **Tezpur University**
2. Name of Principal Investigator (PI): **Shyamal Kumar Das**
3. SERB Sanction order no. & date: **FILE NO. CRG/2018/000263** Dated 09.03.2019
4. Title of the Project: Identification of electroactive materials for high energy and high power rechargeable aluminum-ion battery
5. Name of the SERB Scheme : **CRG**
6. Whether recurring or non-recurring grants : **Recurring grant**
7. Grants position at the beginning of the Financial year (Grants released by SERB)
   (i) Cash In Hand/Bank /Carry forward from previous financial year: Rs. 4,52,804/-
   (ii) Others, If any : NIL
   (iii) Total : Rs. 4,52,804/-
8. Details of grants received, expenditure incurred and closing balances: (Actuals)

Unspent Balance of Grants received previous years figure as at Sl. No. 7(iii)]	Interest Earned thereon	Interest deposited back to the SERB	Grants received during the year In ₹			Total Available funds (1+2-3+4) In ₹	Expenditure incurred In ₹	Closing Balances (5-6) In ₹
1	2	3	4			5	6	7
			Sanction No. (i)	Date (ii)	Amount (iii) In ₹			
4,52,804/-	8,230/-	NIL	Diary No. SERB/F/1290/2022-2023	9-6-2022	3,50,000/-	8,11,034/-	NIL	8,11,034/-

Component wise utilization of grants:

Grant-in-aid-general	Total In ₹
1. Manpower	NIL
2. Consumables	NIL
3. Travel	NIL
4. Contingencies	NIL
5. Overhead	NIL
Total	NIL

Details of grants position at the end of the year

(i) Cash in Hand/Bank : Rs. 811034/-

(ii) Refunds to SERB, If any : NIL

(iii) Balance (***To be refunded to SERB as unspent balance***) : Rs. 8,11,034/-

Signature of PI	Signature with Seal Name: Chief Finance Officer (Head of Finance)	Signature with Seal Name: Head of Organisation

Finance Officer
Tezpur University

Registrar
Tezpur University

RECURRING

GFR 12 – A [(See Rule 238 (1))]

UTILIZATION CERTIFICATE (UC) FOR THE YEAR 2022-2023

in respect of *RECURRING*

as on 11.09.2022 to be submitted to SERB

Is the UC ……*(Provisional/Audited)*

(To be given separately for each financial year ending on 31st March)

Certified that I have satisfied that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:

(i) The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.

(ii) There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.

(iii) To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.

(iv) The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.

(v) The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.

(vi) The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.

(vii) It has been ensured that the physical and financial performance under **CRG** (Name of the scheme has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure – I duly enclosed.

(viii) The utilization of the fund resulted in outcomes given at Annexure – II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications.)

(ix) Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure –II (to be formulated by the Ministry/Department concerned as per their requirements/specifications).

Date: 6/12/22

Place: Tezpur University

Signature of PI	06/12/2022 Signature with Seal Name: Chief Finance Officer (Head of Finance)	6-12-22 Signature with Seal Name: Head of Organisation
	Finance Officer Tezpur University	Registrar Tezpur University

Annexure-II

REQUEST FOR ANNUAL INSTALMENT WITH UP-TO-DATE STATEMENT OF EXPENDITURE

[For the Financial year 01.04.2022 to 11.09.2022]

1. SERB Sanction Order No and date: **FILE NO. CRG/2018/000263** Dated 09.03.2019 and subsequent orders

2. Name of the PI : **Shyamal Kumar Das**

3. Total Project Cost : Rs. **32,82,400/-**

4. Revised Project Cost (If applicable) : N/A

5. Date of Commencement : 12.03.2019

6. Statement of Expenditure :
(Month wise expenditure incurred during current financial year: 2022-2023)

Month and Year	Expenditure incurred (Rs)
April 2022	Nil
May 2022	Nil
June 2022	Nil
July 2022	Nil
August2022	Nil
September2022	Nil
Total	Nil

1. Grant received in each year:
   a. 1st Year : Rs. 17,74,200/-
   b. 2nd Year : Rs. 6,00,000/-
   c. 3rd Year : NIL
   d. 4th year : Rs. 4,00,000/-
   e. 5th year : Rs. 3,50,000/-
   f. Interest, if any : Rs. 61,374/-
   (Rs. 22,030/- for 2019-20 + Rs. 15,507 for 2020-21 + Rs. 13,659/- for 2021-22+ Rs. 10,178/- for 2022-23)
   g. Interest Refund to SERB: Rs. 3,914/-
   h. Total (a+b+c+d+e+f - g) : Rs. 31,81,660/-

Annexure-II

Statement of Expenditure
(01.04.2022-11.09.2022)

Sr No (I)	Sanctioned Heads (II)	Total Fund Allocated (sanctioned) ($1^{st}+2^{nd}+3^{rd}+4^{th}$ installments) (III) In ₹	Expenditure Incurred					Total Expenditure till 11.09.2022 (IX = IV + V+ VI+VII+VIII) In ₹	Balance as on 11.09.2022 (X = III – IX) In ₹	Requirement of Funds	Remark (if any)
			1^{st} (IV) (12.03.2019- 31.03.2019)	2^{nd} (V) (01.04.2019-31.03.2020)	3^{rd} (VI) (01.04.2020-31.03.2021)	4^{th} (VII) (01.04.2021-31.03.2022)	5^{th} (VIII) (01.04.2022-11.09.2022)				
1.	Manpower costs	18,25,800	NIL	98452	168000	91000	NIL	357452	7.55,520	NIL	*An interest amount of Rs. 3914 was refunded on 06.05.2022. Grand Total Interest = 61,374/- Remaining Interest amount = 61,374-3914 =57,460/-
2.	Consumables		NIL	249864	39470	210662	NIL	499996			
3.	Travel		NIL	30304	5828	26700	NIL	62832			
4.	Contingencies		NIL	93759	6241	50000	NIL	150000			
5.	Others, If any		NIL	0	0	0	NIL	0			
6.	Equipment	10,00,000	NIL	896700	0	0	NIL	896700	1.03,300	NIL	
7.	Overhead	2,98,400	NIL	167519	19814	111065	NIL	298398	2	NIL	
8.	Bank Interest	57,460*	NIL	NIL	NIL	NIL	NIL	NIL	57,460	NA	#Rs.9,16,282/- to be refunded to SERB
9.	Total	31,81,660 (with bank interest)	NIL	15,36,598	2,39,353	4,89,427	NIL	22,65,378	9.16,282# (with bank interest)	NIL	

Name and Signature of Principal Investigator

(SHYAMAL KR DAS)

Signature of Competent Financial Authority with seal and date

06/12/2022

Finance Officer
Tezpur University

Closure Report

File Number : CRG/2018/000263

Project Title : Identification of electroactive materials for high energy and high power rechargeable aluminum-ion battery

Principal Investigator : Dr. Shyamal Kumar Das
Tezpur University
Distt. sonitpur p.b.no.72 napaam, tezpur, Tezpur, Assam-784011

Total Sanctioned Amount : 32,82,400 (INR)

Total Released Amount : 31,24,200 (INR)

Start Date of the Project: 12 Mar, 2019

Date of completion: 11 Sep, 2022 (42 months)

Approved Objectives :

The various proposed objectives of the project are as follows: 1. Developing strategies for encapsulation of transition metal compounds in highly electronically conductive matrix for utilization as cathodes in rechargeable aluminium-ion batteries. 2. Identification of electrolytes for aluminium-ion batteries which are non-corrosive and compatible with traditional battery packaging materials. 3. Determination of structure property correlation of the synthesized cathode materials using analytical and structural tools. 4. Electrochemical evaluation of the synthesized cathode materials. The evaluation mostly comprises of galvanostatic cycling and cyclic voltammetry testing. 5. Development of prototype of aluminium-ion batteries for powering small-scale utilities to demonstrate the feasibility of such batteries for large-scale utilization.

Deviation made from original objectives (If Any) :

No deviation is made.

Ph.D. Produced/ Likely to be Produced : 2

Technical Personnel Trained : 1

Total Expenditure : 22,65,378 (INR)

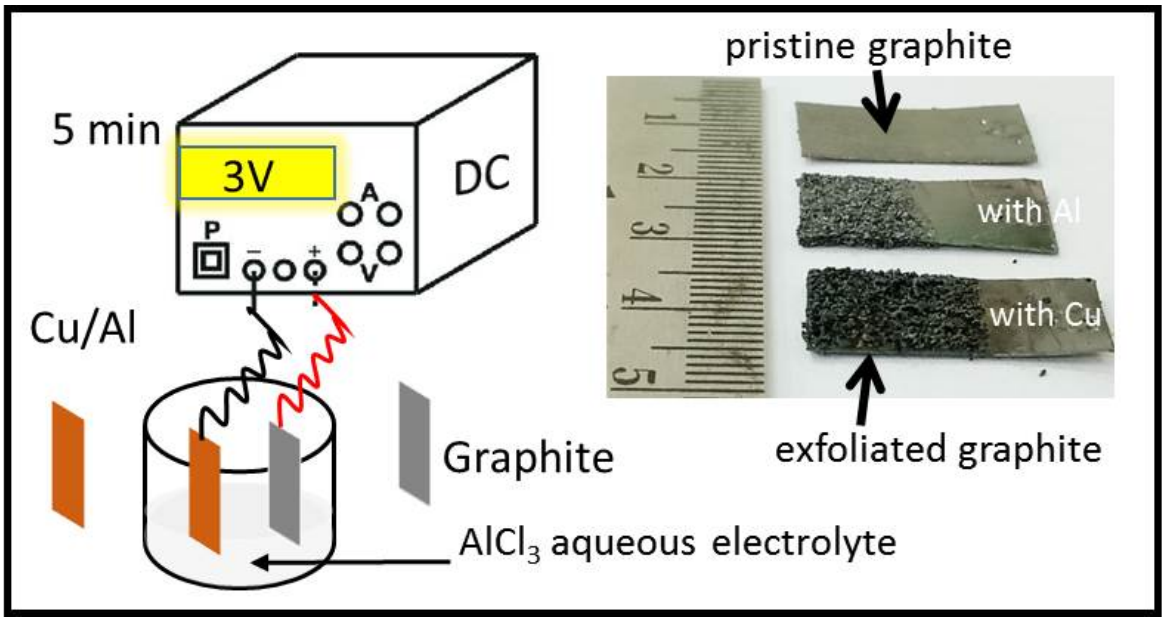
Concise Research Accomplishment :

We demonstrated, for the first time, the rechargeability of an aqueous aluminium-metal battery with highly porous exfoliated graphite electrodes. In contrast to extremely corrosive and expensive chloroaluminate electrolytes that are predominantly being used in aluminium-ion/metal batteries, we proposed to use aqueous electrolyte which is least corrosive and highly economic. We also developed a simple and facile electrochemical method to produce the exfoliated graphite. Building upon this success, in order to improve the performance of the aqueous aluminium-metal battery, the exfoliated graphite electrodes were further thermally treated to achieve more porous graphite electrodes. Again, we demonstrated the electrochemistry of tungsten trioxide, bismuth oxide, bismuth oxychloride, vanadyl ethylene glycolate, molybdenum ditelluride, lithium manganese oxide, lithium manganese phosphate for aluminum-ion battery in aqueous electrolyte for the first time. We could enhance the stability and capacity by effective encapsulation of these electrode materials in highly electronically conducting carbon matrix.

Closure Details

Experimental/ Theoretical Investigation carried out

We developed a simple and facile electrochemical method to obtain highly porous and highly electronically conducting graphite matrix. For this purpose, a pair of Cu and graphite electrodes were used and a dc voltage of 3-5 V for 5 minute was applied in between these electrodes in an electrochemical cell containing aqueous aluminium chloride electrolyte. It is schematically shown in the attached figure. It resulted in foam like structure of graphite. This was further heat treated at 800 oC for 30 s to obtain more porous graphite matrix. Electroactive materials such as bismuth oxide, bismuth oxychloride etc. were hydrothermally grown on this porous graphite matrix to obtain binder free electrodes for aluminium-ion batteries. The most widely used electrolyte in aluminium-ion/metal battery is chloroaluminate electrolyte. A common example is a mixture of anhydrous aluminium chloride and 1-ethyl-3-methyl imidazolium chloride ionic liquid. This electrolyte is highly corrosive, moisture sensitive and expensive. In an effort to getting rid of this electrolyte, we planned to use aqueous aluminium electrolytes. The investigated electrolytes are aqueous AlCl3, Al(NO3)3, Al2(SO4)3, Altriflate. This could be prepared without use of any glove box.



Detailed Analysis of result

We demonstrated, for the first time, the rechargeability of an aqueous aluminium-metal battery in aqueous electrolyte. The Al3+ ion electrochemistry of tungsten trioxide, bismuth oxide, bismuth oxychloride, vanadyl ethylene glycolate, molybdenum ditelluride, lithium manganese oxide, lithium manganese phosphate is also illustrated for the first time.

Conclusions

As per the proposed objectives, the research work was undertaken and could identify certain novel electrode materials for rechargeable aluminum batteries.

Scope of future work

The progress made in the project work resulted in the identification of several electrodes and electrolytes for rechargeable aluminum-batteries. While investigation, it was also found that there are challenges to surmmount to achieve ultra long life and high storage capacity aluminum batteries. Therefore, this project work opens up ample avenues for making further progress in the area of rechargeable aluminum batteries.

List of Publications (only from SCI indexed journals) :

Title of the Paper	List of Authors	Journal Details	Month & Year	Volume	Status	DOI No	Impa Fact
Realizing a Low-Cost and Sustainable Rechargeable Aqueous Aluminum-Metal Battery with Exfoliated Graphite Cathode	Sunny Nandi, Shyamal K. Das	ACS Sustainable Chemistry & Engineering (International)	Jun-2021	24 (19839)	Publishe d	https: //doi. org/10. 1021/acss uscheme ng. 9b05185	8.19
Exploring the electrochemical activity of bismuth oxychloride for rechargeable aqueous aluminium–metal battery and a method for enhanced performance	Sunny Nandi, Shyamal K. Das	BULLETIN OF MATERIALS SCIENCE (International)	Jul-2021	44 (234)	Publishe d	https: //doi. org/10. 1007/s120 34-021-02530-2	1.78
Reversible Al3+ ion insertion into tungsten trioxide (WO3) for aqueous aluminum-ion batteries	Homen Lahana and Shyamal K. Das	DALTON TRANSACTIONS (International)	Apr-2019	48 (6337-6340)	Publishe d	DOI https: //doi. org/10. 1039/C9D T00844F	4.39
A simple strategy to improve the electrochemical performance of rechargeable aqueous Al-graphite battery	S. Nandi, S. K. Das	MATERIALS LETTERS (International)	Jun-2021	301 (130263)	Publishe d	https: //doi. org/10. 1016/j. matlet. 2021.1302 63	3.23
An electrochemical study on LiMn2O4 for Al3+ ion storage in aqueous electrolytes	Sunny Nandi and Shyamal K. Das	PHYSICAL CHEMISTRY CHEMICAL PHYSICS (International)	Aug-2021	23 (19150)	Publishe d	DOI: 10.1039 /d1cp030 12d	3.67
Vanadyl ethylene glycolate A novel organic-inorganic electrode material for rechargeable aqueous aluminum-ion battery	Sunny Nandi, Yichen Yan, Xintong Yuan, Chongzhen Wang, Ximin He, Yuzhang Li, Shyamal K. Das	SOLID STATE IONICS (International)	Dec-2022	389 (116085)	Publishe d	doi. org/10. 1016/j.ssi. 2022.1160 85	3.6
An electrochemical study on bismuth oxide (Bi2O3) as an electrode material for rechargeable aqueous aluminum-ion battery	Sunny Nandi, Shyamal K. Das	SOLID STATE IONICS (International)	Jan-2020	347 (115228)	Publishe d	https: //doi. org/10. 1016/j.ssi. 2020.1152 28	2.88

List of Papers Published in Conference Proceedings, Popular Journals :

Title of the Paper	List of Authors	Journal Details	Month & Year	Volume	Status	DOI No	Imp Fact
Not Available							

List of Patents filed/ to be filed :

Patent Title	Authors	Patent Type	Country/Agency Name	Patent Status	Application nt No.
Not Available					

Equipment Details :

Equipment Name	Cost (INR)	Procured	Make & Model	Utilization %	Amount Spent (INR)	Date of Procuremen
Power Stabilizer or UPS	56,755	Yes	Quanta	99	56,700	08 Oct, 202
Electrochemical Work Station	9,57,850	Yes	Metrohm AUTOLAB204	90	8,40,000	18 Oct, 201

Plans for utilizing the equipment facilities in future:

Not Available