| 2015 IGEM Special Allocation Grant Proposal<br>Cover Sheet | |
|---|---|
| Proposal Number:<br>(Assigned by Board Office) | Amount Requested:$35,028.75 |
| Name of Institution: Boise State University | Name of Industry Partner: INOVUS |
| Name of Institution Contact: Claire Xiong | Name of Industry Contact: David Gonzalez |
| Phone Number: 208-426-5671<br>E-mail Address:clairexiong@boisestate.edu | Phone Number: 208-639-9417<br>E-mail Address: dgonzalez@inovussolar.com |
| Title of Proposed Project: Statewide Collaboration to Develop Energy Storage Technology for Extreme Environments | |

Project Description:

***Idaho Public Institution**: Boise State University*
***Project Title**: Statewide Collaboration to Develop Energy Storage Technology for Extreme Environments*
***Industry Partner Supported:** INOVUS*
***Requested IGEM Grant Amount:** $35,028.75*

***1. Objectives and Potential to Increase Competitiveness in Idaho.*** This proposal will support collaborations between Boise State University (BSU), the Center for Advanced Energy Studies (CAES), University of Idaho (UI), Idaho National Laboratory (INL) and a number of collaborators in and outside the state of Idaho. The objective of this proposal is to enhance critical capabilities among CAES partners for energy applications subjected to extreme environments. Extreme environments such as temperature extremes, atmospheric moisture and contaminants represent a fundamental roadblock to a variety of critical infrastructure energy applications including energy storage. In fact, temperature extremes arguably offer the most significant technical challenge for the development and deployment of robust battery systems for year-round reliable and economic performance. The focus of this proposal is to conduct R&D on novel battery materials and sensors for extreme environments, provide education and training to next generation scientists and engineers, support Idaho universities, INL and industry partners, as well as support the growing research needs among CAES partners. This work addresses the core scientific question of whether we can alter and optimize structures and interfaces of battery materials to enhance ion transport and charge transfer kinetics at extreme temperature and radiation fields and hence mitigate several hindrances to deployment of electric vehicle, portable and grid battery systems at northern latitudes and in other applications (space) that have similar constraints. Through a partnership involving BSU, INL, CAES, and UI, this work will identify suitable battery materials for low-temperature operation and for high radiation fields, and will enable BSU and our CAES partners to capture a national, leading role in the science, development of performance testing of energy storage materials in extreme environments.

2. ***Potential to Enhance the Economic Growth of the State.*** To ensure accurate and sound analysis of battery materials for extreme environments, environmental chambers and a corresponding electrochemical testing station are requested to support the proposed work. The need for precise temperature control capabilities among CAES partners for a variety of new energy research programs has grown substantially. Establishing improved capabilities for handling materials under extreme environments will aid a large number of existing research projects funded by DOE, NRC, NSF, BEA, NASA and industry, and will make possible the submission of new projects currently under development. In addition, this testing capability will be accessible to other industry, university, and national laboratory partners for new program and product development. As the CAES research capability coordinator for

energy storage, the PI has extensive collaborations with CAES partners from INL, UI and University of Wyoming (new addition to CAES) through an existing project funded by NSF. In addition, the PI is currently working with CAES partners from UI and INL on a NASA EPSCoR proposal (selected to address material and device issues for space power generation and storage). The proposed new capability will expedite these projects and the success of the projects will ensure the leadership and competitiveness of BSU/CAES in materials development for extreme environments as well as enhance the economic growth of the State. While the capability will be initially applied to energy storage materials, the capabilities will also have great value to local industries, made available through the CAES industrial portal, as well as other CAES related research including sensor development and monitoring of the nation's spent nuclear fuel.

***3. Technical Relevance Specific to Industrial Partner.*** The local private sector has already shown considerable interest in the topic of battery diagnostic and prognostic (the PI was contacted by Inovus since 2013), and we expect that this interest will persist if not increase in coming years in the attempt to deploy battery energy storage throughout more of the US. Success in this area will have a fundamental transformative impact on the battery industry in terms of improving product performance and expanding the marketplace. It is expected that in addition to the specific industrial benefits and market opportunities addressed in this project, the testing system will enable the generation of many new research projects at BSU and among its CAES partners, and will be a capability made available to local industry through the recently established CAES industry portal system.

***4. Alignment with the Statewide Higher Education Research Strategic Plan.*** This proposal aligns with the statewide higher education research strategic plan by providing high quality education and training to undergraduate and graduate students in the PI's lab, providing access to undergraduate and graduate students from partner Idaho institutions. In addition, through the creative R&D activities in this project, our researchers and students will create knowledge and fundamental understanding of the battery science and technology and transfer the knowledge to provide societal, economic, and cultural benefit through peer-reviewed publications, transferring the technology, and outreach activities.

***5. Future Plans:*** Through this IGEM Special Allocation grant, BSU will establish a unique battery material testing capability for extreme environments. Specifically, the system will be used to measure the electrochemical properties of novel nanostructured battery materials developed by BSU and INL. Because the scientific knowledge behind low temperature and high radiation performance of batteries and the interaction between electrode and electrolyte is largely unknown, such work would be of interest for the DOE Office of Science, Basic Energy Science, and NSF *Energy for Sustainability* program. DOE-EERE/VTP, DOE-OE, DOE-ARPA-E, NASA's Game Changing Development and SBIR/STTR programs, and private sector companies could provide potential funding support for facilitating and accelerating the transfer of technology out of our research lab. Funding opportunities will also be sought within DoD sectors, since resolving low temperature battery performance issues would enable soldiers to carry less battery weight in the field during winter conditions.

| Project Start Date: 3/1/15 | Project End Date:6/30/15 |
|---|---|
| Total Project Budget: $35,028.75 | Annual Project Budget (Fiscal Year): $35,028.75 |
| Authorized Organization Representative Signatures | Date |
| Institution: | Matt G. Smith |
| Partner: Not Required | |

## Project Budget

A. Personnel Cost (Faculty, Staff, Visiting Professors, Post-Doctoral Associates, Graduate/Undergraduate Students, Other)

| Name/Title | Salary/Rate of Pay | Fringe | $ Amount Requested |
|---|---|---|---|
| | | | |
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| | | | |
| | | | |
| | | | |
| % of Budget | | Subtotal | |

B. Equipment (List each item with a cost in excess of $1,000. Lump small items together)

| Item/description | $ Amount Requested |
|---|---|
| Environmental Chambers (BTU-133, BTZ-133) | 15,615 |
| Electrochemical Workstation | 19,413.75 |
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C. Operating Expenses (Including but not limited to materials and supplies, consultant services, subcontracts, etc.)

| Item/description | $ Amount Requested |
|---|---|
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D. Other Costs

| Item/description | $ Amount Requested |
|---|---|
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| | |
| E. Total Costs | |
| F. Total Amount Requested | |

## Institutional and Other Sector Support

A. Institutional/Other Sector Dollars

| Source/Description | Amount |
|---|---|
| | |
| | |

B. Faculty/Staff Positions (Description)

Claire Xiong – Assistant Professor, Material Science and Technology

| C. Capital Equipment (Description) |
| --- |
| Environmental Chambers: ESPEC's Criterion benchtop chambers offer extended temperature ranges, making testing at extreme conditions possible without buying a larger, stand-alone chamber. Units are available that go as cold as -70°C. The Criterion series can cycle temperatures at rates up to 5°C/minute without requiring liquid nitrogen. Significant test time can be saved, as well as creating added thermal stress on the samples. The Criterion platform has been re-engineered from the ground-up to be consistent, reliable, and easy to maintain. ESPEC stands behind the chambers with a comprehensive one-year parts and on-site labor warranty.<br><br>Electrochemical Workstation: BioLogic's SP-300 is a state-of-the-art modular research grade potentiostat / galvanostat / FRA with remarkable specifications. The SP-300 chassis offers two slots. The first one is used by a potentiostat. The second one remains available for an option such as an additional potentiostat board (either standard or EIS) to reach a bipotentiostat configuration. It is also a multiple user system as the two channel boards can be used independently by two different users. A booster kit can also be selected in the range of four internal boosters (1, 2, 4, 10 A) and plugged in the second slot. The base specifications include floating mode, analog filtering, built-in calibration board, and stability bandwidths. ES capability can be added as an option. The built-in FRA has a frequency range of 10 µHz up to 7 MHz. This instrument is supplied with EC-Lab® software package providing a wide range of techniques and applications. |
| |
| D. Facilities & Instrumentation (Description) |
| |
| |

**Bio-Logic USA, LLC**
9050 Executive Park Drive
Financial Plaza
Suite 105C
Knoxville, TN 37923
Telephone: 865-769-3800 Fax: 865-769-3801
Web: www.bio-logic.us

# QUOTATION

**Hui (Claire) Xiong**
**Boise State University**
**Department of Materials Science and Engineering,**
**MEC 403D,**
**1910 University Drive**
**Boise State University**
**Boise, ID 83725**
**Tel.: (208) 426-5671**
**Email: clairexiong@boisestate.edu**

Date: 2/10/2015
Quote No.: **024136UIDAF**
Inquiry No.:
Valid Until: Monday, May 11, 2015
Terms: Net 30 Days
F.O.B.: Knoxville, TN PP & Add
Delivery: 30 Days ARO

| Item | Qty | Description | See Note | List Price | Unit Price* | Extended Price |
|---|---|---|---|---|---|---|
| | | **SP-200 w/ EIS** | | | | |
| 1 | 1 | Model SP200-CHAS. SP-200 chassis - (1 channel max) - NO channel - including calibration board & EC-Lab software package | | $6,455.00 | $6,003.15 | $6,003.15 |
| 2 | 1 | Model SP200/Z-01. Potentiostat/galvanostat board with EIS(/Z) option (without cell cable) - uses one slot - +/- 12V +/-500mA | | $5,595.00 | $5,203.35 | $5,203.35 |
| 3 | 1 | Model SP200-CBL. Standard cell cable with electrometer for SP200/240 potentiostat board (1.75 m) | | $835.00 | $776.55 | $776.55 |
| | | **Total Extended Price:**<br>***Note:** A discount has been applied to the Unit Price.* | | | | **$11,983.05** |
| | | **SP-240 w/ EIS (4 A booster included w/chassis)** | | | | |
| 1 | 1 | Model SP240-CHAS. SP-240 chassis including - 3V, +14V / 4A booster – (1 channel max) - NO channel - including calibration board & EC-Lab software package | | $11,475.00 | $10,671.75 | $10,671.75 |
| 2 | 1 | Model SP240/Z-01. Potentiostat/galvanostat board with EIS(/Z) option for SP-200/SP-240 (without cell cable) – uses one slot – +/-12 V +/-500 mA | | $5,595.00 | $5,203.35 | $5,203.35 |
| 3 | 1 | Model SP240-CBL. Standard cell cable with electrometer for SP-200/240 potentiostat board (1.75 m) | | $835.00 | $776.55 | $776.55 |
| | | **Total Extended Price:**<br>***Note:** A discount has been applied to the Unit Price.* | | | | **$16,651.65** |

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Knoxville, TN 37923
Telephone: 865-769-3800 Fax: 865-769-3801
Web: www.bio-logic.us

| Item | Qty | Description | See Note | List Price | Unit Price* | Extended Price |
|---|---|---|---|---|---|---|
| | | **SP-300 w/ EIS & non-EIS channels** | | | | |
| 1 | 1 | Model SP300-CHAS. SP-300 chassis — 2 slots (2 channel max) - NO channel - includes communication and calibration boards & EC-Lab Software Package | | $10,140.00 | $9,430.20 | $9,430.20 |
| 2 | 1 | Model SP300/Z-01. Potentiostat/galvanostat board with EIS(/Z) (without cell cable)- uses one slot - +/- 12V +/-500mA | | $5,595.00 | $5,203.35 | $5,203.35 |
| 3 | 1 | Model SP300-01. Potentiostat/galvanostat board (without cell cable) - uses one slot - +/- 12V +/-500mA | | $3,245.00 | $3,017.85 | $3,017.85 |
| 4 | 2 | Model SP300-CBL. Standard cell cable with electrometer for SP-300/VSP-300 potentiostat board (1.75 m) | | $835.00 | $776.55 | $1,553.10 |
| | | **Total Extended Price:**<br>***Note:** A discount has been applied to the Unit Price.* | | | | **$19,204.50** |
| | | **SP-300 w/ EIS & 10 A booster** | | | | |
| 1 | 1 | Model SP300-CHAS. SP-300 chassis — 2 slots (2 channel max) - NO channel - includes communication and calibration boards & EC-Lab Software Package | | $10,140.00 | $9,430.20 | $9,430.20 |
| 2 | 1 | Model SP300/Z-01. Potentiostat/galvanostat board with EIS(/Z) (without cell cable)- uses one slot - +/- 12V +/-500mA | | $5,595.00 | $5,203.35 | $5,203.35 |
| 3 | 1 | Model SP300-CBL. Standard cell cable with electrometer for SP-300/VSP-300 potentiostat board (1.75 m) | | $835.00 | $776.55 | $776.55 |
| 4 | 1 | Model SP300/10A-01. [0,+5]V/10A Booster board for SP-300/VSP-300/VMP-300 (including connection cable and 1.5 m cell cable) - uses one slot | | $4,305.00 | $4,003.65 | $4,003.65 |
| | | **Total Extended Price:**<br>***Note:** A discount has been applied to the Unit Price.* | | | | **$19,413.75** |

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Web: www.bio-logic.us

**Authorized by:** *Arnold Forman*

Arnold Forman, Ph.D.
Phone: 805-637-1439
e-mail: arnold.forman@bio-logic.us

Federal Identification Number: 26-0530341
Remittance: Bio-logic USA, LLC; P.O. Box 30009; Knoxville, TN 37930

New sales are subject to credit approval. Prices are for USA domestic use. This quote, and any subsequent order, is subject to applicable Bio-logic USA, LLC terms and conditions. If required, sales tax will be invoiced and collected by Bio-Logic USA, LLC. Unless specifically quoted otherwise, "Best Way" shipping charges will be added to inoices for any products shipped by Bio-Logic USA, LLC. Bio-logic USA, LLC products are manufactured and distributed by Bio-logic SAS, Claix. Any purchase order or contract for sale generated from Bio-logic USA, LLC's quotation for the export of goods, technology or services is subject to the Export Control Laws and Regulations of the United States. As a result, the export of such goods, and consequent re-export of such goods, may require an export license prior to shipment.

All past due invoices will be charged 1.5% of the amount past due, per month, or the maximum allowed by law.

ESPEC NORTH AMERICA, INC.
4141 Central Parkway, Hudsonville, MI 49426
877-GO-ESPEC • 616-896-6100 • fax 616-896-6150
www.espec.com

# Quotation

| | | | |
|---|---|---|---|
| **SALES REP #:** | RSC | **DATE** | **SHIPPING TERMS** |
| **QUOTATION #:** | ***BM020915-08*** | Feb. 10, 15 | FCA Origin, Hudsonville, MI |
| **REVISION #:** | ***2*** | **OFFER VALIDITY** | **TERMS** |
| | | 30 Days | Determined with credit approval |

Claire Xiong *(208)426-5671 clairexiong@boisestate.edu*
**Boise State University**

Boise, ID 83716

ESPEC is pleased to submit the following proposal for your consideration.

**Quick Ship** *chambers ship within two business days if no options are required, one week for Canada or Mexico. Shipment will be within two weeks for added options (except as listed) or if credit approval is needed.*

## BTU-133 1.5 CU. FT. BENCHTOP TEMPERATURE CHAMBER

Price..... **$7,220.00**

### GENERAL SPECIFICATIONS

| | |
|---|---|
| Temperature range: | -20°C to 180°C (±0.5°C fluctuation at control sensor after stabilization) |
| Temperature cycling rate: | 2°C/min heat & 1.6°C/min cool (empty chamber, per IEC 60068 3-5, at supply sensor. *Actual change rate depends on testing range and test sample load.*) |
| Interior volume: | 1.5 cubic feet |
| Interior dimensions: | 19.6" x 11" x 12" (W x D x H) |
| Exterior dimensions: | 29" x 33.5" x 33" (W x D x H) |
| Power supply source: | 115V 1Ø 60Hz 16A full load (NEMA 5-20 plug) |
| Heat to room: | 3,600 BTU/hr (steady room temp., 18 to 27°C, for assured performance) |

## BTZ-175 1.5 CU. FT. BENCHTOP TEMPERATURE CHAMBER

Price (units available for **Quick Ship**) ..... **$9,290.00**
**Requested options:**

Temperature control sensor output (type T thermocouple)..... **$350.00**

Adjustable wire shelf for 1.5 cu. ft. models (capacity 15 lbs. per shelf, 45 lbs. total)..... **$120.00**

Additional cable port, 2" diameter, with flexible silicone plug (location selector) ..... **$170.00**

**Subtotal BTU-133 and BTZ-175 with requested options ..... $17,150.00**

Discount for purchase of 2 chambers..... **(-$515.00)**

**Total BTU-133 and BTZ-175 with requested options and discount..... $16,635.00**

Qty. 2 Standard LTL freight via special commodities carrier..... **$1,050.00**
— Liftgate delivery adds $375

### GENERAL SPECIFICATIONS

| | |
|---|---|
| Temperature range: | -70°C to 180°C (±0.5°C fluctuation at control sensor after stabilization) |
| Temperature cycling rate: | 5°C/min (empty chamber, per IEC 60068 3-5, at supply sensor. *Actual change rate depends on testing range and test sample load.*) |
| Interior volume: | 1.5 cubic feet |
| Interior dimensions: | 19.6" x 11" x 12" (W x D x H) |

| | |
|---|---|
| Exterior dimensions: | 30" x 33.5" x 34" (W x D x H) |
| Power supply source: | 208/230V 1Ø 60Hz 12A full-load (NEMA 6-20 plug) |
| | Please specify if 230V is needed when ordering |
| Heat to room: | 9,000 BTU/hr (steady room temp., 18 to 27°C, for assured performance) |

## STANDARD FEATURES

### CHAMBER DESIGN FEATURES:

- High performance and quiet operation (65 dBA)
- Space-saving footprint, designed for flush installation to wall
- Stainless steel exterior and durable thermoformed plastic door
- Full thermal break around doorframe
- One 2" diameter cable port on left, with flexible silicone plug
- Three levels of overheat protection, plus overcool protection
- Detachable eight-foot power cord with plug

### WATLOW F4 PROGRAMMER/CONTROLLER

- Popular PID controller for test chambers
- Stores 40 different profiles (total 256 steps)
- Step types include: ramp, soak, jump, auto-start, and end
- RS-232C Modbus interface (free standard 'configurator' software via download, Windows XP compatible only)

*Not for use with specimens which are explosive or inflammable, or which contain such substances. To do so could be hazardous, as this may lead to fire or explosion. Depending on your test operation, periodic manual defrosting maybe required; does not apply to humidity mode.*

## OPTIONS for Two Day Quick Ship

Heated window with light (Two Day Quick Ship availability as listed above by model) ... **$1,520.00**

Factory calibration certificate ..... **$150.00**

—Calibration by NIST traceable instruments is standard, this option is for written document for buyer

Extended warranty to two years parts & labor..... **10% of system price including options**

## OPTIONS for Standard Quick Ship

External paperless recorder with Ethernet access and USB storage (6-channel) ..... **$4,370.00**

Computer interface RS-485 in lieu of standard RS-232 ..... **n/c**

Ethernet Interface for RS-232 (compatible with Watlow software)..... **$610.00**

Emergency stop, red mushroom button type ..... **$260.00**

Additional cable port, 2" diameter, with flexible silicone plug (location selector) ..... **$170.00**

Cable port, 4" diameter, with flexible silicone plug (location selector) ..... **$400.00**

Cable port, 6" diameter, with flexible silicone plug (location selector) ..... **$580.00**

Mobile cart with cabinet door and built-in shelf (Additional freight charges may apply)... **$1,680.00**

Printed & bound manual set (in addition to standard CD-ROM version) ..... **$120.00**

## OPTIONS for Built-to-Order

Dry air purge for minimizing risk of condensation during cycling (wall mount) ..... **$2,050.00**
—Requires 8 CFM compressed air at 80-100 PSI and 115V
—*Lead-time may extend three weeks*

$LN_2$ injection boosts cooling for faster pull downs ..... **$1,870.00**
—Requires 30-35 psig liquid nitrogen supply and appropriate ventilation/exhaust
— *Lead-time may extend two weeks*

## START-UP

Start-up and training for one unit ..... **$2,500.00**
Start-up, training, and instrument calibration for one unit ..... **$2,800.00**

- Start-up of the system by a qualified service technician
- Completion of diagnostic and performance verification to assure proper operation
- One training session for up to three people on the operation and maintenance of the system
- Calibration, if selected, includes NIST traceable certificate.
- Specific and/or additional acceptance tests/procedures required by the buyer may be at additional cost.
- Customer is responsible for installing the unit, including: facility modifications, rigging/move-in, uncrating/pallet removal, placement of unit, and utility connections. Start-up will be scheduled when unit installation is confirmed by the buyer.

## TERMS AND CONDITIONS

- **One year parts and labor warranty is included**. Labor warranty is valid for continental U.S. and parts of Canada, including southern Ontario & Quebec, and greater Vancouver. *Warranty coverage includes window, refrigerant, and express shipment.*
- Shipment for the above equipment is currently **11-13 weeks** after mutually agreed terms and conditions of your order. Some options, as noted, may require additional time.
- **Quick Ship units** will ship two days after the receipt of your order and mutual agreement of terms and conditions. Shipments to Canada or Mexico will be within one week. Shipment will be within two weeks if added options are required (except window, as indicated, and calibration certificate). Must be an existing customer or have pre-approved credit to ensure two day shipment. Check current availability before ordering at **espec.com/quick** or with your salesperson.
- Shipment must be via an air-ride special commodities carrier. Please identify your shipping carrier's name, phone number and your account number. If you do not have an appropriate freight carrier, we can provide you with a quotation from one of our authorized carriers.
- This quotation is valid only for final destinations within North America unless otherwise noted. Inquire regarding exporting of ESPEC products.
- Usual payment terms are Net 30 days, with approved credit. Progressive payments for orders over $50,000 are: 20% down, 70% with shipment, and 10% with acceptance (within 30 days of shipment). Cancellations are subject to a fee, and invoices beyond terms may accrue interest of 1.5% per month. Surcharge will be incurred for payment by Credit Card (MC/Visa/DC/Amex), not to exceed our cost of acceptance. Other terms need to be agreed upon by ESPEC.
- Prices are in U.S. dollars and are exclusive of all federal, state, and local taxes, licenses, permits, inspections, compliance, or other fees unless specifically noted. The customer is responsible for connecting utilities and obtaining approval from the appropriate authorities to satisfy any and all code requirements.

# Quotation

Thank you for your interest in ESPEC Benchtop test chambers. We look forward to serving you.

Sincerely,

Brian McDuffee
Product Specialist

Please contact your local sales rep or sales manager listed below with any questions or requests.

**Local Sales Representative:**
Randy Bloom, 503-528-8378,
randy@W5engineering.com

**Regional Sales Manager:**
Yoshi Saito, 408-592-4059, ysaito@espec.com