Opportunity Title: High Energy Density and Safe Electrochemical Energy Storage Devices
Opportunity Reference Code: ARL-R-SEDD-1521053651

Organization DEVCOM Army Research Laboratory

Reference Code ARL-R-SEDD-1521053651

Description **About the Research**

To further increase the energy density of the state-of-the-art (SOA) lithium-ion (Li-ion) batteries, advanced Li-ion batteries are under active development. These batteries employ higher voltage/higher capacity lithium transition metal oxide materials than those of the SOA as cathodes, and higher capacity silicon (Si) based materials than that of graphite as anodes.

Despite significant progress, challenges remain. On the cathode side, structural instability at high voltage of the cathode itself, and high electrochemical reactivity with electrolyte shortens cycle life and reduces safety. On the anode side, large volume change of Si and lack of functional and stable solid electrolyte interphases on Si during lithiation (alloying) and de-lithiation (de-alloying) reactions for the protection of Si also shortens cycle life and reduces safety.

Research and development opportunities include: (1) exploring changes in the stability of electrode materials with the change of compositions, and their reaction with electrolyte during charge and discharge reactions; (2) developing strategies for modifying the electrode materials' compositions, structures, or morphologies, thus enabling the stable cycling of the electrode materials; and (3) identifying compatible and nonflammable electrolytes that enable the effective protection of both electrodes and facile redox reactions without undesirable reactions.

References

D. Liu, W. Zhu, C. Kim, M. Cho, A. Guerfi, S. A. Delp, J. L. Allen, T. R. Jow and K. Zaghib, J. Power Sources, 2018, 388, 52-56.
J. G. Lapping, S. A. Delp, J. L. Allen, J. L. Allen, J.W. Freeland, M.D. Johannes, L. Hu, T. R. Jow, J. Cabana, Chem. Mater. 2018, 30, 1898-1906.
T. R. Jow, S. A. Delp, J. L. Allen, J.-P. Jones, M. C. Smart, J. Electrochem. Soc. 2018, 165(2), A361-A367.
S. A. Delp, O. Borodin, M. Olguin, C. G. Eisner, J. L. Allen, T. R. Jow, Electrochimica Acta, 2016, 209, 498-510.

Keywords: Lithium-ion batteries; silicon anode; high voltage high capacity cathodes; electrolytes; solid-electrolyte interfaces (interphases)

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About SEDD

The Sensors and Electron Devices Directorate (SEDD) is the Army's principal center for research and development in the exploration and exploitation of the electromagnetic spectrum, which includes radio frequency, microwave, millimeter-wave, infrared (IR), visible, and audio

regions. SEDD is responsible for advances in laser sources, RF sources, IR sensors, signature detection and decoding, target imaging and its interpretation, fusion of data derived from several sensors, and electromagnetic protection.

In addition, SEDD is responsible for improving the technology base for electron devices and materials related to sensors and power devices. Research is conducted in related aspects of physics, electrical engineering, computer science, solid-state physics, chemical engineering, material sciences, and electrochemistry.

About ARL-RAP

The Army Research Laboratory Research Associateship Program (ARL-RAP) is designed to significantly increase the involvement of creative and highly trained scientists and engineers from academia and industry in scientific and technical areas of interest and relevance to the Army. Scientists and Engineers at the CCDC Army Research Laboratory (ARL) help shape and execute the Army's program for meeting the challenge of developing technologies that will support Army forces in meeting future operational needs by pursuing scientific research and technological developments in diverse fields such as: applied mathematics, atmospheric characterization, simulation and human modeling, digital/optical signal processing, nanotechnology, material science and technology, multifunctional technology, combustion processes, propulsion and flight physics, communication and networking, and computational and information sciences.

A complete application includes:

- **Curriculum Vitae or Resume**
- **Three References Forms**
  - An email with a link to the reference form will be available in Zintellect to the applicant upon completion of the on-line application. Please send this email to persons you have selected to complete a reference.
  - References should be from persons familiar with your educational and professional qualifications (include your thesis or dissertation advisor, if applicable)
- **Transcripts**
  - Transcript verifying receipt of degree must be submitted with the application. Student/unofficial copy is acceptable

If selected by an advisor the participant will also be required to write a **research proposal** to submit to the ARL-RAP review panel for :

- Research topic should relate to a specific opportunity at ARL (see Research Areas)
- The objective of the research topic should be clear and have a defined outcome
- Explain the direction you plan to pursue
- Include expected period for completing the study

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- Include a brief background such as preparation and motivation for the research
- References of published efforts may be used to improve the proposal

A link to upload the proposal will be provided to the applicant once the advisor has made their selection.

Questions about this opportunity? Please email ARLFellowship@orau.org

Eligibility Requirements

- **Degree:** Bachelor's Degree, Master's Degree, or Doctoral Degree.
- **Academic Level(s):** Any academic level.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Engineering** (4 👁)
- **Age:** Must be 18 years of age