Center for Autonomous Solar Power  
(CASP)  
Charles R. Westgate, Director, ECE  
Alok Rastogi, Associate Director, ECE  
Tara Dhakal, Research Assistant Professor  

Binghamton Faculty Associated with Center  
Wayne Jones, Chemistry  
David Klotzkin, ECE  
Timothy Singler, ME  

Binghamton Graduate Students Associated with Center  
Siva Pramod Adusumilli (PhD 2014)  
Vadim Bromberg (PhD 2014)  
Amin Emrani (PhD 2017)  
Abhishek Nandur (PhD 2014)  
Pravakar Rajbhandari (P)  
Navjot K. Sidhu (PhD 2015)
I. Center Description:

a. Describe Center structure, interest areas and functions:

Structure:
The center presently has the following structure:
Areas of Research:
1. Flexible, low cost solar cells suitable for fabrication on a roll-to-roll (CAMM)
2. Integrated energy storage: thin film ultracapacitors with high energy densities
3. Antireflective coatings for solar cells

Functions:
1. Research and Development
2. Industry collaboration and support

b. Describe how the center encourages cross-disciplinary research:

CASP has accessible deposition and characterization facilities used by faculty and graduate students in several science and engineering departments. These facilities support efforts in the IEEC and CAMM as well.

c. What are the goals of the center?

1. To develop essential process technologies and manufacturing know-how for flexible solar cells
2. Develop cell level modeling and simulation
3. Help support test facilities for small solar industries by working with CeCeT, a new consortium working in Intertek
4. Develop standardized accelerated tests
5. Establish basic understanding for life-time performance degradation

d. Identify focus of Center: research, economic development, community service:

Economic Development: CASP is collaborating with Primet Precision Materials, Custom Electronics, ETM Solar Works, Unique Technical Solutions, Charge CCCV, ADI

e. Describe centers accomplishments and how the center brings visibility to the University

1. CASP assists faculty in their research programs and interacts closely with industries
2. Publications and presentations at technical conferences and at Greater Binghamton events
3. Web page

II. Source of Support:

a. Describe the critical role (if any) that the existence of the center played in the development of each research proposal and grant award submitted through the Center.

Center faculty are active in submitting collaborative proposals for funding to DOD, NSF, and DOE.
Phase 1 and Phase 2 proposals to DARPA and ONR; Phase 1 and II of NYSERDA proposal with INTERTEK. Proposal through TSEC for education and training in collaboration with SUNY Orange (funded). CASP is leading a DOE proposal for integrating high penetration solar energy systems and another DOE proposal for new window layers for thin film solar cells. CASP is used heavily in a funded CAMM project with Corning

b. Identify other funds used to support the development proposals, conference, seminars and other activities of the Center.

NSF PFI - Alok Rastogi, PI
NSF REU – Wayne Jones, PI; Charles R. Westgate co-PI

III. New Budget Request and Justification:

a. Justify the use of current funds:
   No funds were allocated

b. How is the Center reducing reliance on internal support?
   Center is self funded by external grants.

c. What does the Center cause to happen that would not happen without a center Designation?
   CASP provides an environment to support collaboration, sharing facilities, and pursuing research funding

IV. Future Directions

a. Summarize briefly the long-range plans and directions of the Center:

The center research staff are currently working on a new thin film solar cell using non-toxic and earth abundant materials. The center has been successful in developing processes for a transparent conductor, the n-type layer, and all three candidates for the p-type materials.

Cell fabrication and testing is underway. Beginning with Phase 2, research in thin film ultracapacitors has begun. Ultracapacitors will be integrated with the solar cells to form autonomous solar energy systems. Center staff are also working on reliability of solar systems.

The goals are to conduct research that will lead to new, low cost solar cells that can successfully compete with conventional photovoltaic devices and that can lead to much higher energy storage densities for ultracapacitors as replacements for batteries.

Smaller efforts are directed to a new thermoelectric material and organic thin film solar cells.
V. Center Productivity over Past 12 Months [not included in three page limit]

In addition to publications and presentation, the center has transferred the transparent conducting layer to CAMM while CASP refines deposition of other layers and complete cell fabrication and focuses on energy storage.

(A list of publications and presentations through December 31, 2014 follows)

**CASP 2014 Publications**

Cui, Weili; Wayne Jones, David Klotzkin, Greta Myers, Shawn Wagoner, Bruce White, “Realization of a Comprehensive Multidisciplinary Microfabrication Education Program at Binghamton University” IEEE-Transactions on Education, 2014, 99, 1-5. (Also credited to IEEC and ADL).


Emrani, Amin, Tara Dhakal and Charles R. Westgate, “CZTS solar cells fabricated by fast sulfurization of sputtered Sn/Zn/Cu precursors under H$_2$S atmosphere”, 40th IEEE PVSC conference proceedings, June 8-13, 2014, Denver, Co


Liu Jian, Ph.D. ABD; Siva P Adusumilli, Ph.D. Candidate; John J Condoluci, Bachelor; Alok C Rastogi, Ph.D.; William E Bernier, Ph.D.; Wayne E Jones, Jr., “Effects of H2 Annealing on
Polycrystalline Copper Substrates for Graphene Growth during Low Pressure Chemical Vapor” Deposition
Carbon, 2015, under revision. (Also credited to IEEC and ADL)


Skorenko, Kenneth, Austin Faucette, Nicholas Ravvin, William Bernier, Jeffrey Mativetsky, Wayne E. Jones, Jr., “Vapor Phase Polymerization and Mechanical Testing of Highly Conducting Poly(3,4-ethylenedioxythiophen) for Flexible Devices Applied Materials and Interfaces, 2015 submitted. (Also credited to IEEC and ADL)


Presentations
Adusumilli, Siva P., Jeremiah M Dederick, Tara Dhakal, In Tae Bae, Sean M Garner, Patrick Cimo, Alok C Rastogi, Anju Sharma, and Charles Westgate, “Iron pyrite thin films grown through a one-step sulfur annealing of iron oxide using TBDS and H$_2$S on rigid and flexible glass substrates”, MRS Fall Meeting, November 30-December 5, 2014, Boston, MA


Dhakal, Tara P., Pravakar P. Ragbhhandari, Reid R. Tobias, Michael Hatzistergos, Harry Efstathiadis, Neville Sun, and Richard Sun, Development and characterization of copper zinc tinsulfide (CZTS) thin films for solar cells applications, MRS Fall Meeting, November 30-December 5, 2014, Boston, MA


Jones, Wayne E., Jr., “Capturing the Power of the Sun: Molecular Wires and Devices for Photovoltaics and Environmental Sensors,” New York ACS Local Section keynote address, St. Joseph’s College, Brooklyn, NY 2015. (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Fabrication of TiO2 Electrospun Nanofibers for Photodegradation of Toxins, ACS National Meeting, Dallas, TX, 2014. (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Implementation of a Multidisciplinary Introduction to Microfabrication”, ACS National Meeting, Dallas, TX, 2014. (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Inorganic/organic Hybrid Structures for Photovoltaics: Low cost Roll-to-Roll Processing of Solar Cells.” New York ACS Local Section, Queens, NY 2014. (Also credited to IEEC and ADL)


Tobias, R. Reid, Tara P. Dhakal, Pravakar P Rahbhandari, Charles R. Westgate, and Peter Borgesen, “Electronic loss mechanisms of Cu₂ZnSnS₄ (CZTS) thin film solar cells: perspective from I-V and QE measurements coupled with 1-dimensional hetero-structure simulations”, MRS Fall Meeting, November 30-December 5, 2014, Boston, MA


**Symposia, Invited Lectures, Meetings, Short Courses**

Jones, Wayne E., Jr., “Fluorescent Conjugated Polymer Chemosensors for Environmental Monitoring,” Queensborough Community College, Queens, NY 2014 (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Fluorescent Conjugated Polymer Chemosensors for Environmental Monitoring,” SUNY Old Westbury, NY, 2014 (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Charting Your Chemistry Career Pathway”, Ithaca College, Ithaca, NY 2014. (Also credited to IEEC and ADL)
“Capturing the Power of the Sun: Molecular Wires and Devices for Photovoltaics and Environmental Sensors,” Ithaca College, Ithaca, NY 2014 (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Capturing the Power of the Sun: Molecular Wires and Devices for Photovoltaics and Environmental Sensors,” Sage College, Troy, NY 2014. (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Capturing the Power of the Sun: Molecular Wires and Devices for Photovoltaics and Environmental Sensors,” Elmira College, Elmira, NY 2014. (Also credited to IEEC and ADL)

Jones, Wayne E., Jr., “Nanofibrous Materials for Photocatalytic Degradation of Chemical Warfare Agents,” Northwestern University, Evanston, IL, 2014. (Also credited to IEEC and ADL)

**Poster Presentations**

Shim, Jong Hyun, J. Cho., “Nanostructured TiO$_2$ and ZnO Thin Films Prepared by Low Temperature Solution Processing Poster presentation at the 2014 Electronics Packaging Symposium, Binghamton, NY, October 8-9, 2014 (Also credited to ADL)

**Patents**


**IP disclosures:**
