2013 – 2014
Annual Report to the Alabama Commission on Higher Education

Alabama EPSCoR
NSF EPSCoR works to develop a stronger science and technology base, increase geographic distribution of research and technology resources, strengthen and expand education and training opportunities in science, engineering, mathematics, and technology, and increase opportunities for women and minorities.

DOE EPSCoR supports collaborative research programs of importance to state priorities, develops partnership programs with federal labs, supports young investigators, and links the State’s diverse and dispersed technological communities, institutions and industries involved in Energy Research and Development.

NASA EPSCoR seeks to effect a permanent increase in the national competitiveness of a jurisdiction’s basic programs in targeted aeronautics and space research areas: remote sensing for improved crop production, nanotechnology materials, and smart sensor arrays.

USDA EPSCoR works to increase the amount of agricultural research at academic institutions in the state through identification of critical issues facing agriculture today, stimulating the development of collaborative networks across the state and providing resources and funding.

The NIH Institutional Development Award (IDeA) program broadens the geographic distribution of NIH funding for biomedical research. Alabama is currently ineligible for IDeA funding.

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The Alabama Experimental Program to Stimulate Competitive Research (ALEPSCoR) program is dedicated to the advancement of economic development via scientific and engineering research through a collaborative effort among the State’s research universities. The focus of activities is designed to attract and retain distinguished scientists and researchers for Alabama; to develop new cutting-edge technologies and high-tech industry; and to stimulate state competitiveness in medicine, biotechnology, engineering, and other applied sciences.

ALEPSCoR was very successful in the last year, and secured more than $10.9M in new federal research funding during FY 2013. Federally funded research expenditures for the same period exceeded $17.9M. Awards were received from the federal EPSCoR programs of the National Science Foundation, U.S. Department of Energy, National Aeronautics and Space Administration and the U.S. Department of Agriculture. These awards range in duration from one to six years and employ numerous researchers, graduate students, and undergraduate students. In addition, large numbers of K-12 teachers and students are involved in ALEPSCoR K-12 outreach activities. A special emphasis is placed on outreach and collaborations with underrepresented groups to encourage involvement and knowledge in STEM (Science, Technology, Engineering and Mathematics) fields.

State support for the ALEPSCoR program included $342K for administration and $765K for the Graduate Research Scholars Program (GRSP). The GRSP has supported over 203 graduate students since 2006, leading to 39 Master’s degrees and 111 Ph.D. degrees. During the fall of 2014, 36 students were awarded GRSP funding in Round 9, 16 of these are new awardees. Seven are working toward a Master’s degree while twenty-nine are working toward a Ph.D. More information regarding the GRSP can be found in Volume 7 of the GRSP Booklet published December 2014.

The ALESPCoR program continues to be a valuable contributor to scientific and engineering infrastructure, research capabilities, education, and economic development across the state. We look forward to continued investment for a stronger, more prosperous Alabama. For more information, please log on to www.alepscor.org.

Respectfully,

Shaik Jeelani, Ph.D.      Christopher M. Lawson
Chair, Alabama EPSCoR Steering Committee   Executive Director, Alabama EPSCoR
Vice-President for Research & Sponsored Programs   Vice Chair, Coalition of EPSCoR States
Tuskegee University   Professor, Department of Physics
        University of Alabama at Birmingham
The Experimental Program to Stimulate Competitive Research (EPSCoR) was started by the National Science Foundation (NSF) in 1978 when Congress authorized the agency to create a new program in response to broad public concerns about the extent of geographical concentration of federal funding of research and development (R&D). Eligibility for EPSCoR participation is limited to those jurisdictions that have historically received lesser amounts of federal R&D funding and have demonstrated a commitment to develop their research bases and to improve the quality of science, technology and engineering research conducted at their universities and colleges.

The success of the NSF EPSCoR program during the 1980s subsequently prompted the creation of EPSCoR and EPSCoR-like programs that currently exist in four other federal agencies: the Department of Energy (DOE), the U.S. Department of Agriculture (USDA), the National Aeronautics and Space Administration (NASA), and the largest of all, the National Institutes of Health (NIH).

The mission of EPSCoR was originally designed to meet the NSF statutory function “to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education.” ALEPSCoR is currently eligible to participate in EPSCoR programs associated with NSF, DOE, NASA, and USDA. ALEPSCoR is currently ineligible for participation in the EPSCoR program associated with the NIH which is called IDeA or Institutional Development Award.

**EPSCoR GOALS**

- To provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness.
- To advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

**EPSCoR OBJECTIVES**

- To catalyze key research themes and related activities within and among EPSCoR jurisdictions that empower knowledge generation, dissemination and application.
- To activate effective jurisdictional and regional collaborations among academic, government and private sector stakeholders that advance scientific research, promote innovation and provide multiple societal benefits.
- To broaden participation in science and engineering by institutions, organizations and people within and among EPSCoR jurisdictions.
- To use EPSCoR for development, implementation and evaluation of future programmatic experiments that motivate positive change and progression.
**Activities sponsored by Alabama EPSCoR**

affect, in some manner, the economy of every county in Alabama and the lives of Alabama citizens in many ways including: education, health care, and employment.

To build, maintain, and grow Alabama EPSCoR is to build, maintain, and grow Alabama’s education future.

**ALEPSCoR** is a consortium of academic, government, and industrial organizations established in 1985. The core ALEPSCoR academic institutions in Alabama include the seven Ph.D. granting research universities: Alabama A&M University, Auburn University, University of Alabama, University of Alabama at Birmingham, University of Alabama in Huntsville, Tuskegee University, and the University of South Alabama. Other academic institutions participate in and benefit from program activities through satellite or outreach efforts and NSF Co-funding.

The primary goal of the consortium is to establish the infrastructure needed to increase sustained national science and technology research competitiveness. This goal is accomplished by:

1. Supporting research clusters based on current Alabama research strengths.
2. Carefully planning major equipment purchases that significantly increase state capabilities.
3. Facilitating the hire of new faculty and research personnel in targeted areas.
4. Broadening participation of students in research cluster-related science and engineering fields.
5. Linking these clusters with higher education, government agencies, and the private sector.
2013 and 2014 Notable Achievements

- GRSP funded 36 students in Round 9 with 14 new awardees starting August 2014
- Research expenditures in FY 2013 exceeded $17.9M
- FY 2013 new awards exceeded $10.9M
- Ongoing support for the NSF RII Track 1 project, entitled, Enhancing Alabama’s Research Capacity in Nano/Bio Science and Sensors
- Alabama received $9.7M in new NSF Co-funded awards in FY 2013
- Extension of Alabama DOE Implementation Grant graduate student support and Human Resource Development through a $294K award
- Two new USDA AFRI Strengthening awards totaling $750K in FY 2013, two new awards in early FY 2014 for $300K
- In FY 2013, Alabama NASA EPSCoR was awarded five NASA Seed Grant Awards. In early FY 2014 (October 1, 2013) Alabama NASA EPSCoR received a $750K Cooperative Agreement Notice (CAN) Award

ALEPSCoR Specific Goals

- Increase R&D funding in Alabama to the national level.
- Increase competitiveness of all research institutions in the state by measured publications, patents, research faculty, research equipment, etc.
- Increase minority and under-represented group participation.
- Develop industry-government-university partnerships to contribute to technology development and economic growth in Alabama.
- Increase effectiveness of EPSCoR programs.

ALEPSCoR Plan for Achieving Goals

- Develop a coordinated plan for research within the state and aid in the development of consistent plans for each agency.
- Provide guidance in conducting competitions, where possible.
- Select programs which have the greatest potential for achieving national competitiveness and determine the resources required to reach that potential.
- Use strengths and focus areas identified in the review and selection process.
- Function as a liaison with the Alabama Commission on Higher Education.
- Participate in EPSCoR Foundation and Coalition activities, as well as other groups that have impact on federal funding agencies.
The ALEPSCoR program is dedicated to the advancement of economic development via scientific and engineering research through a collaborative effort among the State’s research universities. The focus of activities is designed to attract and retain distinguished scientists and researchers for Alabama; to develop new cutting-edge technologies, companies and opportunities; and to stimulate state competitiveness in medicine, biotechnology, engineering, mathematics and other applied sciences.

ALEPSCoR seeks to increase Research and Development (R&D) competitiveness through the development and utilization of science and technology resources residing in Alabama’s major research universities. It strives to achieve its objectives by stimulating sustainable infrastructure improvements at the state and institutional levels that significantly increase the ability of ALEPSCoR researchers to compete for federal and private sector R&D funding, and accelerate the movement of ALEPSCoR researchers and institutions into the mainstream of federal and private sector R&D support.

As a member of the EPSCoR program, Alabama receives federal funds to stimulate nationally competitive research and to increase the ability of its scientists to compete successfully for research funds from NSF and other federal agencies. The ALEPSCoR consortium of academic, government, and industrial organizations supports projects that establish an infrastructure within the state capable of developing and sustaining high-quality science and engineering research and education that can potentially contribute to statewide national competitiveness.

Over the long term, ALEPSCoR is enhancing valuable resources that can influence Alabama’s research capacity in the 21st Century. Alabama depends on its colleges and universities to provide well educated workers that leading companies require if they are to compete in a knowledge-based global economy. A highly educated work force is the most critical factor in attracting and retaining the kind of leading companies that bring 21st century jobs to the state.

Increasing Alabama’s scientific and technology research competitiveness is critical for the long term economic health of the state. Specifically, ALEPSCoR makes a difference to Alabama through education, outreach, increased diversity, partnerships, infrastructure building, economic benefit/jobs, business opportunities, and a system that encourages graduation and self-sustainability.

During FY 2013, Alabama researchers were awarded in excess of $10.9 million in new awards. These were from the National Science Foundation Co-funding program, the Department of Energy, NASA and USDA. Research expenditures for FY 2013 exceeded $ 17.9 M as a result of the ongoing NSF RII Track 1 project, Enhancing Alabama’s Research Capacity in Nano-Bio Science and Sensors, that began in 2011; numerous ongoing NSF Co-funded projects, two DOE projects - the NEPCM Implementation grant and Dr. Pan’s Lab Partnership grant; several NASA Cooperative Agreement Notice awards; and multiple USDA AFRI Strengthening Grants.

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ALEPSCoR Improves Education

ALEPSCoR makes a difference through the state’s colleges and universities, their science and engineering faculty, and students. A primary focus of the team is preparing students for careers in engineering, materials sciences, biological sciences, physics, optics and lasers, energy, forestry, etc. Through mandates by NSF and other EPSCoR agencies, a portion of the agency investment goes to promote programs for K-12. Citizens of the state benefit by outreach efforts which includes basic community math programs, teacher education opportunities, and development of new science-based curricula. These efforts improve K-12 education without significant investments from the state.

ALEPSCoR Encourages Partnerships

ALEPSCoR cooperates with state leaders in government, higher education, and business to establish productive, long-term partnerships between universities, colleges, K-12 educational institutions, Alabama businesses, and other governmental agencies. These partnerships are designed to stimulate local action resulting in lasting improvements to the state’s academic research infrastructure and increased national research and development (R&D) competitiveness.

ALEPSCoR Enhances Infrastructure

Human infrastructure is enriched by opportunities to establish relationships with national laboratories, to use equipment and collaborate with federal researchers, and hiring new faculty in targeted research “growth” areas which enables Alabama to achieve “critical mass” in these high growth research areas. Equipment infrastructure is improved by targeted equipment purchases which enable Alabama researchers to perform research in new cutting-edge technologies.

ALEPSCoR Provides Economic Benefits & Jobs

External EPSCoR funded grants support new faculty hires which provide salary for new research assistant professors, post-doctoral research associates, graduate student stipends and tuition, as well as undergraduate student support. These external grant funds provide jobs for hundreds of people in the state, helping to stimulate the state’s economy. By establishing the research infrastructure in the state’s targeted areas, Alabama researchers become competitive in obtaining federal non-EPSCoR grant funding. New external grant funds provide an additional economic benefit to the state by providing support for faculty and graduate students.

ALEPSCoR Creates High Tech Business Opportunities

ALEPSCoR funded research leads to intellectual property that can serve as a catalyst for the creation of high technology companies in the State. ALEPSCoR funded research has led to numerous patents, licencing agreements, and small business start-ups. These new companies will provide additional long-term jobs for Alabama residents.
MANAGEMENT

Alabama EPSCoR Steering Committee

The ALEPSCoR Steering Committee (AESC) is responsible for fiscal and programmatic aspects of ALEPSCoR activities. Members include representatives from the seven research institutions, Alabama A&M, Auburn University, Tuskegee University, University of Alabama, University of Alabama at Birmingham, University of Alabama in Huntsville and University of South Alabama as well as the Alabama Commission on Higher Education.

In May 2013, Dr. Shaik Jeelani became Chair of the Alabama EPSCoR Steering Committee while Ms. Lynne Chronister became the Vice-Chair. Dr. Jeelani serves as the Vice President for Research and Sponsored Programs at Tuskegee University. Ms. Chronister is Vice President for Research at the University of South Alabama.

ALEPSCoR Executive Director

Dr. Christopher Lawson has served as ALEPSCoR Executive Director since 2010. He previously served as ALEPSCoR Associate Executive Director from 2007-2010 and ALEPSCoR Co-Director from 1999-2005. Dr. Lawson is a Professor of Physics at the University of Alabama at Birmingham, with a research specialty of optical sensing and nonlinear optics, and has published over 70 journal articles and 10 books or book chapters in these areas.

The Executive Director is the chief administrative officer of ALEPSCoR, and is appointed by the AESC. The ALEPSCoR Executive Director has overall responsibility and authority for the day-to-day operation, management and coordination of the ALEPSCoR program. He is responsible for constructing and administering a budget that best serves the needs of all federally funded EPSCoR programs and providing reports to the Alabama Commission for Higher Education, fiscal agent for state funds in support of EPSCoR. He also supervises and administers the state funded Graduate Research Scholars Program (GRSP). The ALEPSCoR State Agency Directors and GRSP Campus Coordinators report to the Executive Director.

Dr. Lawson also serves on the Board of Directors of the EPSCoR/IDEA Foundation/Coalition, which assumes a leadership role in coordinating national EPSCoR activities. In addition, in 2013 Dr. Lawson was elected by the EPSCoR Coalition Board of Directors to serve as Vice Chair of the Coalition. As part of those duties, in March of 2013 (as well as previously in March of 2012) at the request of the EPSCoR/IDea Foundation, Dr. Lawson testified in front of Congress in support of the NSF EPSCoR and NASA EPSCoR budget requests.
Agency Directors

The ALEPSCoR Agency Directors provide oversight responsibility for the day-to-day operations of federal EPSCoR research programs in Alabama, including responsibility for coordination, notification and supervision of all EPSCoR announcements and awards issued by the federal government.

The ALEPSCoR Agency Director is the administrative officer for a designated EPSCoR program in Alabama. He or she is appointed by the ALEPSCoR Steering Committee and is responsible for carrying out the administrative functions of the AESC, providing management, coordination and direction of the EPSCoR program in Alabama and for such other duties assigned by the Executive Director and AESC. ALEPSCoR currently has an EPSCoR Agency Director for NSF, DOE, NASA, and USDA.

Alabama NSF EPSCoR State Agency Director

Dr. Hosur is the Alabama NSF EPSCoR Agency Director as well as PI on the NSF-EPSCoR RII grant headquartered at Tuskegee University. He also leads the effort on the Nano and Biomaterials thrust. The thrust also consists of researchers at Auburn University, University of Alabama at Birmingham, the University of Alabama, and the University of South Alabama. Together, they study a broad spectrum of areas connected to materials research and engineering including nanotechnology, advanced biomaterials, carbon/epoxy composites, epoxy syntactic foams, and nanomaterials for drug delivery applications. The research has the potential to create a new generation of automobile, aircraft, spacecraft, locomotives and sporting goods materials. Further, the nanotechnology work could lead to new types of biosensors, drug delivery systems, and heat exchangers.

Dr. Hosur earned his B.E. in Civil Engineering, M. Tech in Aeronautical Engineering and Ph.D. in Aerospace Engineering from India. His is currently a Professor in Materials Science Engineering at Tuskegee University. For more information, contact Dr. Hosur at 334.724.4220 or hosur@myu.tuskegee.edu.

Alabama NASA EPSCoR State Agency Director

Dr. John Gregory has served as the Alabama Space Grant Director since 1991 and the NASA EPSCoR Director since the program was first funded in 1994. Dr. Gregory has had programs funded by NASA and the NSF in high energy astrophysics and in materials science in Space for 40 years, flying many instruments and experiments in Space on various platforms. He was one of Alabama’s first NSF EPSCoR PIs in the 1980s. He is currently Professor of Chemistry and Materials Science at the University of Alabama in Huntsville. For more information contact Dr. Gregory at 256.824.6028 or jcgregory@matschi.uah.edu.

Alabama DOE EPSCoR State Agency Director

John W. Steadman, P.E, serves as the Alabama Department of Energy (DOE) EPSCoR State Agency Director, the Dean of Engineering at the University of South Alabama, and is a licensed professional engineer. Dr. Steadman previously served as Associate Dean and Head of the Department of Electrical Engineering at the University of Wyoming. He earned his B.S. and M.S. degrees in electrical engineering from the University of Wyoming and the Ph.D. degree from Colorado State University. Dr. Steadman was a research engineer for General Dynamics, Convair Division in San Diego, California before joining the faculty at the University of Wyoming and served as a Distinguished Visiting Professor at the United States Air Force Academy.
Dr. Steadman has received several awards, including the IEEE United States Activities Board Citation of Honor, the NCEES Distinguished Service Award with Special Commendation, the Wyoming Engineering Society Outstanding Engineer Award, and the AT&T Foundation Award for Excellence in Teaching. Professor Steadman was appointed to the Board of Registration for Professional Engineers and Professional Land Surveyors in Wyoming by three different governors serving on that board for more than sixteen years. He has also been active in the National Council of Examiners for Engineering and Surveying (NCEES), serving on several of the national committees, as treasurer, and as the national president in 1993-94.

In addition to his engineering education responsibilities, Dr. Steadman was 2004 President of IEEE-USA, Past Chair of the Board of Governors of the Order of the Engineer, and participates in accreditation of engineering programs for ABET. Dr. Steadman is the author of more than 60 journal publications, book chapters and patents. He has been honored with election to Fellow grade in the National Society of Professional Engineers and the American Society for Engineering Education. For more information, contact Dr. Steadman at 251.460.6140 or jsteadman@southalabama.edu.

Alabama USDA EPSCoR State Agency Director

Dr. Frank F. (Skip) Bartol is the Alabama USDA EPSCoR State Agency Director, Alumni Professor of Reproductive Biology in the Department of Anatomy, Physiology and Pharmacology, Associate Dean for Research and Graduate Studies, and Interim Director of the Scott-Ritchey Research Center in the College of Veterinary Medicine at Auburn University (AU). Additionally, since its establishment in September, 2014, Dr. Bartol serves with Dr. Greg Barsh of the HudsonAlpha Institute for Biotechnology, as co-Director of the HudsonAlpha/Auburn University Center for Comparative Genomics and Translational Research. A member of the AU faculty since 1983, Bartol obtained the BS degree from Virginia Polytechnic Institute and State University (Virginia Tech) and both MS and PhD degrees through the Interdisciplinary Reproductive Biology Program from the University of Florida. Additionally, he obtained advanced training in molecular biology as a Visiting Scientist and Scholar in the Center for Animal Biotechnology at Texas A&M University. In 2005, Bartol was honored by his doctoral alma mater when he was named a Donald Henry Barron Lecturer at the University of Florida in recognition of “outstanding research and scholarly activities in the field of reproductive biology.” His research, which focuses on identification of mechanisms regulating development and function of female reproductive tract tissues in domestic ungulates, has been supported by competitive grants from the USDA National Research Initiative, the National Institute of Food and Agriculture (NIFA), the National Science Foundation, and private organizations in the U.S. and abroad, as well as by the Alabama Agricultural Experiment Station. Currently (2014-15), Dr. Bartol is serving as Panel Manager for the U.S. NIFA Animal Reproduction program. He is an active member of the Society for the Study of Reproduction (SSR), the American Society of Reproductive Immunology (ASRI), and the Society for Theriogenology (SFT), and was elected as an Honorary Member of the Society of Phi Zeta, the honor society of veterinary medicine, for “distinguished service in the advancement of science relating to the animal industry.” An advocate of the responsible use of animals in research and education, Dr. Bartol has served as chair of the Auburn University Institutional Animal Care and Use Committee, and both Animal Care and Experimentation and Animal Ethics sub-committees for the SSR. In addition to teaching the graduate course in reproductive biology at AU, Bartol lectures in bioethics and animal law in the AU veterinary curriculum and has spoken nationally and internationally on these topics. For more information, contact Dr. Bartol at 334.844.3700 or bartoff@auburn.edu.
Graduate students who represent the next generation of researchers and innovators are critical to the advancement of Alabama’s high-tech human resource capacity. To assist our institutions of higher education in training this next generation of scientists and engineers investments are required to attract the brightest and best scholars who will contribute to the state’s vision of economic growth and prosperity.

In 2013-14, the Alabama Legislature continued the appropriation to ALEPSCoR through the Alabama Commission on Higher Education for the purpose of funding the GRSP. Since its inception in 2006, the program has funded more than 203 exceptional graduate students.

Round Nine began in the Fall of 2014 funding 36 students with 14 new recipients for students conducting research funded by EPSCoR (Experimental Program to Stimulate Competitive Research) programs at the National Science Foundation, National Aeronautics and Space Administration, U.S. Department of Agriculture, and the U.S. Department of Energy Office of Science. Of the thirty-six students, twenty-nine (29) are pursuing a Ph.D. while seven (7) are working towards a Master’s. Students are selected competitively by a team consisting of one campus coordinator from each of the Ph.D. granting institutions in the ALEPSCoR Program. Renewals are granted each year subject to satisfactory progress in a given year and available funding.

The goal of the ALEPSCoR GRSP is to invest in Alabama universities to expand research output and attract eminent senior faculty and quality graduate students. The program’s objective is to provide a highly trained workforce to fuel the growth of high technology companies in Alabama.

The quality of work generated as part of the first eight funding rounds was both cutting-edge and novel. Encouraged by the success of the program, researchers have leveraged state funds with other research based resources to supplement the GRSP and increase participation in the program. Students whose proposed research or field of study and career interests were congruent with the funded science and technology programs of the NSF, DOE, NASA, USDA at Alabama EPSCoR universities are eligible to apply. The AESC created GRSP Subcommittee to monitor and continually make revisions to improve the program.

Additional information regarding the GRSP can be found in Volume 7 GRSP Booklet published December 2014.
The following written testimony was provided by Dr. Christopher Lawson Executive Director, Alabama EPSCoR, Director of the Graduate Research Scholars Program Professor, Department of Physics, University of Alabama in support of the NSF EPSCoR and NASA EPSCoR federal budgets to the U.S. House Committee on Appropriations Subcommittee on Commerce, Justice, Science and Related Agencies in March, 2014.

My name is Dr. Christopher Lawson and I am the Executive Director of the Alabama Experimental program to Stimulate Competitive Research (EPSCoR) and a member of the Board of the Coalition of EPSCoR/IDeA States. I am also a professor of physics at the University of Alabama at Birmingham (UAB) and Director of the Alabama Graduate Research Scholars Program.

I want to commend this Committee for soliciting input on the contributions of research to innovation and for conducting a well-advised hearing on this subject on April 29. In our knowledge-driven and technology-based economy, the importance of research to our competitiveness and well-being can hardly be overstated. Research affects us as individuals; it affects our states; it affects our nation. It impacts us intellectually, economically, militarily, medically, socially and beyond.

The federal investment in research dates back to World War II when the cooperation between the Federal government and the research community is credited with helping us and our allies achieve victory -- and a victory against an opponent that was also taking advantage of scientific and technological advances. According to the recently released 2014 Science and Engineering Indicators academic R&D remains a key component of the US R&D enterprise with the federal government providing about $38.9 billion of the $62.3 billion of academic spending on S&E R&D in FY 2012. Go to any research university and they will tell you that they are highly dependent upon the federal research support system. And, while the $38.9 billion may sound substantial, we all know that there is much more that needs to be done.

Consequently, I would first like to support a robust federal research base that will allow us to address more effectively and more quickly the many issues facing our nation.

Secondly, I encourage the support of a national research community that utilizes the talents and expertise of all of our talented researchers regardless of where they may reside and provides the benefits of a strong research base to all states. The state-based land grant institution has been the bulwark of our higher education system for more than a century and it should be supported by a healthy research capacity throughout the nation. Innovation is essential for us all and the research base is key to that innovation.

Today, some 25 states and 3 territories do not fully participate in the national research community. These states are often referred to as the EPSCoR/IDeA states because of their participation in EPSCoR/IDeA programs in federal research agencies. These states have about 20% of the nation’s population, close to 25% of its doctoral research universities and 25% of its scientists and engineers but receive only about 10% of all federal research funding.

The EPSCoR program originated in the National Science Foundation (NSF) as a way to compensate for geographical imbalance in research funding. Today, any state or territory that receives 0.75% -- three-quarters of one percent or less -- of NSF research funding over a three-year running period qualifies as an EPSCoR state, with eligibility calculated each year. In fact, most of the eligible states receive less than half of a percent of such research funding annually.

The NIH version of EPSCoR, called the Institutional Development Award (IDeA) program, was established in 1993 and currently serves 24 states. The program has a strong record in strengthening biomedical research capacity and expanding the professional workforce in participating states. States have seen NIH funding increase and numerous junior investigators participating in the IDeA program subsequently win non-IDeA NIH research awards.

Congress created an EPSCoR program at the Department of Energy (DOE) in 1992 to address the same basic principles as NSF EPSCoR. Today, EPSCoR states are leaders in energy
innovation, responsible for about 42.5 percent of the United States’ total energy production. Unfortunately, DOE research funding disparity still exists. A strong commitment to DOE EPSCoR from Congress and DOE would be of great benefit to the nation.

The original NSF EPSCoR program was a response to the directive in the original NSF authorizing legislation that NSF avoid an “undue concentration” of research and education in science and engineering, thus its legal beginnings. But, it is also a matter of basic fairness. The benefits of a strong research capacity are so great that all states not only deserve but require a research infrastructure if they are to meet the needs of their people. And, beyond that, there are simply practical reasons for a widespread research community that leads to innovation.

A recent study of the EPSCoR/IDeA programs, conducted by the National Academy of Sciences made several pertinent comments:

One, “science and engineering talent can be found among young people in every state and the long-term health of the U.S. research enterprise depends on providing opportunities for these young people to develop their talents no matter where they may live or attend college.”

Two, “participation in research is an essential component in science and engineering education. Consequently, students in all parts of the country must have the chance to participate in high-quality research, and it is in the national interest that federal funding be provided to universities in every state to ensure that these research opportunities are available.” Add to these such factors as the following:

• faculty who remain current in their fields produce better students who can move quickly and seamlessly into the workforce, especially in science and engineering. For faculty to remain current they must continue involvement in research and participate in their respective scientific organizations. This means they must have research support.

• technology driven companies tend to cluster in areas where they have access to a trained workforce, expertise (faculty and graduate student), and facilities. Equipment, laboratories and clean rooms at universities are attractive both to existing and start-up companies. Most states, including the EPSCoR/IdeA ones, find that clusters and corridors develop around their research institutions.

• the EPSCoR/IDeA states have a long tradition of promoting economic development, job creation and innovation in their areas. Many have assisted with SBIR and STTR development. Several operate Manufacturing Extension Partnership (MEP) programs. Almost all have healthy business incubators that not only support local businesses but help their faculty and students develop emerging startup companies.

• the EPSCoR/IDeA states are geographically located in the areas of strategic importance to our nation. Many are involved in food production and security, which in turn evoke challenges related to water, weather and climate and natural resource use. Others are major energy producing and energy exporting states. Still others are coastal states, facing issues of oceans and litoral consequence. Several share borders with other countries or are main transit points. Several contain national laboratories. National and international issues that demand innovation and creativity arise and are addressed in the EPSCoR/IDeA states on a daily basis.

The conclusion, it seems to me, is obvious. There is a two-way street here. The EPSCoR/IDeA states have much to offer in terms of talent, expertise and response to a diversity of issues. But, the EPSCoR/IDeA states also have much to gain, especially economically, from the benefits of a strong research base which will enhance their competitiveness and enable them to make greater contributions to their own well-being.

In testimony before the Senate Committee on Commerce, Science and Transportation last November, National Science Board vice chair Kelvin Droegemeier, also from an EPSCoR/IDeA state, talked about the “research capacity-building” impact of the programs. The NAS report also noted the importance of the “core elements” of the programs — “to enhance research excellence through competitive processes” and “to enhance capacity for postsecondary training in STEM fields”. This is what forms the base for innovation in about half the states.

If we want innovation and creativity throughout the nation — if we want all states to participate and to benefit from research capacity — then we need to make investments across all states. The EPSCoR/IDeA programs have served to
help the eligible states, but the work is far from complete. These states still have far to go to ensure that they are indeed part of a national research community that keeps this country in the forefront of innovation and technological advancement.

Now, let me turn briefly to several examples of the impact of EPSCoR/IDeA on innovation in Alabama. I truly believe that EPSCoR/IDeA has been a catalyst for these developments and that without the programs, my state would not have these same levels of accomplishment.

At my own university, EPSCoR federally funded research has seeded the innovation in the development of a new type of ultra-sensitive laser based sensor for olfaction, an “optical nose”, that can be used to detect and characterize (“sniff”) environmental toxins from spills caused by natural disasters. The same technology could ultimately be used for medical diagnosis of diseases such as lung cancer by the rapid analysis of the breath of patients during routine visits to the dentist. This innovative technology has led directly to the creation of a new multi-million dollar startup company in Alabama.

Federal investment has also spurred innovation at UAB to develop synthetic diamond technology for industrial and biomedical applications. Nanostructured diamond coated orthopedic and dental implants could extend the lifetime of these joints to over thirty years as compared to the ten-year lifetimes of current joint replacements. Similar technology innovations are providing nanostructured diamond coated cutting tools. These innovations are being commercialized by Vista Engineering, a spin-off company.

As another example, current composite materials are petroleum based with synthetic fibers that require large amounts of energy to produce. NSF EPSCoR funded research at Tuskegee University has led to advanced green composites that use plant oil based polymers and fibers. These materials will lead to reduced dependency on fossil fuels, and because they are biodegradable, they will not have to end up in landfills like traditional composite materials.

Federal investment in Auburn research has produced innovation in the form of a new drug delivery system involving DNA. This system enables precise, timed release of drugs and represents a novel advance in nano medicine that could lead to improved targeting of cancerous tumors. Complementary advances in ribonucleic acid (RNA) engineering produced a new microfluidic technology for ‘instant’ detection of RNA degrading agents. This detection platform should revolutionize our ability to detect and monitor contaminated food, which could significantly improve food safety and decrease food poisonings.

Federal investment in Cyber Security research at UAB has led to a number of important technical innovations and inventions. UAB researchers created a data-analytics based method for identifying the possibility of infection outbreaks in hospitals. This method could reduce hospital patient days due to secondary illnesses, which can have profound health and economic benefits. This technology has been commercialized by MedMined, now part of CareFusion. Federal investment at UAB has also led to innovative methods to identify cyber threats and thwart emerging e-mail attacks on organizations across the United States and worldwide, and this technology has led to another start-up company, Malcovery.

It is clear that in my state, federal research investment has led to numerous important technical innovations. This research investment has kept Alabama at the “cutting edge” of research and enabled students to encounter the type of research experiences that have been proven to be crucial for both undergraduate and graduate education. Federally funded technology innovations in Alabama have proven to be a crucial growth engine for the development of high technology spin off companies as described before. Finally, federal investment in EPSCoR states makes sense in order for the USA to maintain its technology edge and maintain its standard of living in the face of stiff global competition. We simply cannot afford to be training bright students and developing innovation in only a few states or institutions, we need to be training and utilizing ALL of our nations brainpower, and EPSCoR has proven to be an effective means to achieve that goal.
In summary, the Alabama Experimental Program to Stimulate Competitive Research is dedicated to the development of scientific and engineering capabilities through state research university collaboration. Research performed by our universities represents a substantial industry in Alabama. Activities are designed to attract distinguished scientists, young investigators, and researchers from various fields, fostering economic development through investments that result in cutting-edge technologies and stimulate competitiveness in medicine, biotechnology, engineering, mathematics, and other applied sciences.

Alabama EPSCoR was very successful in securing new funding from the NSF, DOE, NASA, and the USDA during 2013-2014. Significant state commitment is necessary to sustain the ALEPSCoR activities and to provide concrete evidence to the NSF and other agencies that the State is willing to partially match the large federal research investment in these activities. Continued state support ensures EPSCoR federal funding will continue to be available for our scientists and demonstrates a willingness on the part of the State of Alabama to make a full commitment to building research capabilities to support state economic development. For more information on Alabama EPSCoR programs within the NSF, DOE, USDA, and NASA see the following sections.

In 2012, as part of Alabama Governor Robert Bentley’s “Accelerate Alabama” Program, the State created the Alabama Innovation Fund (AIF) with an appropriation of $4M to maximize the use of the state’s economic resources by leveraging annual research and development expenditures by public institutions of higher education to generate high technology resources to support economic development activities. Additional information about the AIF can be found on page 59.

A strong commitment for EPSCoR is a sound investment for our State’s future.
The Experimental Program to Stimulate Competitive Research (EPSCoR) is designed to fulfill the mandate of the National Science Foundation to promote scientific progress nationwide. The NSF EPSCoR program began in 1978 and is a federal-state partnership designed to help America maintain its global leadership by capitalizing on talents and resources available in all states of the union. The program promotes the intellectual and human development missions of NSF by supporting basic research activities which span a broad range of science, engineering and technology and by supporting training of future scientists and engineers in states where NSF research support is equal to or less than .75 per cent of the total NSF research and related activities budget for the previous three years. (p.58) The NSF EPSCoR Office is located in the Office of the NSF Director where all EPSCoR awards are made through a rigorous merit review process.

Alabama first became eligible for EPSCoR funding in 1985. In 2014, a total of twenty-seven states and two territories were eligible for NSF EPSCoR funding. The colleges and universities in all the 28 EPSCoR states plus Guam, Puerto Rico and the U.S. Virgin Islands receive only about 10 percent of the NSF budget. The remaining ninety percent of NSF funding goes to non-EPSCoR jurisdictions.

NSF allocated nearly 90 percent of research funding through a competitive merit review process as grants or cooperative agreements to individual researchers and groups at colleges, universities, academic consortia, non-profit institutions, and small businesses. In FY 2013, the grand total of NSF

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* Amount shown in thousands
The Alabama NSF EPSCoR RII Track I grant entitled, RII: Enhancing Alabama’s Research Capacity in Nano Bioscience and Sensors (NBs) had an original period of performance from September 1, 2011 to August 31, 2014, This grant was
The NSF RII Track I continues an integrated, statewide partnership among multiple academic institutions, including: Alabama A&M University (AAMU), Auburn University (AU), Tuskegee University (TU), the University of Alabama (UA), the University of Alabama at Birmingham (UAB), the University of Alabama in Huntsville (UAH), and the University of South Alabama (USA). ALEPSCoR-RII-3 aims to enhance research capacity and competitiveness in the emerging, interdisciplinary area of nano/bioscience and sensors. To fulfill this mission, ALEPSCoR developed a strategic initiative to develop and strengthen Alabama’s knowledge-based economy in these areas. Activities related to research, education and outreach are carried out through four thrusts: Nano and Biomaterials, Biotechnology, Optics and Sensors, and Nanofabrication. Five junior faculty members have received funds to kick-start their research activities.

**The Nano and Biomaterials Research Thrust**

The Nano and Biomaterials Research Thrust, led by Dr. Mahesh Hosur at TU, involves the development of new nanostructured materials with enhanced thermal, physical, mechanical, and biodegradable properties. The tasks being performed are divided in three main areas: polymeric nanocomposites, advanced green composites, and synthesis of nanoparticles for drug delivery applications. In polymeric nanocomposites area research is being carried out to include nanoparticles like nanoclay, single and multiwalled carbon nanotubes, metal and metal oxide nanoparticles to improve the performance of polymers which are then used for fabrication of fiber reinforced composites for different high technology applications. Advanced green composites research is looking at the use of plant based polymers and natural fibers as viable alternates to synthetic polymers and fibers which are petroleum based and non-biodegradable. In the studies on synthesis of nanoparticles for drug delivery applications different types of nanoparticles are being synthesized using microwave and sonochemical methods. Based on these studies, researchers have been able to obtain additional funds to establish RISE and CREST centers.
The Biotechnology Research Thrust

The Biotechnology Research Thrust, led by Dr. Skip Bartol at Auburn University (AU), is developing and using organismal models to identify mechanisms of adaptation to natural and manmade environmental challenges that enable development and testing of nanomaterials and nanoscale devices. The Biotechnology Thrust serves as the life sciences arm of the ALEPSCoR Bio-Nano Program. It is the translational interface between the basic science of discovery at the cellular and molecular levels and the development of materials, products, and applications by the Engineering Thrusts of the program. Specifically, the Biotechnology Thrust focuses on the discovery and development of model ‘sentinel’ organisms, translational animal model systems and the molecular tools needed for use in the emerging area of nano-ecotoxicology, and the study of cellular organelles, cells, and tissues, as examples of and/or platforms for nanoengineering of biological processes. As this Thrust has evolved and matured, the research has expanded to also include the investigations of nano-molecular mechanisms of drug delivery, biologically compatible carbon nanotubes and nanofabricated niches for use with stem cells in the treatment of cardiovascular disease and injury, antimicrobial compounds, and landscape phage display-based therapies for the treatment of disease.

The Nanofabrication Research Thrust

The Nanofabrication Research Thrust, led by Dr. Anup Sharma at AAMU, is applying cutting-edge nanoengineering to develop molecular sensors, regimented nanomaterials and nanostructures with applications in chemical, biological, and thermo-electric devices. Investigation of lithography of substrates of biological interest was continued, both using lithographic masks as well as by interferometric lithography. Thermoelectric cooling devices and thermoelectric generators are being fabricated and tested from the super-lattices nanolayered multilayer and single layer thin films. In another work, fabricating and testing of thermoelectric cooling devices and thermoelectric generators from the super-lattices nanolayered multilayer and single layer thin films making nano-clustering in the films and mult-layers to cause decrease in the thermal conductivity, increase in both the electrical conductivity and Seebeck Coefficient is being carried out. Focus of another work is to fabricate high-performance single-walled carbon nanotube field-effect transistors (CNTFETs) with high on/off drain-source current (IDS) ratio and excellent saturation of drain-source current (IDS) using semiconductors as the source/drain contact material and to fabricate CNTFET-based logic circuits. Work at UAB involves synthesis and characterization of new materials for sensor protection and organic LEDs. Objective for the UAH Nanofabrication effort has been applying nanotechnology to improve chemical and biological sensors. In collaboration with Sandia National Laboratory, researchers at AU are studying deposition of Cu films by pulsed laser deposition (PLD) at both room temperature and liquid nitrogen temperatures. This temperature difference during deposition directly influences the microstructure-the room temperature films are nano-twinned while the liquid nitrogen samples are only nano-crystalline.

The Optics and Sensors Research Thrust

The Optics and Sensors Research Thrust, led by Dr. Sergey Mirov at the University of Alabama at Birmingham (UAB) in association with UA involves research into a wide range of new spectroscopy based tools for analysis of organic and inorganic materials. These activities include development of the necessary broadly tunable mid-infrared laser sources, development of the spectroscopy platforms that separates and analyzes the spectral signatures, and nonlinear optical methods for protection of the optical sensors. The first mid-IR Cr:ZnSe planar waveguides lasing has been demonstrated. The lasing of the Cr:ZnSe waveguide was achieved at 2.6 µm under optical pulse excitation at 1.907 µm. The laser threshold was equal to 0.5 mJ/cm2. Highly doped Cr:ZnSe/sapphire sample was used for passive Q-switching of the fiber pumped Er(0.5%):YAG laser operating at 1645 nm. It was a very important milestone to obtain level of optical quality of the pulsed laser deposited waveguides sufficient for lasing under optical excitation. The next step will be to achieve lasing under electrical excitation. Researchers at UA in this thrust are focusing on organic compounds in the environment, their sources, and control.
NSF RII Track 1 Education Outreach

All thrust areas have education and outreach activities which focus on coordinating and collecting data on education, diversity, outreach/partnering, and workforce development in the state relevant to the science and technology foci of ALEPSCoR-RII-3. The broader impact goal of the education, outreach and diversity program is to ensure that research and information generated by the ALEPSCoR program is broadly and widely disseminated in a clear and accessible manner, and that it functions to stimulate the student pipeline into STEM programs feeding into NBS. Expanded contact allows for increasing demographic, geographic, institutional, and curricular diversity, as has been shown in the RII3 annual reports. A strong focus on diversity helps ensure that students are exposed to NBS principles within a global and diverse context, teaching them new ways of looking at both complex scientific and societal interactions. Together, the thrust leaders have organized and participated in outreach activities such as the Research Experience for high school students, Research Experience for Teachers, Research Experience for Undergraduates, the Teaching Enhancement Award (TEA) program, and Science and Technology Open House. These activities have seen participation from all thrust areas where the faculty members have addressed an audience including community leaders, K-PhD students, and elementary-through-high school teachers. Other NSF funded programs at TU including MSP, CREST and HBCU-RISE have been leveraged to carry out these activities and will be continued in the future. The math and science partnership (MSP) program spearheaded by Tuskegee researchers provides an opportunity for the STEM faculty to develop modules that will be introduced in the middles school science curriculum in the black belt region of Alabama. All thrust area participants will continue to make a broad impact in the research community by actively disseminating and communicating research activities to national and international audience. Significant numbers of under-represented minority students are being trained in the emerging fields of nano-bioscience and sensors. Almost all thrust area researchers are engaged in collaborative research activities with partners from academia, industry and national labs within the USA and abroad. Partnerships with Alabama Department of Economic and Community Affairs, Alabama Development Office, Eight Research Universities, and Economic Development Partnership of Alabama will assist businesses in addressing nano and biotechnology needs to increase the competitiveness of Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) grants.

The primary goals of our outreach activities are to enhance interest in STEM and to support improvements in education at K-12 levels. While most of the outreach activities are ongoing in summer of 2014 on each campus, those held in summer 2013 will be discussed in detail in the later sections. The annual Science & Technology Open House hosted by Tuskegee University and sponsored by Alabama Experimental Program to Stimulate Competitive Research (EPSCoR) to provide college and high school students the opportunity to choose STEM (Science, Technology, Engineering and Mathematics) related field was held on Friday February 7 to Saturday February 8, 2014. The focus of this annual meeting was to provide college students an opportunity to showcase their research accomplishments from almost all science and engineering disciplines from doctoral granting institutions in the state of Alabama.

Tuskegee University has received funding for a REU program from NSF. Current batch of students are undergoing extensive 10-week training. In addition, FASTREC and MITE program are currently ongoing. The seniors who participated in the 2013 MITE Program received early admission and one participant received the Presidential Award for fall 2014. FASTREC is recognized as a national model by the National
Science Foundation and noted as a key strength of the college of engineering program. Additionally, the FASTREC program provides steps for individuals to succeed in college and beyond.

Alabama State University and Tuskegee University jointly presented the first annual NanoBio Summit that began on Thursday, October 17 and concluded with a closing banquet and awards ceremony on Friday, October 18, 2013 at the Renaissance Montgomery Hotel & Spa at the Convention Center in Montgomery, Alabama. Over 230 people attended the event that was primarily sponsored by National Science Foundation funded programs- CREST, EPSCoR-RII, Historically Black Colleges and Universities-Undergraduate Program and National Institutes of Health. The NanoBio Summit consisted of a series of invited talks showcasing over 100 poster presentations and was anticipated to promote the building of a research community as well as to foster collaboration between research institutions across the state of Alabama and surrounding areas.

The Alabama A&M Outreach Project involved ten high-school students and two high-school teachers from local schools in the Huntsville area. Where available, the internees were guided on day-to-day tasks by Ph.D. and M.S. level graduate students. At the end of the internship period, all participants presented their research on posters.

Auburn held its first Women in Engineering Camp from July 7 through 12, 2013. On November 6 2013, Dr. Virginia Davis, and members of Auburn’s SHPE, NSBE and Omega Chi Epsilon Chapters performed science and nanotechnology activities at Greater Peace Community Development Center’s STEM After School Program in Opelika. Fifty-five African American children ranging in grade from K-8 the majority of which are considered at-risk, participated. In March, 2014 Auburn held a large Nanodays event. It was held in the evening at Auburn’s Ag Heritage Pavilion and advertised through Auburn’s COSAM Outreach. It attracted 51 K-12 students and their parents.

In Summer 2013, Bridge Program, the Rural Entrepreneurial Internship Program (EIP) was established in Moundville, Alabama, targeting Hale and Green County students representing the poorest performing counties in Alabama. It provided instruction on intellectual property rights and protection with 22 students from surrounding rural counties. In Spring 2014, NUE Pilot on “Societal Implications of Nano Bio” developed summer 2013 to introduce 15 honors students spring 2014 to RII concepts of new technologies and sustainability with inquiry based opportunity to use hands on modules developed through the Alabama MSP in Nano Bio. Professor Thompson, along with his colleagues in Chemistry – Dr. Martin Bakker – hosted an ASM Materials Camp for middle and high school teachers in the region.

The Physics Bridge program provides area rising 9th grade graduates from the local Birmingham community with an exciting experience in optics, lasers, and light by conducting hands on experiments working with great UAB faculty, students, and staff to understand physics.

The Alabama Composites Conference was held in Birmingham on June 18-20, 2013. The conference was attended by 410 participants and featured High Technical Quality conference, exhibits and workshop focusing on applications development for Engineered Composites in transportation, defense, power and energy sector, corrosion prevention, infrastructure and emerging technologies.

Dr. Guo from UAH and his graduate students supervised Madison County Liberty Middle School students to participate 2014 Alabama State Science Fair.

The E2 (ENGINEERING EXPLORATION) program at the University of South Alabama recruited high achieving students that were just admitted to go to various engineering majors at the University of South Alabama in Fall 2013. Communication is enhanced through cyberinfrastructure mainly through enhancing the facilities. Additionally, all partnering institutions were involved with the EPSCoR C2 program. The NSF EPSCoR RII C2 program, “Alabama Cyber Connections in Nanotechnology, Bioscience and Sensors” further supports Alabama research and education efforts in nanotechnology, bioscience and sensors by strengthening research and education through infrastructure investments in advanced broadband networks and cyberinfrastructure tools and technologies. A new Website created for Bridge Program EIP linked with City of Moundville, Alabama, Hale County, http://eip.ua.edu. A new internal Blackboard website created for NUE “Societal Implications of Nano Bio”. A new database has been created to share content from the NUE
pilot “Societal Implications of Nano Bio”. The database is to be made accessible to cross disciplinary students taking the class on the UA campus as well as collaborators off campus. The database is to contain the new class materials. Two year colleges involved in the MSP Nano Bio Sciences grant with RII researchers developed visualization tools from data generated by the grant. The UA team continued to provide cyber infrastructure for online virtual sessions linking with Boys State and worked nationally to identify infrastructure for the creation of a national EOD webinar series for EPSCoR.

Dr. Pamela McCauley of TSTEM- Inc is the external evaluator of the program. Dr. McCauley visited all universities with RII PD/PA involved with Alabama EPSCoR RII in March and interacted with faculty, students and RII management team. She was provided with all the data since last year’s report that was collected in January 2014 which she analyzed and presented during the virtual EAB meeting held on April 28, 2014. A further update to all the data was provided to her. Per her report, “The program evaluation analysis indicates that the ALEPSCoR is on course to achieve the goals outlined in the strategic plan and NSF Proposal in the areas of research, student involvement, scholarly production and faculty development.” During the EAB virtual meeting, presentations were made by the thrust leads. A report from the EAB is attached at the end along with our response.

All the researchers are aggressively seeking extramural funds to sustain their research beyond the EPSCoR grant. A total of 76 ongoing grants worth ~$35M are being leveraged. Notable among them are the MSP, CREST, RISE, and IGERT funded by NSF. During this reporting period 137 new proposals were submitted by RII faculty members totaling over $70.78M out of which 47 with ~$10M are funded.

Science & Technology Open House 2014

The annual Science & Technology Open House hosted by Tuskegee University and sponsored by Alabama Experimental Program to Stimulate Competitive Research (EPSCoR) was held Friday, February 7 - Saturday, February 8, 2014. The focus of the meeting was to provide college students an opportunity to showcase their research accomplishments in science and engineering disciplines from the seven PhD granting institutions including Alabama A&M University, Auburn University, Tuskegee University, University of Alabama, University of Alabama at Birmingham, University of Alabama at Huntsville, and the University of South Alabama.

Dr. Mahesh Hosur, PI/PD of the NSF EPSCoR RII grant along with Dr. Shaik Jeelani, Tuskegee University’s Vice President for Research and Sponsored Programs welcomed participants to the Open House. Keynote speaker, State Representative Greg Canfield, Alabama Secretary of Commerce, stressed the need for Alabama’s future workforce to remain essential in the 21st century economy. He also emphasized the need for students to embrace changes due to advancements in science and technology, while promoting science and technological education in Alabama.

Another goal of the Science and Technology Open house was to motivate secondary students to choose careers in science and technology fields. On Saturday February 8th, several hands-on activities were organized for over 100 high school students in attendance.

RII Track 1 Proposal Submission

In 2013 ALEPSCoR was eligible to submit a new $20M RII Track 1 proposal to NSF EPSCoR in response to the NSF RII Track 1. The proposal selected by ALEPSCoR was: “Expanding Alabama’s Research Capacity in Cyber Security and Cyber Incident Response,” headed by Dr. Alec Yasinsac, Dean of the University of South Alabama’s School of Computing. This proposal formed a statewide team that focused on the high priority research area of Cyber Security and Response and was submitted in August 2013. This proposal was rejected,
revised and resubmitted in August 2014. The new submission is entitled, Advancing Alabama’s Science and Technology Roadmap- Cybersecurity Research for Critical Infrastructure Protection (ACCIP).

The project includes four research thrusts including: 1) Cyber Physical Systems Research; 2) Digital Forensics Research. 3) Cyber Threat Assessment Research, and 4) Workforce Development. The research team will be led by Dr. Alec Yasinsac and Ms. Rebecca Bace at the University of South Alabama to study, experiment, create, and advance novel algorithms and prototypes that defend against threats to cyber elements of critical infrastructure resources. The comprehensive cyber critical infrastructure protection (CIP) research program includes theoretical analysis, laboratory studies, and live exercises in test beds delivered as part of the infrastructure improvement element. The project will mine forensic data as strategic feedback into future designs, better processes, and adaptive architectures that are resilient under cyber-attack. The investigators will undertake transformative research in malware analysis, secure software engineering, and innovative testing that will mitigate large classes of CIP threats. The team will enhance CIP for cyber physical systems, industrial control systems, automotive and aviation systems, and healthcare information, paying particular attention to CIP vulnerability associated with human factors.

The ACCIP team has plans to deliver cybersecurity to participants including K-12 students through partner schools and after-school programs for low-income and minority populations, as well as through the Louis Stokes Alliance of Minority Participation (LSAMP) and Judson College for Women.

**NSF RII Track 2**

In 2014, Alabama EPSCoR was eligible to submit a NSF Track 2 proposal. In February 2014, Dr. Andrew Ernest, UA’s Director of The Environmental Institute and Professor in the Civil, Construction, and Environmental Engineering led the two-state effort with Kentucky researchers on a submission entitled, Collaborative Research: Alabama-Kentucky Research Infrastructure on Drought Management in the Southeastern US (ARID-SE). The project planned to develop the first drought-focused cybercollaboratory in the Southeastern U.S. for the study of water-supply-and-demand from both the scientific-engineering and socio-economic perspective. This proposal was not selected for funding.

In October 2014, the NSF Track 2 program underwent a complete revision. It was renamed the NSF Track 2 FEC (Focused EPSCoR Collaboratons) with specific interests in 1) understanding the human brain, or 2) the water-energy-food nexus. The human brain interests are: multiscale integration of the dynamic activity and structure of the brain; neurotechnology and research infrastructure; quantitative theory and modeling of brain function; and brain-inspired concepts and design. The research areas of the Water-Food-Energy Nexus include: integrated analysis and modeling; advanced materials and technological solutions; the integrated science behind improvements of feedstock production systems, including aquaculture; and advanced sensors and analytics.

Instead of single collaborative proposal from multiple states, all eligible institutions in a single jurisdiction have the opportunity to apply as the prime institution. An institution can also partner with one or two states, the overall cap for a two-state proposal submission is $1M, while the three-state collaboration is limited to $1.5M. The expected deadline for proposals is January 2015.
NSF Co-funding

NSF Co-funding is not a program that can be applied to directly but works internally at NSF to provide joint support for certain meritorious proposals submitted to NSF’s research, education, and cross-cutting competitions with a goal of:

- increasing the number and competitiveness of EPSCoR jurisdictions investigators and institutions who participate in NSF research, technology, and education programs
- increase the participation of EPSCoR jurisdiction researchers and institutions in regional alliances and national collaborations
- broaden participation in science and engineering by institutions, organizations, and people within and among EPSCoR jurisdictions.

In 2013-2014, Alabama institutions received NSF Co-Funding through various kinds of awards including:

The Research Experience for Undergraduates (REU) program supports research participation by undergraduate students in any of the research areas supported by NSF. A REU Site may be either an independent project that engages a large number of undergraduate students with a single discipline or academic department with a single theme; or as an REU Supplement that includes a undergraduate research component to a new or already existing NSF grant or cooperative agreement.

The Major Research Instrumentation (MRI) program catalyzes new knowledge and discoveries by empowering the Nation’s scientists and engineers with state-of-the-art research instrumentation. The MRI Program enables research-intensive learning environments that promote the development of a diverse workforce and next generation instrumentation, as well as facilitates academic/private sector partnerships.

A CAREER Award is NSF’s most prestigious award in support of junior faculty who exemplify the role of teacher-scholar through outstanding research, excellent education, and the integration of education and research within their organizations. These activities start the foundation for a lifetime of leadership in education and research.

The East Asia and Pacific Summer Institutes for U.S. Graduate Students (EAPSI) award provides U.S. graduate students in science and engineering first-hand research experiences in Australia, China, Japan, South Korea, New Zealand, Singapore or Taiwan by providing an introduction to the science, science policy, and scientific infrastructure of the respective location and an orientation to the society, culture and language. The primary goals of EAPSI are to introduce students to East Asia and Pacific science and engineering in the context of a research setting, and to help students initiate scientific relationships that will better enable future collaboration with foreign counterparts. All institutes, except Japan, last approximately eight weeks from June to August. The Japan Institute lasts approximately ten weeks from June to August.

The Grant Opportunities for Academic Liaison with Industry (GOALI) Initiative aims to synergize university-industry partnerships by making funds available to support an eclectic mix of industry-university linkages. Special interest is focused on affording the opportunity for: faculty, postdoctoral fellows and students to conduct research and gain experience with production processes in an industrial setting industrial scientists and engineers to bring industry’s perspective and integrative skills to academe interdisciplinary university-industry teams to conduct long-term projects

This initiative targets high-risk/high-gain research with a focus on fundamental topics that would not have been undertaken by industry, new approaches to solving generic problems, development of innovative collaborative industry-university educational programs, and direct transfer of new knowledge between academe and industry. Some Alabama NSF Co-funded project descriptions follow.
<table>
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<th>Award Number</th>
<th>Title</th>
<th>Principal Investigator</th>
<th>Organization</th>
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<td>Rita Fincher</td>
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<td>Maobing Tu</td>
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<td>Early Career: Acquisition of an Accelerated Solvent Extractor and a Gas Chromatography-Mass Spectrometer for Lipid Analyses in Organic Geochemistry Research</td>
<td>Yuehan Lu</td>
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<td>Patrick Fantom</td>
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<td>Collaborative Research: Dynamics of Ecosystem Carbon Dioxide and Methane Fluxes from the Florida Everglades--Effects of Hydrology and Vegetation on the Net Radiative Forcing</td>
<td>Gregory Starr</td>
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<td>MRI: Development of Instrument on Robot-aided, Cognitive Virtual Reality for Rehabilitation of Automatic Physical Training of Individuals with Disabilities (RAPID)</td>
<td>Fei Hu</td>
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<td>RAPID GOALI: Chemical Contamination and Remediation of Plastic Drinking Water Infrastructure during the West Virginia American Water Drinking Contamination incident</td>
<td>Andrew Whelton</td>
<td>University of South Alabama</td>
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<td>Daniel Warner</td>
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<td>Mustafa Morsy</td>
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<td>Karolina Mukhtar</td>
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<td>Tara DeSilva</td>
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<td>Alice Ortmann</td>
<td>Marine Environmental Sciences Consortium</td>
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**Total Awarded Amount To Date:** 9,786,216
Sleep and Adaptation for Preschool Children
Dr. Brian Vaughn, Auburn University

Sleep is a critical element of adaptive functioning across the whole human life cycle, and is crucial during infancy, childhood, and adolescence. The fundamental importance of sleep, as both as state and a process, for development has been recognized by developmental scientists for over 20 years and studies have linked quantitative (e.g., total amount of sleep per night) and qualitative (e.g., sleep efficiency--time in bed that the person is actually asleep) sleep parameters to a broad range of health-relevant outcomes in samples of children. Researchers also have identified many biological and social factors that influence both sleep quantity and quality, however, the bulk of research with children has focused on infancy, school-age children, and adolescents; with relatively little research attention devoted to the impact of sleep during early childhood (nominally 2.5-6 years). Moreover, most studies covering the early childhood period relied on subjective reports from sleep diaries or questionnaires completed by parents and examined problems associated with medical conditions or with sleep deficits. Finally, most of these studies recruited families in which children were cared for at home by a parent. This study of up to 270 children (90 in each of 3 consecutive years), recruited between the ages of 2.5 and 4.5 years of age and followed up to two years after initial enrollment, starts from the premise that sleep parameters are continua ranging from maladaptive to optimal, with most children falling in a mid-range that is adequate for normal growth and functioning, rather than from the premise that sleep parameters are either “disordered” or not. The investigators for this project will recruit the sample from a high-quality early education center in a large metropolitan area from the Southeastern USA. Selecting such a sample allows them to consider both the positive growth promoting benefits of sleep as well as the constraints on development and adaptation imposed by less adequate sleep. The sample also allows generalization of prior research on home-reared children to the most common child-care setting now being used in the USA (group care). The researchers will also measure sleep objectively by using activity monitors worn by the children over a week’s time, which makes it possible to examine the trajectories of nighttime and naptime sleep in greater detail than is possible from parent reports; although the project will retain the parent diary method so as to provide contextual information (e.g., any illnesses the child suffered while sleep was monitored; medications taken, etc.) to supplement the sleep measures from activity monitoring. The investigators also will conduct a comprehensive assessment of child adaptation in their homes and early education center classrooms, including the domains of social, emotional, cognitive, and academic functioning. These assessments involve extensive direct observations of child behavior at home and in the classroom, standard tests of receptive vocabulary and age-appropriate academic achievement, laboratory tasks designed to assess self-regulation, emotion knowledge, executive functioning, and parent/child and teacher/child relationships.

The study will provide fundamental information about the developmental course of sleep (quantity and quality) over early childhood and the environmental factors that constrain and/or promote adequate and optimal sleep. Because children will be observed repeatedly over the course of the study, the researchers will also be able to examine the temporal/causal influences of parent/child relationships on sleep (and vice versa), as well as the relative influences of both sleep and adult/child relationships on the quality of social/emotional and...
cognitive/academic functioning assessed in the classroom. A fourth valuable contribution of the study arises as a consequence of the sample itself. The early education program collaborating with the study serves a multi-ethnic but predominantly middle-class population (about 30% ethnic minority status families enrolling children) but also serves children from low-resource families (~10% of total enrollment). This distribution of children will permit testing hypotheses concerning health disparities between minority ethnic status and/or more economically challenged groups (compared to majority ethnic status and/or middle SES groups) with regard to sleep and its consequences. In addition to these fundamental contributions to the science of sleep, this study will likely have broad implications for childcare policy, curriculum development for young children, teacher training, and parent education.

CAREER: Carbonyl Inhibition of Butanol Production from Biomass Hydrolysates by Clostridium acetobutylicum
Dr. Maobing Tu, Auburn University

Butanol is one of the promising advanced biofuels being pursued by industry for the next generation of alternative fuels. However, cost-effective production of butanol from lignocellulosic biomass is still challenging. In particular, hydrolysate inhibition limits butanol fermentation efficiency. The overall objectives of this project are to identify fermentation inhibitors in biomass hydrolysates, to elucidate the alkaline detoxification mechanisms, and to improve butanol fermentation rates and yields. The specific research objectives of this CAREER project are to: (1) Establish quantitative structure-activity relationships (QSAR) between the molecular structure and inhibitory effects of model carbonyl compounds on microbial fermentation; (2) Identify carbonyl compounds in real biomass hydrolysates and predict their inhibitory effects on microbial fermentation; and (3) Design carbonyl-based selective chemical reactions for detoxifying biomass hydrolysates to improve butanol fermentation with Clostridium acetobutylicum. The PI’s long-term educational goal is to train the next generation of scientists and engineers with advanced knowledge and research experience that will reinvigorate the national forest and biorefinery industries.

This project addresses fundamental understanding of carbonyl inhibition in fermentation of biomass hydrolysates. The results forthcoming are critical for cost-effective biofuels production from biomass. The central hypothesis of this research is that the inhibitory effects of biomass hydrolysates on microbial fermentation are governed by the electrophilic reactivity of carbonyls to the biological nucleophiles, with that reactivity dominated by physicochemical properties that are controlled by molecular structure. This hypothesis is based on preliminary findings, which show an aromatic carbonyl compound can be detoxified through carbonyl aldol condensation between carbonyl aldehyde and glucose elonate. The understanding the structure-activity relationships between the molecular structure and inhibitory effects of biomass-derived toxic compounds would establish a scientific framework for removing inhibitors cost-effectively in biofuels production. By integrating computational study and experimental determination, new information will be generated to correlate carbonyl molecular structure to their reactivity and inhibitory effects on microbial fermentation. Building QSAR models to predict these effects makes an important contribution to biomass processing chemistry.

The proposed research addresses the national interest of developing sustainable alternative fuels from renewable resources. This research is complemented by multi-faceted
and conference presentations, and will advance scientific
discovery of biomass-derived carbonyls and the fundamental
understanding of carbonyl reactions in biomass processing.
Successful undertaking of the proposed work is expected
to lead to significant promotion of biofuels production,
which will benefit the nation’s economy, energy security,
environment and society.

**CAREER: Investigating Mechanisms of Regulatory and Functional Diversity in an Enzyme Superfamily**
Dr. Patrick Frantom, University of Alabama

Allosteric regulation is a central tenet of modern biochemistry, however, it is a mechanism that is still not well understood. The long-term goal of this project is to understand how allosteric and catalytic mechanisms work together in multi-domain enzymes. This research examines the mechanistic and evolutionary interactions between two conserved domains in the context of the DRE-TIM metalloenzyme superfamily. An integrated experimental approach, including biochemical, structural, and bioinformatics techniques is used to (a) determine the identity of kinetic steps perturbed in allosteric inhibition, (b) predict and verify functional and structural diversity and (c) investigate the role of conserved residues in the allosteric mechanism. This type of approach overcomes several difficulties commonly encountered in the study of allosteric enzymes, moves away from the phenomenological description of different allosteric mechanisms and considers the impact of evolutionary pressures on the diversity of mechanisms within a conserved protein scaffold. Rapid-reaction kinetics and kinetic isotope effects will be used to investigate the changes to enzyme mechanisms caused by allosteric inhibitors. The creation of a protein similarity network for the model allosteric domain will provide rapid organization for a large number of diverse sequences predicted to contain the domain. High-throughput structural techniques will provide essential structural coverage for clusters of sequences currently lacking structural description. Mechanistic and structural data will be mapped onto the protein similarity network to define the functional and structural boundaries of the model allosteric domain. The integrated results will provide a description of structure/function relationships contributing to functional and allosteric diversity and also give insight into how a single protein scaffold evolves multiple allosteric mechanisms. The outcomes of this research will impact the growing areas of allosteric biosensors and metabolic engineering of bacterial strains for industrial uses.

This project will promote interdisciplinary training of graduate and undergraduate students at The University of Alabama. Graduate student training will be enhanced by an on-site visit to the laboratory of Dr. Patricia Babbitt at the University of California, San Francisco for hands-on training in cutting edge bioinformatics techniques. Undergraduate training will be accomplished through two mechanisms designed to increase exposure to original hypothesis-based research. The first mechanism will provide multiple positions in the Frantom laboratory for undergraduate researchers from the University of Alabama Emerging Scholars to continue performing mentored research. The second mechanism is the creation of a formal undergraduate laboratory course to mimic key experiences encountered in undergraduate research. Students unable to participate in direct scientific research will benefit from a laboratory course built around performing original hypothesis-driven experiments that contribute directly to the intellectual merit of this project.

**Collaborative Research: Dynamics of Ecosystem Carbon Dioxide and Methane Fluxes from the Florida Everglades—Effects of Hydrology and Vegetation on the Net Radiative Forcing**
Dr. Gregory Starr, University of Alabama

The primary objective of this study is to determine how alterations in hydrology impact the carbon dynamics of Everglade fresh water marshes. Eddy covariance flux measurements will quantify carbon exchange (CO2
and CH4) from both short and long hydroperiod (the duration of inundation) marshes in the southern Florida Everglades. The expected results of these studies will lead to an improved understanding of how changes in wetland hydrology and vegetation structure influence the balance between the uptake and release of CO2 and CH4.

The Everglade watershed provides an excellent opportunity to study the effects of hydroperiod on wetland carbon balance, especially since water management practices are likely to change substantially in the near future due to the implementation of the Comprehensive Everglades Restoration Plan. This watershed is also important due to its peat-forming wetlands that contain vulnerable stocks of soil carbon. Because wetland ecosystems are of great significance globally in sequestering carbon dioxide and releasing methane, and many are threatened by changes in land use and climate, research is needed to provide better estimates of their role in providing an overall carbon balance on regional and global scales.

**Early Career: Acquisition of an Accelerated Solvent Extractor and a Gas Chromatography-Mass Spectrometer for Lipid Analyses in Organic Geochemistry Research**

Dr. Lu Yuehan, UA

This award provides funding to acquire an Accelerated Solvent Extractor (ASE) and a Gas Chromatography-Mass Spectrometer (GC-MS) at University of Alabama (UA). These two instruments are essential for reliable lipid analysis, which is the core research tool utilized by the PI to understand organic matter cycling in aquatic environments. Lipids are important tracers indicating sources, quality and preservation of organic matter in contemporary and paleo-ecosystems. Examples of application from the PI’s past and on-going research projects include: reconstructing environmental changes in the Lake Erie during the development and remediation of its cultural eutrophication; understanding the effects of human development in watershed on organic matter cycling within aquatic environments; and developing biomarkers for sulfide-tolerate microbes that inhabited oceans during past periods of anaerobicity.

The instrumentation provides state-of-the-art technological support for research and education in Earth Sciences at UA. It enables the PI, an early career organic geochemist, to develop an independent research program, establish cross-disciplinary and inter-institutional collaboration and attract quality graduate students. The instruments further enhance the research capacity of a research consortium at UA investigating past climatic and environmental changes, which comprises a group of diverse and talented faculty members and students. This enhanced infrastructure allows more effective integration of research, teaching and student training. A variety of courses in geological and environmental sciences will benefit from hands-on activities, such as analyzing environmental pollutants or identifying compounds indicating activities of past organisms. Currently, 12 students (5 undergraduates and 7 graduates) are conducting research projects requiring the use of the requested instruments. Most importantly, the research topics supported by the new instrumentation have important society values, including understanding distribution and metabolism of organic pollutants, and elucidating factors governing climate changes.

**Immunomodulatory ultrathin coatings for pancreatic islet transplantation**

Dr. Eugenia Kharlampieva, UAB

The proposed research presents new opportunities for the development of novel cytoprotective materials to be used for basic research applications as well as a cell-based transplantation therapy for diabetic recipients. Our proposal is particularly timely since current islet encapsulation systems are challenging for transplantations due to high cytotoxicity and the requirement for large injection volumes. The design of novel immunoprotective materials will open new prospects for developing biomaterials with unique characteristics having applications in various bio-related
areas such as bioengineering and tissue engineering. The educational objective of this project is to develop a discovery-driven, multidisciplinary biomaterials/polymer sciences program at UAB to promote diversity from the high school through graduate-level. The PI is currently developing a polymer science program at UAB with a specific focus on biomaterials at the B.S. and Ph.D. levels. High school, undergraduate, and graduate students, including underrepresented minorities, will be trained in modern aspects of biopolymer science including state-of-the-art synthetic and analytical methods, and will take part in intensive multidisciplinary collaborations throughout and beyond UAB. The proposed activities will develop interdisciplinary collaborative research between the Departments of Chemistry, Surgery, and Microbiology. These collaborative efforts will stimulate awareness of the needs of the UAB biomedical research community for specialized polymer-based biomaterials as novel platforms for cell transplantation therapy. The results will be disseminated through publications in peer-reviewed journals and presentations at national and international scientific conferences.

“Using the Social Sciences, Natural Sciences, and Mathematics to Study Crime” is an interdisciplinary REU program that brings together faculty from three programs (Criminal Justice, Forensic Science, and Computer Forensics) at the University of Alabama at Birmingham (UAB). This eight-week summer program combines the strengths of these distinctive, yet interrelated, programs into a synergistic relationship. Students work with faculty in one of three research tracks: 1) Criminal Justice, 2) Forensic Science, or 3) Digital Forensics. This collaborative venture benefits REU student participants, faculty mentors, two academic departments, the College of Arts and Sciences, the Center for Information Assurance and Joint Forensics Research, the university research infrastructure, and the scientific community via intellectual merit and broader impacts.

2013 REU students with Dr. Kerley
This REU program addresses emerging issues of crime and criminal investigation by uniting a traditional Social Science discipline (Criminal Justice) with two STEM disciplines (Forensic Science and Computer and Information Science). Our program provides a much-needed opportunity for undergraduate students to conduct interdisciplinary research on a pressing social problem. The overall objective of this program is to involve a diverse group of undergraduate students in interdisciplinary research that prepare them for a wide range of post-graduate programs in Criminal Justice/Criminology, Sociology, Biology, Chemistry, Forensic Science, Computer Science, and Computer Forensics. This REU program broadens the research participation of underrepresented groups and students from colleges and universities where research opportunities in STEM are limited through targeted recruitment and mentoring. UAB is one of the most ethnically diverse universities in the Southeastern region of the United States and is surrounded by a large number of universities with similar levels of diversity, as well as many Historically Black Colleges and Universities (HBCUs). The research infrastructure and personnel are in place at UAB to deliver a strong interdisciplinary research program targeted to a diverse group of undergraduate students from across the nation. In addition to learning scientific content and participating in real research projects, students also learn about the interdisciplinary nature of scientific inquiry, research ethics, post-graduate options, and professional and career development.

EAPSI: Studying the potential impacts of ocean warming and acidification on the immune response in sea urchins
Ms. Cecilia Brothers, UAB

Climate-induced changes in oceanic temperature and pH are occurring rapidly around the world, and are primarily attributed to increasing levels of atmospheric carbon dioxide (CO2). As atmospheric CO2 levels rise, it is predicted that surface seawater temperatures will increase while pH will decrease. A number of recent studies have suggested that in these near-future ocean conditions, marine organisms will become more vulnerable to infectious diseases. However, no studies to date have examined the effects of both warming and acidification on the immune response of sea urchins.
which are both ecologically and economically important. The intertidal sea urchin, Heliocidaris erythrogramma is commonly found in eastern Australian waters, a region that is experiencing rapid climate-induced environmental impacts. This project will investigate the prospective effects of warming and acidification on various immune system parameters of Heliocidaris erythrogramma. This research will be conducted at the University of Sydney, Australia in collaboration with Dr. Maria Byrne, an internationally-known expert on the impacts of ocean warming and acidification on marine invertebrates.

Sea urchins will be exposed to treatments at current and near-future seawater temperature and pH and following three different exposure periods (1 day, 2 weeks and 4 weeks), a variety of immune parameters will be measured. These parameters will include coelomocyte (cells associated with sea urchin innate immunity) number, spreading, and adhesion, as well as the ability of coelomocytes to phagocytosis and respond to a common marine pathogen. Collectively, these measures will provide an evaluation of the ability of Heliocidaris erythrogramma to respond to immune challenges in a rapidly warming and acidifying marine environment. This NSF EAPSI award is funded in collaboration with the Australian Academy of Science.

RAPID GOALI: Chemical Contamination and Remediation of Plastic Drinking Water Infrastructure during the West Virginia American Water Drinking Contamination Incident

Dr. Andrew Whelton, University of South Alabama

An accidental spill of a currently unknown quantity (estimated between 3,000 and 7,500 gallons) of 4-methylcyclohexane methanol from a coal preparation plant in Charleston, WV has compromised the drinking water supply for up to 300,000 water users in Charleston and nearby counties. This tragedy has caused the ban of use of potable water and has resulted in closure in several establishments including schools and business. President Obama issued a federal disaster declaration for the state on Friday, January 10, 2014 to provide federal aid for the state.
REU SITE: Undergraduate Research Experiences in Coastal and Nearshore Marine Systems of the Northeastern Gulf of Mexico
Drs. Alice Ortmann & William Patterson, Marine Environmental Sciences Consortium

The Dauphin Island Sea Lab (DISL), located on the Gulf of Mexico in southern Alabama, will offer 10-week summer research experiences to 8 undergraduate students each summer for two years. Students will work with mentors who share their research interests and carry out independent research while interacting with graduate students, post-doctoral researchers and faculty in a setting with ready access to the nearshore environment. REU students will participate in a series of workshops designed to develop critical skills in experimental design, scientific writing and presentations. The students, under the guidance of faculty mentors, will then design, implement, analyze and report on independent laboratory and field research projects. Projects will focus on coastal and nearshore processes in the waters surrounding the research station. Research questions may address aspects of ecology, fisheries biology, evolution, ecosystem interactions, conservation, microbiology, biogeochemistry and physical oceanography. The REU students will attend seminars by DISL and visiting faculty, interact with resident graduate students and participate in individual lab group meetings, providing opportunities to explore research topics outside of their own projects. Students will also be encouraged to publish results of their research and to attend scientific conferences to present their work.

MRI: Development of Instrument on Robot-aided, Cognitive Virtual Rehabilitation for Automatic Physical Training of Individuals with Disabilities (iRAPID)
Dr. Fei Hu, UA

This project, developing iRAPID, a robot-aided cognitive virtual rehabilitation instrument for automatic physical training of individuals with disabilities, integrates several hardware components (the KineAssist robot, programmable treadmill, biomarkers (sensors) and Xbox kinect sensors) to build an augmented virtual reality animation of the patient. A series of newly developed software tools will support virtual rehab research computations of body balancing and neuro-pattern changes during rehab.

The instrument will be designed to be suitable for three different cost/performance levels, with successive levels making use of more comprehensive sensors. Combining the sensors (e.g., functional NearInfraRed and EEG brain imaging) with physical rehab mechanisms (e.g., treadmill) make possible interesting research areas related to the effectiveness of physical rehabilitation training. Hence, iRAPID will be a cognitive, research-oriented rehab instrument with automatic, accurate rehab training progress computation. To enable the stated goals, the system should be capable of recording a wealth of sensor measurements. Advancing the next-generation rehab system, the work
• Adopts a hierarchical (3 layers), incremental (3 modes) development strategy,
• Supports computational rehabilitation research
• Adopts evolution-oriented software design.

The instrumentation enables research an education of an exciting new field, Cognitive ElectroBiomedical Systems (CEBS), enables the training in CEEBS of two PhD students, and outreach to minorities. CEBS is a trans-disciplinary (TrD) field has distinguished features compared to multi-disciplinary (MuD) and inter-disciplinary (InD). The authors compare these fields to a cake where different ingredients are not easily distinguishable (TrD) giving a new format product, and a plate of salad that still has clear existence of different ingredients ((InD). The PhD training program will have a training structure included TrD/ MuD/InD curriculum and service learning. The Director of Multicultural Engineering Program (MEP) will assist in involving underrepresented students with summer CAMP and K-12 activities. This development is likely to highly contribute within an EPSCoR jurisdiction.
REU Site: Fundamental Research Topics Related to Unmanned Systems  
Drs. Farbod Fahimi and Ramazan Aygun, UAH

The University of Alabama in Huntsville (UAH) Research Experience for Undergraduates program focuses on the missing links of fundamental research in five related fields of science and engineering: Dynamics & Controls, Video Processing and Data Mining and Compression, Human-Machine Interface, Physics of Sensors, Material Science. As an example, one of the broader societal/economic impacts of these related fields is that they help the proliferation of Unmanned Systems civilian applications that affect humans quality of life. First, interaction-based learning controllers are formulated, which are able to learn how to control a system only by interacting with it, similar to the way humans learn how to control machines with minimum instructions. Second, vision-based object 3D reconstruction and classification will be researched. The goal is to formulate a method that only uses 2D videos to generate a 3D model of an arbitrary object, and classify objects using 2D video. In addition, the students will learn about data mining techniques for classification of phases of protein crystal growth classification of images based on presence of crystals. Third, new ways of integration of data from heterogeneous sensors will be researched. The goal is to be able to fuse data gathered from different sensor types to reconstruct a 3D environment. Fourth, research will be focused on finding optimum ways of real-time compression of video data. The goal is formulating a method that optimizes the need for computational power, use of energy, weight, and data bandwidth. Fifth, new ideas for human-machine interface will be generated. The objective is to fill the gap in the inability of human-agent interfaces to intuitively interpret the users intent. Sixth, fundamentals of physics will be employed to invent new sensors for accurate real-time measurement of high-frequency strain. Seventh, the specific catalytic activity of the IPPase under different temperatures, pH and ionic concentration will be determined.

The undergraduate students will be exposed to the state-of-the-art knowledge and background related to the research project of their choice. They will be trained in the required research techniques, methods of literature survey, generating hypotheses, formulating tests to validate hypotheses, collecting data, and communicating with colleagues via written materials and oral presentations at professional and scientific meetings. Students will solve research problems with the help of mentors, and will transform themselves into relatively independent young researchers. The research experience and independence generates enthusiasm and confidence for the students, and highly increases the their likelihood of pursuing graduate studies and careers in STEM-related fields. The program encourages diversity among US future scientific talent. Three two-year colleges and seven undergraduate institutions in Alabama and Central Southern Tennessee (EPSCoR states) are identified. The total student population of these ten institutions consists of 51% women and 82% minorities. By focusing most of the recruitment efforts on these institutions, the program aims for recruiting at least 50% of the students from two-year colleges and at least 70% participation by women and minorities. Students will prepare papers for presentation at relevant conferences and for publication in related conference proceedings and science/engineering journals.

REU Site: Development of Safe Nanomaterials for Biological Applications  
Drs. Komal Vig and Shree Singh, Alabama State University

This REU Site award to Alabama State University, located in Montgomery, AL, will support the training of 10 students for 10 weeks during the summers of 2014 - 2016. The focus of this program is to provide research experiences in the multidisciplinary fields of nanotechnology and biotechnology. Faculty from biological sciences, chemistry, physical sciences and other related disciplines will be serving as mentors for the program. All research projects will be based on novel concepts of design and development of new nanomaterials for biological applications. Students will participate in a full-time closely mentored lab research project along with seminars and various professional development workshops, such as the responsible conduct of research, professional communication skills, career opportunities in academia and industry, and the graduate school application process.
Students will present their findings at both a poster session and research symposium during the final weeks of the program. Students will also take field trips to encourage interactions with the faculty and students at Alabama State University. Housing, a stipend, and meal and travel allowances will be provided. Students will be selected based on their interest in research, academic record, and phone interviews with potential faculty mentors.

The REU program is intended to encourage students to pursue a career in STEM fields. Students will learn how research is conducted and many will present the results of their work at scientific conferences. Members of underrepresented minority groups and from colleges with limited research opportunities are especially encouraged to apply.

Program evaluation will use both internal evaluations and the BIO REU common assessment tool. Students are required to be tracked after the program and must respond to an automatic email sent via the NSF reporting system. More information is available by visiting http://www.alasu.edu/REU, or by contacting the PI (Dr. Komal Vig at komalvig@alasu.edu) or the co-PI (Dr. Shree R. Singh at ssingh@alasu.edu).

Collaborative Research: Urban Adaptation and its Role in the Success of Biological Invasion in Anolis Lizards
Dr. Daniel Warner, UAB

Urban areas are expanding rapidly around the globe, resulting in drastic changes to the environment compared to natural landscapes: buildings and parking lots replace natural vegetation in cities. The urban environment, which encompasses a major portion of the US, directly affects the ecology and evolution of species, but little research has been conducted to understand the intensity and scope of these effects. Another critical dimension of global change is biological invasions, which threaten biodiversity worldwide. This project connects two important dimensions of global change to test a novel hypothesis that urban adaptation may increase the success of biological invasions, which often have dramatic ecological and economic effects on the invaded habitats. This award will also support the STEM training of a postdoctoral researcher and numerous graduate and undergraduate students. Curriculum materials will be developed for K-12 education and outreach efforts will target the urban areas where this research will be conducted and where the research team members live.

The way organisms interact with their environment is expected to drive intense natural selection on their morphology and behavior. This work will study the crested anole lizard, which is native to Puerto Rico but established via human-mediated introductions in several places outside its natural range. This research will use field and laboratory studies to first test the hypothesis that a widespread lizard species is adapted behaviorally, morphologically, and physiologically to urbanization. Second, the study will test if adaptation occurs at multiple life history stages, including embryos and juveniles. Lastly, the study will investigate a novel idea in invasion biology that adaptation to urban environments may predispose populations to become successful invaders of other urban areas, using molecular data to identify source populations. Detailed portions of the research will estimate thermal tolerance and examine behavioral thermoregulation in different habitats, use SNPs to identify the source population of the invaders, and examine habitat influence on development in the field. This research will help to establish whether or not adaptation to urban areas can facilitate the process of biological invasion, and will likely lead to conclusions that can be generalized across other urban tolerant species and biological invasions.

RUI: Confirmation of the roles of fungal genes in plant stress tolerance
Dr. Mustafa Morsy, University of West Alabama

The 3-way symbiosis at the focus of this project is intriguing by virtue of the host plants gaining tolerance to soil temperatures of up to 125°F, a temperature at which most plants cannot grow. Plants survive this temperature due to their association with a particular fungus infected with a specific virus. Virally infected fungi living symbiotically with a host plant provide heat tolerance to a wide range of crop plants including tomato, corn, and rice. In a field trial, tomato plants harboring a fungal-viral symbiont showed improved growth and fruit production at elevated temperatures compared to non-infected plants. With
the US economy losing more than $15 billion annually in crop production due to environmental factors, it will be potentially helpful to understand the mechanisms by which thermotolerance is induced in this virus-fungus-plant symbiosis. Insights gained from the research are likely to help in the development of methods to retain crop productivity in the face of high temperature stress. The project will provide hands-on multidisciplinary research training and educational opportunities for underrepresented minorities and first-generation college students at the University of West Alabama, a designated Minority Serving Institution. In addition, the project will include an educational outreach program for underprivileged K-12 students and adults through the Science Saturdays and Science Coffee Shop outreach programs, respectively. Finally, the physiological and molecular roles of fungal metabolites in stress tolerance will be of broad interest to the scientific community.

In the geothermal soils of Yellowstone National Park, where temperatures can reach 65°C, a 3-way mutualistic association has evolved among panic grass (Dichanthelium lanuginosum) and a fungal endophyte (Curvularia protuberata) bearing a mycovirus, Curvularia thermotolerance virus (CThTV), which allows the 3 organisms to cooperatively survive extreme temperatures. Metabolic analyses showed significant changes during stress in our model system tomato (Solanum lycopersicum) infected with C. protuberata. The data collected in those analyses provide strong evidence that fungal trehalose and melanin are essential for the heat-stress tolerance mechanisms conferred by the 3-way symbiosis. In addition, CThTV contributes to thermotolerance via its interaction with a fungal translationally controlled tumor protein (TCTP) and catalase/peroxidase (KatG), which control fungal cell cycle and cellular redox, respectively. The hypotheses of this research are that C. protuberata carrying CThTV confers thermotolerance in plants via: 1) production of large quantities of trehalose, which is transported into plant tissues and functions as a signalling or osmoprotectant molecule to regulate plant biochemical processes during stress; 2) fungal melanin, which likely alters fungal cell walls to control trehalose transport into and accumulation in plant tissues during stress; and 3) CThTV, promotes thermotolerance by interacting with fungal TCTP and KatG to control fungal cell cycle and cellular redox during stress. In particular, the proposed research is designed to test the involvement of fungal trehalose, melanin, TCTP, and KatG genes in thermotolerant tomato associated with fungal-viral symbionts. The aims of this study are to: 1) knock down the trehalose, melanin, TCTP, and KatG genes in thermotolerant C. protuberata-carrying CThTV, thermotolerance will be completely abolished in trehalose or melanin synthesis knock downs, and reduced by knocking down TCTP or KatG expression; and 2) overexpress the same genes in non-thermotolerant C. protuberata without CThTV, plants are expected to gain thermotolerance characteristics in the case of trehalose and melanin biosynthetic gene overexpression, and exhibit improved thermotolerance in the case of TCTP and KatG overexpression.
Spectroscopic, Collisional, and Laser Cooling Studies of Atomic Gadolinium
Dr. Clayton Simien, UAB

A new element will be investigated as a prospective candidate for a next generation optical atomic clock and for laser cooling. Atomic clocks have been instrumental in the advancement of science and technology in the twentieth century, leading to innovations such as global positioning, advance communications, and tests of fundamental particle physics. A next generation optical atomic clock would extend the capabilities of these systems and will enable a renaissance of timing applications such as enhanced security for data routing and communications, advanced earth and space time-based navigation, geophysical surveying, testing Einstein’s Theory of General Relativity, and searches for variations in the fundamental constants of the universe. Laser cooling is a technique for which the mechanical action of light is used to reduce the velocity of an atom in a gas. The use of lasers to cool atoms opened up new frontiers in physics ranging from the formation of new states of matter to enabling novel nanotechnologies. The extension of laser cooling to a new atomic species will enable the creation of novel ultracold atomic systems with unique properties and dynamics. The goal of this project is to investigate the atomic physics properties and implement laser cooling of atomic gadolinium for its potential use as an optical frequency standard and as a step to create new research avenues in atomic physics cross-fertilized with condensed matter physics. More specifically, these experiments will use lasers as a probe to determine the influence of external perturbations that limits its accuracy as an atomic clock. In addition, the spectral features of gadolinium will be characterized as a diagnostic tool to determine its cooling limits. This specific milestone will enable a gadolinium optical clock of greater accuracy and the realization of exotic ultracold quantum physics systems. This research program will support and train undergraduate and graduate students to become the next generation of scientists and engineers for fundamental and applied research in Atomic, Molecular, and Optical Physics.

This project is an experimental research program directed towards investigating collisional and spectroscopic properties of atomic gadolinium (Gd). Gd is a novel class of atom that has an exotic electronic configuration and large ground state magnetic moment, which allows it to have submerged shell optical clock transitions, ultracold collisions having ground state angular momentum, and exotic quantum gas phases and phenomenon dominated by dipole-dipole forces. In particular, the collision studies involve measurements of collision quenching cross sections, and pressure broadening and shifts of the atomic states and line shapes of the optical clock and laser cooling transitions inside a Gd vapor cell. The objective is to characterize the collision sensitivity of these atomic transitions to give insight into the combined action of electron screening and configurational interactions. In addition, the radiative lifetimes, hyperfine structure, and isotope shifts of identified intercombination laser cooling transitions will be determined using laser induce fluorescence spectroscopy with an atomic beam. The determination of these spectroscopic properties are necessary for implementing narrow-line laser cooling for both bosonic and fermionic isotopes of gadolinium. Narrow-line laser cooling is essential for achieving quantum degeneracy with gadolinium, since its large ground state magnetic moment prevents evaporative cooling in a magnetic trap. In addition, laser cooling and trapping using electric-dipole transitions will be executed to create a magneto-optical trap of gadolinium as a first step towards performing precision measurements, investigating ultracold collision, and for studying atomic dipolar physics.

The experimental program will have three categories of broader impacts. First, forbidden transitions of rare earth elements are virtually unexplored. These atomic resonances are well suited as potential candidates for next generation frequency standards, with Q-factors nearly four orders of magnitude larger than current neutral atom clock lines, a suppression of black-body radiations shifts by exponents
in the fine structure constant, and reduced sensitivity to collision. Moreover, for Standard Model Physics, these transitions have enhanced sensitivities to variations in the fine structure constant. Second, a laser cooled and trapped gas of gadolinium will allow for economizing nuclear fuel consumption, ultrasensitive isotope trace analysis of the element for cosmo-chemical studies and biomedical sample testing respectively. Also with respect to nanostructure fabrication, an ultracold gas of Gd can be used for controlled doping or nanoscale milling to create novel magnetic devices. Third, graduate and undergraduate students who will help perform the proposed experiments will be trained. A goal of this project is to attract and retain more students in Atomic Molecular and Optical physics through the involvement of university students in the proposed experiments. This is augmented by the fact that the University of Alabama at Birmingham (UAB) is a major research institution in the geographical region with an annual enrollment of nearly 18,000 students, and the research project involves the extensive use of lasers that is ideal for capturing a student’s imagination. An additional goal is to recruit underrepresented minorities, which represents 25 percent of UAB’s student population. Underrepresented minorities represent a large untapped wealth of potential for becoming contributors in the fields of science and engineering. To help address this matter a major plan is to involve minority graduate, undergraduate, and high school students via existing UAB outreach and REU programs to participate in research projects in the Simien Spectroscopy and Laser Cooling group. Furthermore, special outreach activities will be done with the aim to get K - 12 students interested in science and engineering by performing various physics, chemistry, and material science demonstration at local schools in the region.

The Role of AMPA Receptors in Activity-dependent Myelination
Dr. Tara DeSilva, UAB

In adult demyelinating diseases such as multiple sclerosis, new early stage myelin-producing cells proliferate but fail to rebuild the insulation around nerve fibers as they would during normal development. Myelin increases the speed and efficiency of nerve impulses, protects the nerve fiber from injury, and provides metabolic support to nerve fibers. The aim of this project is to determine how glutamate signaling between nerve fibers and early stage myelin-producing cells provides a signal that directs development of the myelin sheath. Beyond its potential to increase our basic understanding of normal myelination processes, the work also has the potential to increase our understanding of demyelinating diseases, such as multiple sclerosis. The PI will instruct, participate, and oversee all experiments outlined in the research proposal. In conjunction with the University of Alabama Center for Community Outreach Development (CORD), members of the DeSilva laboratory will give a one hour interactive lecture highlighting how myelin increases the speed of nerve impulses, and the emerging roles of glia in the central nervous system to designated 7th grade programs (~400 students/year; 98% minority and 60% high needs). Furthermore, through the National Multiple Sclerosis Foundation the DeSilva laboratory will hold a bi-annual lab tour and lecture to educate the community about advances in her laboratory on myelin research.

It is known that vesicular release of glutamate from axonal synapses induces glutamate receptor mediated currents in postsynaptic oligodendrocyte progenitor cells (OPCs). The goal of this project is to determine how this glutamatergic axon-glial signaling process promotes myelination. Preliminary data suggest that activity-dependent mechanisms generate action potentials causing axonal release of glutamate, which then activates glutamate receptors (AMPA receptors) on OPCs to elicit a mitogen-activated protein kinase (MAPK) signaling cascade, known to be important for myelination. The PI developed a novel in vivo approach to mechanistically link retinal ganglion cell activity with glutamatergic axon-OPC signaling in the optic
nerve by either (a) regulating retinal ganglion cell action potentials or (b) inducibly deleting AMPA receptors on OPCs using a cell specific knockout mouse. Alterations in the phosphorylation state of the AMPA receptor-MAPK pathway in OPCs will be evaluated using fluorescence activated cell sorting. Perturbations in myelin thickness of axons in the optic nerve will be determined using electron microscopy. These measurements will elucidate sensitive periods when neuronal activity is necessary to promote AMPA receptor-MAPK signaling necessary for OPCs to mature and form the myelin sheath. Knowledge gained from these studies will establish a fundamental mechanism in axon-OPC communication with important ramifications for promoting central nervous system repair in multiple sclerosis.

**CAREER: Towards an accurate and illuminating theory of weak interactions between open-shell systems**

Dr. Konrad Patkowski, Auburn University

Konrad Patkowski of Auburn University is supported by the Chemical Theory, Models, and Computational Methods program in the Chemistry division to develop a new approach to computing noncovalent interaction energies between open-shell systems - a multireference version of symmetry-adapted perturbation theory (SAPT). The unique feature of SAPT is its combination of high accuracy and interpretive power, the interaction energy is obtained as a sum of well-defined contributions corresponding to electrostatics, exchange repulsion, induction, and dispersion. Prof. Patkowski and his group extend the applicability of SAPT to interacting systems with significant static correlation that cannot be described by a single Slater determinant. The newly formulated methods are used to compute and interpret interaction energies involving atmospheric radicals, organic polyradicals, and small molecules adsorbed within metal organic frameworks. The knowledge gained in this way helps design new frameworks that can be more effective in gas separation, in particular, in removing carbon dioxide from flue and exhaust gases so that it does not get released into the atmosphere. The new methods are implemented in an open-source computer code that is freely available to other researchers. In addition, Prof. Patkowski and his group are developing hands-on computational chemistry modules within the framework of the Auburn University Summer Science Institute, providing realistic research experience to gifted high-school students and enhancing their awareness of the careers in science.

An example fragment of a metal organic framework (with the transition metal ion in purple) interacting with a carbon dioxide molecule: a model for the study of carbon dioxide capture using methods developed in this project.
CAREER: Research on Weather and Climate Impacts of Land Use and Land Cover (LULC) Change-Supporting Technology-Driven Science Inquiry as Pedagogy
Dr. Udaysankar Nair, UAH

The impacts of Land Use and Land Cover (LULC) change on weather and climate are expected to vary depending upon the island geometry (size, aspect ratio and shoreline shape) and terrain. A conceptual understanding of such variations will be established though idealized numerical modeling experiments (NME). The concept developed will be used to analyze more realistic NME, investigating the weather and climate impacts of observed LULC changes (2000-2010) in the maritime continent, which exerts an important influence on tropical climate. Educational aspects of this project is the integration of Polaris, a discovery engine designed for operating on big data, with NME outputs generated from the Principal Investigator’s (PI) research (past, ongoing and future) to transition from a deductive to inductive methodology for teaching of graduate level courses in Atmospheric Dynamics.

LULC change can have a substantial impact on weather and climate, but varies in complex fashion depending upon geographical setting, especially terrain and continentality. A conceptual framework for understanding the geographic variability is gradually emerging from prior studies, including those of the PI. The research activities will lead to an important addition to this framework, namely the impact LULC change in the context of island settings, and improved understanding of the effect of deforestation in the maritime continent. Note that the influence of the maritime continent on tropical climate is disproportionate to its land area, contributing to 40% of latent heating in the global tropics (~twice compared to continental convection). A large portion occurs in the vicinity of small islands as sea breeze initiated convection and is potentially impacted by LULC changes. Thus the proposed research is relevant and important, especially in the context of the IPCC determination that radiative forcing caused by land-atmosphere interactions is not well quantified, and is one of the key uncertainties.

Whereas tools for big data analysis are becoming more common in field of Atmospheric Science, incorporation of this capability in classroom settings is lacking. Analysis of large datasets to establish relationship between atmospheric variables relevant to a phenomenon, and inferring the nature of theoretical framework needed to analyze it is an effective method for teaching of Atmospheric Dynamics. Learning in such an inductive setting mimics the natural development of the field. However, the pedagogy required for this purpose is also lacking. The PI addresses these critical gaps through integration of his research and educational activities.

The LULC change impacts could be exacerbating or mitigating the effects large scale climate trends in the maritime continent. For some island settings, deforestation could lead to decrease in rainfall over agricultural regions and thus the concern that increase in productivity gained from expanding the crop lands may be negated by reduced rainfall caused by deforestation. Thus the results from this study have the potential to inform and lead to better policy formulation regarding climate change mitigation and sustainable environmental management. Atmospheric dynamics is often a very difficult course for students in atmospheric science. The teaching method developed via this award has the potential to transition students from mimicry to mastery, improving research creativity and retention in graduate programs. The proposed educational portal will document and share the big data supported inductive pedagogy with a wider community, allowing continued evolution from other educators and students.

CAREER: Elucidating MicroRNA Function: What Are They Targeting?
Dr. Glen Borchert, University of South Alabama

MicroRNAs (miRNAs) are noncoding RNAs widely believed to function primarily in repressing the translation of protein coding messenger RNAs (mRNAs) through complementary basepairing. While novel miRNA discovery has led to the identification of over 24,000 of these ~20 nucleotide RNAs over the last decade, progress in deciphering what genes individual miRNAs are regulating has proven exceptionally challenging largely due to miRNAs requiring very little sequence complementarity to the mRNAs they
coordinate. In contrast to short interfering RNAs (siRNAs) which depend upon almost perfect complementarity to direct message degradation, miRNA target recognition and consequent repression can be mediated through as few as 7 base pairs. This CAREER project will characterize several novel caveats to accurate miRNA targeting including: 1) a subset of miRNAs whose targets cannot be identified by examining genomic sequence as they regulate edited RNAs in the transcriptome, 2) a subset of miRNAs whose targets cannot be identified by screening mRNA sequences as these miRNAs were originally formed from, and therefore likely regulate, other noncoding RNAs, and 3) a subset of miRNAs initially formed from transposable elements, which leads them to target mRNAs containing related transposable element sequences. This research will fill in major gaps in our knowledge of miRNA function and significantly clarify and potentially transform miRNA target prediction through improving the parameters widely utilized by thousands of miRNA research scientists currently using internet-based target prediction programs to generate hypotheses and design experimental strategies.

The proposed CAREER research activities are intimately intertwined with an extensive educational framework incorporating high school, undergraduate and graduate students. In the classroom, education and research will be integrated through a novel computational genomics course, recently developed by PI Borchert, which will directly utilize undergraduates to execute the computational analyses outlined here. Utilizing a project-based learning strategy, this course equips students with a novel informatics tool set and teaches them how to work independently and in small groups to complete a class-wide research analysis. Significantly, in its first two semesters, this pilot course has generated 35 student authorships on peer-reviewed articles. Additional impacts accompanying the adoption of this course include the development of departmental infrastructure for research and education through the enhancement of computer lab facilities, presentations at professional meetings on incorporating research into the undergraduate classroom, and disseminating class informatics training exercises and guidelines for instructors on how to implement similar project based learning strategies on the course website. In the laboratory, education and research will be integrated through mentoring high school, undergraduate and graduate students in hypothesis-driven research projects at the interface of biology and computer science. While undergraduate and graduate researchers will be primarily charged with executing the experimentation outlined here, the Borchert laboratory will also offer summer internships to promising local high school students for the duration of this award. While there are several outstanding high schools in the Mobile area, there are also several struggling, predominately African-American inner city schools that will be directly targeted for the recruitment of interested, talented summer interns. Importantly, at least one position will be reserved for a local minority student each summer helping to expose these students to role models in the biological sciences. These efforts are intended to increase successful completion of BS degrees, increase pursuit of graduate education, and increase freshman enrollment in biology by members of underrepresented groups.
CAREER: Regulatory Mechanisms of Pathogen-Mediated Cellular Stress Signaling in Arabidopsis: Taking Plant Molecular Biology to the Urban Garden
Dr. Karolina Mukhtar

This project will establish an innovative and coherent platform to significantly enhance our understanding of pathogen-mediated endoplasmic reticulum (ER) stress in plants, train next-generation minority scientists, and engage an urban community in citizen science. The research scope of the project addresses a unique connection between the cellular stress and accumulation of unfolded proteins, and the plant immune system. Upon pathogen attack, plant cells increase production of new peptides, which consequently puts a burden on the protein folding machinery in the ER and causes cellular stress. Through this project, the investigators will learn about the molecular mechanisms underlying the efficient alleviation of this stress response in Arabidopsis. The insights gained from this research will impact the agricultural sciences by elucidating mechanisms to develop crop plants with the capacity to function under increased cellular stress - a necessity for a more sustainable future.

Situated in Birmingham, AL, a city that has one of the most diverse and impoverished populations nationwide (74% African American, 25% below the poverty line), the investigators are in a unique position to foster plant biology-related education through outreach programs for underrepresented and socioeconomically underprivileged minorities. The investigators will implement an integrative service- and discovery-based learning outreach platform "OUTPACE" (OUTreach plant PAtiology Clinic & Education) that is directed towards undergraduate students and citizen scientists: low-income urban gardening families of the local Community Gardens. OUTPACE will enable the students to acquire laboratory- and field-based knowledge of plant immunity and assist community growers in diagnosing plant diseases. These efforts are well aligned with current regional initiatives to enhance civic engagement and sustainable living, and combat urban malnutrition and hunger.

Inositol-Requiring Enzyme 1 (IRE1) is a highly conserved eukaryotic endoplasmic reticulum (ER) stress sensor. While chronic ER stress is linked with metazoan immune disorders, the role of IRE1a in plant immunity remains elusive. Recently, the principal investigator established the first known connection between the IRE1a and its client mRNA for the bZIP60 transcription factor in Arabidopsis immune signaling. Based on these findings, the investigators will expand their research questions to other key areas of ER signaling in plant immunity and address the following objectives: 1) Understanding the molecular mechanisms of biotic stress-dependent IRE1a activation and deactivation under oscillating ER stress conditions; 2) Elucidating the regulatory mechanisms of IRE1a functions in cellular adaptation or pathogen-mediated cell death; 3) Deciphering the feedback mechanisms between IRE1a and the salicylic acid receptor NPR1; 4) Genome-wide discovery and characterization of novel IRE1a substrates. To achieve these goals, the investigators will employ well-established and newly developed methodologies, including: mutant/transgenic plants studies, in planta fluorescent reporter-based microscopy, pathogen infections and cell death assays, protein-protein interaction and enzymatic assays, a novel yeast reporter-based system, transcriptional profiling, and bioinformatics-aided analyses.
The DOE EPSCoR Program is positioned in the Office of Science and is the single largest supporter of basic research in the physical sciences. It supports both basic and applied research and development across a wide range of interdisciplinary program areas that include, Advanced Scientific Computing Research, Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, High Energy Physics, Nuclear Physics. The goals of the DOE EPSCoR program are to:

- Improve the capacity to conduct sustainable and national competitive energy-related research
- Jumpstart infrastructure development through increased human and technical resources, training scientists and engineers in energy-related areas
- Build beneficial relationships with ten world class laboratories in designated states and territories, leverage DOE national user facilities, and take advantage of opportunities for intellectual collaboration across the DOE system.

The Alabama DOE EPSCoR program is the central coordinating unit responsible for energy-related research and human resources development issues for the state. Dr. John Steadman, Dean of the University of South Alabama’s College of Engineering, serves as the Alabama DOE EPSCoR Program’s Agency Director.

Twenty-five states are currently eligible for DOE EPSCoR (see photo). Iowa, Tennessee and Utah lost eligibility in February 2013. DOE EPSCoR provides funding support through three types of awards including the Implementation Grant, National Laboratory Partnership Grants, and the Early Career Research Program, each are described below.

The Implementation Grant is for a maximum period of six years with an initial period of three years. Maximum funding for Implementation Grants is $2,500,000 per year and until recently only one active implementation grant per state or territory was permitted at a time. Now any EPSCoR state or territory can apply when there is an open Funding Opportunity Announcement (FOA).

The EPSCoR-State/National Laboratory Partnership Grant is for a maximum period of 3 years. Maximum funding for these grants is $200K per year with no state matching funds required. PIs on current DOE grant awards are not eligible to serve as PIs on Partnership Grant applications. Grants allow EPSCoR researchers to work closely with DOE National laboratories to conduct collaborative research and train students. Multiple submissions per state and laboratory are permitted and expected. There is no limit to the number of state or laboratory submissions per year. All funding resides within the EPSCoR state and no EPSCoR funds are permitted to support DOE National Laboratory activities.

DOE Office of Science Early Career Research Awards are limited to applications received from academic institutions in EPSCoR jurisdictions. A particular DOE Program Area/Office many nominate meritorious applications that would not have been otherwise considered for joint consideration by multiple program areas on a funds available basis.

Alabama DOE EPSCoR Implementation Grant

In March 2014, with short notice and confirmation of eligibility from the Department of Energy, Alabama DOE EPSCoR distributed a letter-of-intent (LOI) request for a state-wide research team to submit to the DOE Implementation grant by April 2014. Seven letters-of-intent, one each from the seven Alabama EPSCoR institutions, were received. The Alabama EPSCoR Steering Committee selected one LOI to be developed into a full proposal. Drs. David Hinton, Yogesh K. Vohra, Ryoichi Kawai and Joseph G. Harrison, (UAB); Patrick LeClair (UA); Jeffrey Weimer and Emanuel Waddell, (UAH); Jianjun Dong, (AU), along with Jacob Burress and Albert Gapud, (USA) proposed a project entitled, Alabama-DOE Partnership in Superconducting Materials, to study the electronic, optical, structural, and magnetic properties of condensed matter to the DOE EPSCoR Implementation grant competition by mid-April 2014. Unfortunately, Alabama’s proposal was not accepted for funding.
NEPCM/ HRD Implementation Grant

In August 2009, Alabama DOE EPSCoR was awarded a DOE EPSCoR Implementation Award entitled, “Nano-Structure-Enhanced Phase Change Materials (NEPCM) Tailored for Energy Efficiency, High-Power Electronics, Thermal Storage/Comfort and Building Materials Applications”, for an initial three years for $1.9M with a matching commitment of $1.1M. The award was located at The University of Alabama and was extended until August 2013. Dr. John Steadman, Dean of the College of Engineering at the University of South Alabama, served as the Project Director and is responsible for the Human Resource Development component. Dr. Jay Khodadadi, Mechanical Engineering Professor at Auburn University, served as the Research Cluster Principal Investigator. The Research Cluster collaborators included: Drs. German Mills and R.L. Jackson, Auburn University; Dr. Muhammad Sharif, University of Alabama; Dr. Tamara Floyd-Smith, Tuskegee University; Dr. Luis Cueva-Parra, Auburn University in Montgomery; and Dr. Kuang Ting Hsiao, University of South Alabama.

In August 2013 the DOE EPSCoR NEPCM project was awarded a two year extension (8/15/2013 to 8/14/2015) for $294K to take the experimental aspects of the project to completion. Drs. Jay Khodadadi and German Mills at Auburn University as well Dr. KT Hsiao at the University of South Alabama were provided support to fund graduate students, travel, and purchase supplies. The researchers will travel to industry related conferences to present their research results. (See below for an update on the research).

The Human Resource Development component continues to support travel for researchers to visit a DOE National Laboratory either for a brief or extended visit and/or present at energy related conferences. This encourages researchers to establish and develop relationships with researchers at DOE National Laboratories or future collaborators. During Year 4 of the grant, students and faculty traveled to several national labs including: Argonne National Lab to perform research on 3-D integration, Oak Ridge National Lab to assess software engineering practices, and Brookhaven National Lab to conduct proof-of-concept tests. Faculty and students also presented research findings at numerous energy related conferences including the American Vacuum Society, 49th Annual Technical Meeting of the Society of Engineering Science, Southwestern Regional American Chemical Society, American Institute of Chemical Engineering, 245th American Chemical Society, Carbon Capture Utilization and Sequestration Conference, Society of Tribologists and Lubrication Engineering, American Society of Heating, Refrigeration and Air Conditioning Engineering. A post doc was also funded to attend a training session at the Institute for Genomic Research.

NEPCM Research

A stepwise procedure was developed to produce surface-coated spherical CuO nanoparticles with concentrations of up to 20 wt% in a variety of hydrocarbons. Long-term stability against particle precipitation was observed for concentrations ≤ 5 wt%. Copper colloids stable in air-free octane were prepared via a simple photochemical method in which the solvent acted as the agent that reduced Cu(II) ions. Detailed mechanistic information about the generation of this novel colloid enabled utilization of the photosynthetic method to achieve stable colloids of Ag, Pd and Pt in alkanes. The photochemical studies provided knowledge about the key role played by oleoyl saecosine as a particle stabilizer. Utilization of this knowledge enabled optimization of reaction parameters (choice of solvent and amount of stabilizer) that ultimately resulted in a very straightforward thermal procedure for the synthesis of concentrated Ag colloids in alkanes. Despite their seemingly ideal properties, only modest enhancements in thermal conductivity were exhibited by the Ag colloids. Currently research is focused on development of nanorods.

Thermal conductivity of the CuO colloids were measured in both liquid and solid states using the transient planar...
source technique. No anomalous improvement of thermal conductivity beyond those predicted by the effective media theory was observed. Molecular dynamics (MD)-based non-continuum simulations of freezing of hydrocarbons in presence of nanoparticles, nanotubes and graphene were conducted. Nanotubes and graphene structures provided templates that promote crystallization of the phase change material leading to improved thermal conductivity. The effect of the length of the chain of alkanes on thermal conductivity was also assessed using MD. Infiltration of phase change materials into pores of carbon foam and subsequent freezing and melting of the system were investigated both computationally and experimentally. Presence of a gas void formed during infiltration was shown to affect the melting/freezing times and the improved thermal conductivity values. Continuum modeling of colloids using a two-fluid model that accounted for rejection of the suspended particles was used to capture growth of dendritic structures during freezing of colloids.

Many approaches to separate the nanoparticles suspended in hydrocarbons were studied. The specific colloidal mixture of dodecane (C12H26) and CuO nanoparticles (1% - 5% mass fraction and 5-15 nm size distribution) was considered. The identified methods include (i) distillation under atmospheric and reduced pressure, (ii) high speed centrifugation, (iii) destabilization of the nanoparticles by adding chemical agents thereby inducing gravitational precipitation, (iv) silica-column chromatography, (v) silica adsorption and (vi) nanofiltration. Performance of these separation methods was analyzed in relation to their effectiveness.

Utilization of colloids in conjunction with microfluidics for microelectronics cooling applications was investigated. A platform for studying microelectronics cooling methods was fabricated and characterized. Both conventional cooling methods and novel cooling methods using microchannels and NePCM were investigated. Further increases of cooling were achieved by switching from PCM to NePCM. A fundamental investigation of NePCM thermal conductivity using non-spherical particles synthesized using stop flow lithography, a microfluidics-based method, was also studied.

A group of undergraduate students concentrated their efforts on development of Molecular Dynamics, Monte Carlo, and Lattice Boltzmann modeling and simulation techniques, and the associated Visualization and Computer Graphics tools. The computational tools were applied to simple fluids for determination of thermophysical properties and thermal transport colloidal systems with some success.

Tribological effect of nanoparticle colloidal lubricants was investigated. Tribological properties of a nano-lubricant that consists of CuO nanoparticles (9 nm average diameter) suspended in mineral base oil using sodium oleate (SOA) as a surfactant are investigated. Nano-lubricants with concentrations of 0.5, 1 and 2 %wt were investigated using a disk-on-disk friction and wear test in the boundary lubrication regime. The CuO/SOA nanoparticle additives reduce the friction between the lubricated disks. Wear analysis based on profilometry suggest that the wear increases with concentration up to a 1 %wt and then decreases for a 2 %wt nano-lubricant. SEM/EDS results suggest that nanoparticles are present on the surfaces after the tests. Different possible mechanisms for nanoparticles at the boundary lubrication were evaluated and reduction in the real area of contact was suggested as the possible mechanism. Modeling of nanoparticles in contact between surfaces uses two sub-models to handle different scales of contact, namely the nano-sized particles and micron-sized roughness features. The results suggest that particles would reduce the real area of contact and therefore decrease the friction force. Also, particles could induce abrasive wear by scratching the surfaces. Friction tests for a nano-lubricant in the elasto-hydrodynamic lubrication regime show that the presence of nanoparticles reduces friction. Through surface analyses and molecular dynamics simulation, effectiveness of different interactions in the system was studied. A novel friction reduction mechanism has been deduced, that is the nanoparticles can induce an obstructed flow in the thin film between lubricated surfaces.

Synthesis and thermal conductivity characterization of colloids of CNF/paraffin wax and HHTCNF/ZnCl2 were studied. The paraffin matrix shows that the thermal conductivity enhancements due to 8 wt% HHTCNF doping were 126.3 and 210.8% in the liquid and solid phases, respectively. The LHT grade CNF provided much less thermal conductivity enhancement. Therefore, it has been concluded that the thermal conductivity enhancement of a CNF/paraffin NEPCM substantially depends on the phase of the PCM, the loading of CNF and the type of CNF used. For the high
temperature HHTCNF/ZnCl2 system, the 8 wt% HHTCNF/ZnCl2 colloid improved the thermal conductivity by almost 200%. Compared with the base paraffin wax PCM, the 8 wt% HHTCNF/paraffin system significantly accelerated the discharging speed and the charging speed to 3 times (340%) and 2 times (200%), respectively. A numerical study of heat dispersion of the liquid-phase NEPCM was performed. Through the unit cell non-isothermal computational fluid dynamics (CFD) simulations, it was concluded that the heat dispersion effect can be approximated as a function of the Peclet number, Reynolds number, and nanoparticle volume fraction. For a simulated micro-channel flow study of a liquid-phase NEPCM consisting of 5% volume-fraction CuO-paraffin, heat dispersion was found to increase the total heat transfer by about 8%.

**DOE EPSCoR State Laboratory Partnership Awards**

The last Funding Opportunity Announcement for State Laboratory Partnership awards was issued April 2009 with proposals due the following November. Dr. Shanlin Pan, Associated Professor, Department of Chemistry at the University of Alabama has the only Alabama State Laboratory Partnership award which began August 15, 2010 and was extended to August 30, 2014.

The central research goal of the Pan group at UA is to study activities of small particles such as electrons in solar cell devices made of organic materials. These organic materials are low cost and can be made in various colors in order to absorb the entire sun light spectrum. This effort of seeking detailed movement of small particles is particularly important to received improved understanding, at the molecular level, of how organic solar cells work, and the challenging issues of current technologies. These challenging issues include how the small particles (charges) must move quickly enough across the organic thin layers in a solar cell, and how they can be produced by sun light more effectively using the organic thin layered materials in a solar cell. Long term stability of organic materials in air is another challenging issues this kind of solar cell faces today.

The Pan group takes tiny cross sections from an organic solar cell and placing them under their “spectroelectrochemistry” microscope and observes how the small particles’ behavior will be affected sending and withdrawing voltage into the samples. The advantage of using this specialized microscope his group has built is to provide good optical and special resolution to study these particles at the nanometer (1 nanometer=10-9 meter) scale. In his recent research publication in a journal Phys. Chem. Chem. Phys, Dr. Pan and his 3rd year graduate student Jia demonstrates this optical microscope technique for studying organic molecules individually. They learn that the electron transfer in such organic molecules placed on a metal oxide surface in quite heterogeneous. Along with another graduate student Mr. Caleb Hill, who is apparently doing his postdoctoral study with a famous electrochemist Professor Allen J. Bard in UT-Austin, Dr. Pan invented a light scattering technique. This technique allows his group to study the growth of single particles at the nanometer scale. Dr. Pan has filed a provisional patent on his technique. This invention is also published in a top chemistry journal J. Am. Chem. Soc. in 2013.

*Graduate student of the Pan group is studying redox activities of single molecules using his spectroelectrochemistry microscope*
The NASA EPSCoR program strengthens the research capabilities of 28 jurisdictions (see below map) that have not in the past participated equably in competitive aerospace and aerospace-related research activities. EPSCoR provides eligible jurisdictions with funding to develop a more competitive research base within their jurisdiction and member academic institutions. The NASA EPSCoR mission is to:

- Increase the understanding, assessment, development and utilization of space resources and provide a strong education base.
- Promote partnerships and cooperation among universities, federal, state, and local governments, and aerospace related industries.
- Provide a university based network responsive to the nation’s aerospace needs.

The Alabama NASA EPSCoR program builds upon existing strengths within the State, using facilities and personnel at the Space Grant Universities and at the NASA Marshall Space Flight Center (MSFC) but extending these to a new set of teachers, researchers, students, and industrial collaborators. The Alabama NASA EPSCoR Program Director also serves as the Alabama Space Grant Consortium Director. The goals of Alabama NASA EPSCoR are to (1) effect a permanent increase in the national research base within their jurisdiction and member academic institutions; (2) enhance research areas which already have strength and which are closely related to special needs of Alabama; (3) provide the basis for continuing expansion of basic research in Alabama in the post-EPSCoR era.

NASA EPSCoR uses two primary funding mechanisms, both types require cost-sharing of 1:1.

The **Research Infrastructure Development (RID)** component enables jurisdictions to build and strengthen relationships with NASA researchers and are awarded to junior faculty. The RID has a three-year base period of performance with a potential single, two-year renewable period of performance. Currently awards are $125K per year. A one-to-one match (cash or in-kind) is required for every NASA dollar awarded.

The **Cooperative Agreement Notice (CAN)** solicits topic-specific proposals addressing high-priority NASA research and technology development needs. Awards are up to $750K for a three-year performance period. Of that, $75K is awarded to Dr. John Gregory (Alabama’s NASA EPSCoR Program Director) at the University of Alabama in Huntsville and $675K is awarded to the researcher. A one-to-one match (cash or in-kind) is required for every NASA dollar awarded. NASA intends to announce the EPSCoR CAN for Research Awards yearly, pending funding availability.

In 2013, Alabama NASA EPSCoR was awarded five NASA Seed Grants and one Cooperative Agreement Notice. (see below table).

<table>
<thead>
<tr>
<th>Type of Award</th>
<th>PI</th>
<th>Title</th>
<th>Inst.</th>
<th>Award Amt</th>
<th>Matching Amt</th>
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<td>NASA Seed Grant (Research Infrastructure Development (RID) of EPSCoR)</td>
<td>Dr. George Nelson</td>
<td><em>Assessing Solid Oxide Electrolyzer Degradation Driven by Gas Consumption</em></td>
<td>UAH</td>
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<td>NASA Seed Grant (Research Infrastructure Development (RID) of EPSCoR)</td>
<td>Dr. Lingze Duan</td>
<td><em>Compact, low-cost semiconductor lasers with ultra-high frequency stability</em></td>
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<td>32,000</td>
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<td>NASA Seed Grant (Research Infrastructure Development (RID) of EPSCoR)</td>
<td>Dr. Sarma Rani</td>
<td><em>Prediction of Combustion Dynamics in Rocket Engines through Computational Enhancements in Loci-CHEM</em></td>
<td>UAH</td>
<td>31,811</td>
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<td>NASA Seed Grant (Research Infrastructure Development (RID) of EPSCoR)</td>
<td>Dr. T. Grant Glover</td>
<td><em>Carbon Dioxide Adsorption in Composite Adsorbent-Supported Ionic Liquid Materials</em></td>
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<td>16,000</td>
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<td>NASA Seed Grant (Research Infrastructure Development (RID) of EPSCoR)</td>
<td>Dr. Jaber Abu Qahouq</td>
<td>Distributed Energy Storage System Architecture and Control for Longer and Healthier System Life and Energy Sharing for Space and Vehicle Applications</td>
<td>UA</td>
<td>16,000</td>
<td>16,000</td>
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<td>Cooperative Agreement Notice FY 09 (CAN)</td>
<td>John Gregory (UAH) - Mgmt; Gary Zank (UAH)</td>
<td>The Dynamical Inner Heliosheath and the Space Radiation Environment</td>
<td>UAH</td>
<td>750,000</td>
<td>750,000</td>
<td>10/1/09 - 9/30/13</td>
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<td>Cooperative Agreement Notice FY 09 (CAN)</td>
<td>Dr. John Gregory (UAH) - Mgmt; Gregory Thompson and Mark Weaver (UAH)</td>
<td>High Temperature Shape Memory Alloys for Improved Efficiency in Aeronautical Turbomachinery</td>
<td>UAH and LA</td>
<td>750,000</td>
<td>750,000</td>
<td>9/12/09 - 9/11/13</td>
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<td>Cooperative Agreement Notice FY 10 (CAN)</td>
<td>Dr. John Gregory (UAH) - Mgmt; Dr. Hardeep Tippur (AU); Dr. Mahesh Hosur (TU); Drs. K. T. Hsiao, Martin Parker, Anh Vu Phan (USA)</td>
<td>Development of Prepreg and Out-of-Autoclave Process for Z-Aligned Carbon Nanofiber Toughened Lightweight Composites</td>
<td>UAH, AU, TU, and USA</td>
<td>750,000</td>
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<td>Cooperative Agreement Notice FY 11 (CAN)</td>
<td>Dr. John Gregory (UAH)-Mgmt; Drs. Kevin Chou, Voila Acoff, &amp; Leila Ladani (UA)</td>
<td>Electron Beam Additive Fabrication Technology for Rapid Manufacturing of Space Vehicle Hardware</td>
<td>UAH and USA</td>
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<td>Cooperative Agreement Notice FY11</td>
<td>John Gregory (UAH)-Mgmt: Ajay Agrawal and Brian Fisher (UA)</td>
<td>Experimental investigation of Noise and Thermosonic Instabilities in Low-Emission, High-Efficiency Combustion Systems for Aviation</td>
<td>UAH and LA</td>
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<td>375,002</td>
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Experimental Investigation of Noise and Thermo-acoustic Instabilities in Low-Emission, High-Efficiency Combustion Systems for Aviation
Dr. John C. Gregory, UAH; Drs. Ajay K. Agrawal and Brian T Fisher, UA

Emissions, noise, and fuel efficiency are the three areas identified by NASA to meet future air transportation needs. Lean direct injection (LDI) combustion has emerged as a promising technique to satisfy these requirements as demonstrated by research conducted at NASA Glenn Research Center (GRC). Prior studies have mainly characterized the overall emissions performance, while the physical and chemical details of the combustor flow field remain unknown. Knowledge of noise and thermo-acoustic instabilities in LDI combustion and a method to effectively control them is also lacking at present. The purpose of this study is to fill the existing gap by acquiring high-fidelity experimental data to understand detailed flow, chemical, and acoustics processes in the combustor, including interactions among them. A suite of advanced diagnostic techniques will be utilized to capture time-resolved details of turbulent fuel spray, fuel-air mixing, flame structure, and acoustics fields. Results will be used to implement a passive technique to control combustion noise and instability. In this passive technique developed at The University of Alabama (UA), ring-shaped porous inserts are placed within the combustor to modify flow-mixing and heat release processes in a favorable manner.

The Combustion Branch at NASA GRC has invested heavily on LDI combustion studies. Working with Dr. Chi-Ming Lee (Branch Chief) and his associates, we will design lab-scale combustors and operating parameters, exchange test data to improve advanced CFD models, and take advantage of the GRC test facilities providing high pressure and high flow rate capabilities. High-temperature metallic porous foam structures for our combustion studies will be produced at NASA Marshall Space Flight Center, which has invested in an Electron Beam Additive Fabrication (EBAF) system capable of fabricating metal components utilizing additive manufacturing techniques. Rolls-Royce will provide in-kind support towards the development of the proposed research which will help establish our collaboration, benefit our capabilities in combustion, and offer training and education opportunities. Project objectives are endorsed by Dr. Rudy Dudebout, Fellow and Chief Engineer at Honeywell Aerospace, who will serve in the role of an advisor to help us focus our research on industry challenges in the area. CFDRC, a Huntsville, Alabama company and leader in computational fluid dynamics (CFD) analysis software has extensive experience in modeling LDI combustion, and they will work us to improve state-of-the-art CFD models and to pursue new collaborative research opportunities.

Research will be conducted in the newly constructed UA Engines and Combustion Laboratory (ECL), which houses six isolated test cells, adjacent control rooms, and several work areas within 11,000 sq. ft. of floor space. The ECL is the first facility of its kind in an academic setting in Alabama. We have a vast array of state-of-the-art equipment for advanced diagnostics, including time-resolved stereoscopic particle image velocimetry (PIV), phase Doppler particle analysis (PDPA), high-speed imaging systems, and gas analysis equipment with fast sampling. Proposed research would leverage these capabilities to facilitate development of an internationally recognized, self-sustaining combustion research program at UA.

Proposed research combines efforts of a chaired professor (Co-I/Science-PI Agrawal) and a tenure-track assistant professor (Co-I/UA-I Fisher) with strong backgrounds in combustion and laser diagnostics. This collaboration will significantly enhance Fisher’s research program and add capability that will benefit both investigators. In addition, the project will provide education and training opportunities for graduate and undergraduate students including those from underrepresented groups. These students will bring advanced skills to the workforce to support local industry and the economy in Alabama.
Development of Prepreg and Out-of-Autoclave Process for Z-Aligned Carbon Nanofiber Toughened Lightweight Composites

Dr. John Gregory, UAH, Dr. Hareesh Tippur, AU; Drs. Kuang-Ting Hsiao, Anh-Vu Phan and Martin Parker, USA

Researchers at the University of South Alabama (USA) and Tuskegee University (TU) found that Carbon Nanofibers (CNF) could effectively inhibit the interlaminar delamination of Carbon Fiber Reinforced Polymer (CFRP) composites. As CFRP is being increasingly used in new aerospace and space vehicle applications, it is crucial to improve the survival rate against impact damage occurring operation, which typically cause the CFRP to delaminate under this surface and requires advanced non-destructive evaluation (NDE) to assess the damage area for repair.

The impact-induced delamination in CFRP structures could add risk to the vehicle and increase the operation and maintenance cost such as longer downtime due to NDE and repair. Researchers led by Dr. Kuang-Ting Hsiao (USA, Manufacturing Process) and Dr. Mahesh Hosur (TU, Impact/NDE Test, Microscopy) have conducted experiments to show that by dispersing CNF into CFRP laminate composites, the impact delamination damage area can be reduced up to 67% in the low velocity impact (ASTM D5628-07). The CNF-modified CFRP and CFRP composites were manufactured via an emerging out-of-autoclave-vacuum-bag-only (OOA-VBO) process, which can be easily scaled-up without the limitation of expensive autoclave. Figure 1 shows the impact damage areas of CFRP and CNF-modified CFRP panels. Significant difference can be found. Figure 2 shows the microscopy comparison of the impact points of CFRP and CNF-modified CFRP panels. It is clearly shown that CFRP was seriously delaminated after the impact and the CNF-modified CFRP was majorly damaged by indentation and fiber breakage. The other researchers contributed to this work are Muhammad M. Rahman (TU), Landon Wallace (USA), and Shaik Jeelani (TU).

Researchers at University of South Alabama (USA) and Auburn University (AU) found that the critical stress intensity factor of a Carbon Fiber Reinforced Polymer (CFRP) composite can be improved by dispersing Carbon Nanofibers (CNF) into the composite system.

Researchers led by Dr. Kuang-Ting Hsiao (USA, Manufacturing Process) and Dr. Hareesh Tippur (AU, Fracture Evaluation) have conducted the stress intensity factor characterization in the in-plane direction of the CFRP laminate and the CNF-modified CFRP laminate and found about 45% improvement (see Table 1). The CNF dispersed in the CFRP apparently served an important role to mitigate the fracture behavior of the CFRP. Most of CFRP in-plane elastic properties are dominated by the carbon fiber and not affected by the polymer matrix nor the nanoparticles dispersed in the polymer matrix. However, for the fracture behavior, the elastic wave propagation serves a major role causing the sudden crack development; it is possible that the CNF in the CFRP provides an effective way to disperse and/or absorb the elastic wave and increases the resistance against the fracture related damages even in the in-plane direction of a CFRP. The CNF-modified CFRP and CFRP composites were manufactured via an emerging out-of-autoclave-vacuum-bag-only (OOA-VBO) process. The other researchers contributed to this work were: Basil I. Farah (USA), Landon F. Wallace (USA), and Dongyeon Lee (AU). The results have been published in SAMPE 2012 (Society of the Advancement of Material and Process Engineering), Baltimore, MD, May 21-24, 2012.

Electron Beam Additive Fabrication Technology for Rapid Manufacturing of Space Vehicle Hardware

Dr. John Gregory, UAH; Kevin Chou, Viola Acoff and Leila Ladan, UA

Electron Beam Additive Fabrication (EBAF utilizes a high-energy electron beam to melt and fuse powders to build full-density parts in a layer by layer fashion. EBAF, a relatively new additive manufacturing (AM) technology, can fabricate metallic components, particularly of complex shapes in an efficient and cost-effective manner compared to conventional manufacturing means. EBAF can be an enabling technology for rapid manufacturing (RM) of space vehicle hardware, and thus can effectively assist in the design and development of next generation spacecraft. However, space
related applications using EBAF remain limited because the effect of EBAF parameters on part characteristics and property variations is not fully understood.

The overarching goal of this project is to broaden the effective usage of EBAF and, through fundamental process understanding, to advance rapid manufacturing of space vehicle hardware. Partnering with Marshall Space Flight Center (MSFC), this research will concentrate on EBAF of titanium alloy components. Research approaches include design of experiments, part fabrications and characterizations, mechanical evaluations, numerical models of the EBAF process physics including the thermal aspects and microstructural evolutions, and solid mechanics. Developed process models will be validated by basic experimentation to measure process variables including temperatures and melt-pool dynamics. Further, validated models will be applied to pursue NASA case evaluations of specific space vehicle hardware for EBAF applications. RM technologies such as EBAF play a vital role in the hardware development of space vehicle systems.

This collaborative research between the University of Alabama (UA) and MSFC will make contributions to both the fundamentals and space applications of EBAF, one of the core technologies in MSFC’s National Center for Advanced Manufacturing. In addition to science and technology advancements, this project will establish diverse graduate research and education programs, involving both students and faculty from underrepresented groups, to increase future workforce in the aerospace engineering fields and to strengthen UA’s research competitiveness.

**The Dynamical Inner Heliosphere and the Space Radiation Environment**

Dr. John Gregory, Dr. Gary Zank, UAH

By combining the collective expertise of the University of Alabama in Huntsville (UAH), NASA Marshal Space Center (MSFC), Alabama A&M University (AAMU), and an industrial partner EXPI, all located in Huntsville, AL, we propose to initiate the development of a physics based predictive model to describe the interplanetary radiation environment throughout the inner heliosphere, including at the Earth. To forecast and nowcast the radiation environment throughout the inner heliosphere, from the solar corona to ~10 AU, requires the fusing of three components: 1) the need to provide probabilities for incipient solar activity (both all clear forecasts and the when, where, and how strong for outbursts); 2) the ability to use these probabilities and daily solar coronal and solar wind observations to continuously model the 3D time-dependent heliosphere, including magnetic field structure, within 10 AU; and 3) the ability to model the acceleration and transport of energetic protons, electrons, heavy ions, and neutrals based on current heliospheric conditions. By developing a physics based radiation model, we will be in a position to transition it to an operational forecast and nowcast tool, positioning us to support 1) NASA’s human health radiation research program, which is critical to reduce uncertainties in radiation effects and to better define radiation limits on future space flight; 2) the NOAA Space Weather Prediction Center (SWPC), which monitors and forecasts the space weather environment and works closely with the JSC Space Radiation Analysis Group (SRAG) and other operational NASA missions; 3) the NASA JSC SRAG which provides and coordinates operational support to human space flight; 4) robotic missions, where the focus is on designing spacecraft to survive the space radiation environment, and for which operational support varies widely from project to project, and finally 5) ongoing defense needs. A successful outcome to this project will therefore significantly increase future research opportunities by opening up a large and varied potential customer base, both in research and in applications to government/federal, defense, and aerospace industrial needs.
High Temperature Shape Memory Alloys for Improved Efficiency in Aeronautic Turbomachinery

Dr. John Gregory UAH, Co-I/Science: Dr. Gregory B. Thompson, UA

Shape memory alloys (SMA) are a unique class of materials which can recover deformation induced at some lower temperature by heating through a given transformation temperature. This deformation recovery can act as a source of work by having the material recover against an applied load and act as compact, low profile, solid-state actuator. To date, the exploitation of SMA is limited because the recovery phenomenon occurs at low temperatures (<100 deg. C). By increasing the transformation temperature, SMA would have immediate usage in several higher temperature aerospace applications. This research program will seed collaboration between Professors Gregory Thompson and Mark Weaver at the University of Alabama and Dr. Ronald Noebe at NASA’s Glenn Research Center in developing a new class of NiTi high temperature SMA. By macro-alloying NiTi with Pt, Pd, Zr and Au, the transformation temperature has been shown to increase upwards of 1000 deg. C for particular elements and amounts. This macroalloying facilitates the precipitation of several metastable nanometer-sized secondary phases. The influence of these macroalloy elements and the thermomechanical fabrication process of the alloys on the elevated temperature shape memory effect are not well understood. To fully exploit these materials and optimize the processing-properties-microstructure relationships, a careful microscopy-based study is required. The team will utilize atom probe tomography for atomic scale partitioning quantification, advanced electron microscopy techniques to determine the crystallographic and deformation stability of these alloys, and Orientation Imaging Microscopy for global grain and phase identification as they relate to alloy chemistry and thermomechanical process history. The program provides for a concentrated effort to link nearly six-orders of magnitude length scales to elucidate the behavior and materials development of these alloys. The results of which will bring to fruition optimal materials engineering necessary for the development and application of high temperature SMA in aerospace and related technologies.
The AFRI Food and Agricultural Science Enhancement (FASE) is an EPSCoR-like program designed to help institutions develop competitive research, education and extension/outreach programs in high-priority areas of national need in agriculture, food, and environmental sciences. Strengthening Awards are EPSCoR grants and include Sabbatical Grants, Equipment Grants, Seed Grants, and Strengthening Standard Project Awards. Ten percent of the Agriculture and Food Research Initiative (AFRI) budget will be set aside for strengthening awards and post doctoral fellowships.

Sabbatical Grants, Equipment Grants, Seed Grants, and Strengthening Standard Project Awards will be available during each funding cycle to ensure that researchers at institutions and states that are underrepresented in terms of federal research, education, and extension/outreach funding receive a portion of AFRI funds. Strengthening grants make up 7.5% of AFRI funding and eligibility for strengthening categories except equipment grants includes:

- ESPCoR states (determined by NSF EPSCoR criteria)
- Academic institutions with a current total enrollment of 17,500 or less including graduate and undergraduate and full- and part-time students
- Accredited academic institutions whose enrollment of a single minority group or a combination of minority groups exceeds 50 percent of the total enrollment, including graduate and undergraduate and full- and part-time students.
- Institutions that are not among the most successful universities and colleges for receiving federal funds for science and engineering research.

Every 3 years the NRI determines which states are eligible for USDA EPSCoR funding by determining those that have had a funding level from the NRI no higher than the 38th percentile of all states, based on total funding for the previous 3-year period (excluding strengthening set-aside funds).

### USDA AFRI Strengthening (EPSCoR) Grants as of Oct 2014

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<td>AU</td>
<td>Williams, Z. T.</td>
<td>Survival of S. Enterica and E. Coli 0157:H7 in Soil and Internalization into Leafy Greens as Affected by the Presence of Biochar and Fungi</td>
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**Nanocrystalline Cellulose Piezoelectric Materials for Energy Stability**

Dr. Maobing Tu, Auburn University

It is our vision that agriculture and forestry are not only the sources for foods, but also the sources for engineering materials. This project is designed to develop piezoelectric materials from renewable biomass. Piezoelectric materials are widely used in sensors, actuators, and transducers, which are the foundation of current and next generation high-tech devices and systems. Piezoelectric materials are crucial for the development of green energy. Current piezoelectric materials are either lead-based ceramics with a high piezoelectric effect or polymers with a low piezoelectric effect. The use of lead-based materials raises great environmental concerns since lead poses a significant health risk. This project will create a new category of piezoelectric materials with expected high piezoelectric effect. Nanocrystalline cellulose (NCC) has been successfully processed from biomass. This project uses the NCCs to develop two types of piezoelectric materials: 1) NCC-based composites, in which the content and orientation of NCCs will be optimized to achieve a high piezoelectric effect; 2) NCC nano-brushes, in which NCCs will be assembled in a brush-like array configuration. The composites will be mainly used in the development of sensors, actuators, and transducers, while the NCC nano-brushes is targeting for the development of energy harvest devices. This project has the potential to revive forest industry by transforming a significant portion of the pulp and paper industry to the development of engineering materials and add high value to the forest biomass.

The primary goal of this proposal is to develop new piezoelectric materials from renewable biomass and to deepen the understanding of the piezoelectricity in nanocrystalline cellulose (NCC). The specific objectives of this study are to: 1) Modify NCC surface with tailored functionalities; 2) Fabricate piezoelectric NCC nano brushes and prepare NCC-polymer piezoelectric composites with controlled NCC orientation; 3) Characterize structure and morphology of NCC nano brushes and NCC-polymer composites and determine materials properties; 4) Establish structure-property relationship for NCC-based piezoelectric materials.

**Identification of Inhibitors for Essential Phospholipid Biosynthetic Enzymes in Haemonchus Contortus**

Dr. William H. Witola, Tuskegee University

In Alabama and other parts of southern United States, Haemonchus contortus is the parasite of primary health concern in goats and sheep leading to significant economic losses. The only mode of control for H. contortus is by using anthelmintic drugs. Unfortunately, H. contortus has developed resistance to virtually all drugs in current use. The absence of any new drugs against H. contortus nearing commercialization calls for intensified research to identify novel strategies for developing new effective drugs. The high fecundity and rapid propagation of H. contortus within infected animal host entails active production of parasite plasma membranes in which phospholipids are major architectural and functional components.

Dr. William Witola observes graduate students in his lab taking microscopic images of the nematode parasite Haemonchus contortus.
suggesting that phospholipids are indispensable for survival of the parasites. Thus, the overall goal of this project is to identify new chemical compounds with inhibitory activity against validated essential phospholipid biosynthetic enzymes important for *H. contortus*’ survival and virulence, namely, Phosphoethanolamine Methyltransferase-1 and 2 (HcPMT-2 and 2). Ultimately, the project aims to validate new chemical compounds that can be used for the development of a new class of drugs that will be effective in the control of *H. contortus* infections in livestock leading to increased productivity and profitability of the goat and sheep industry. Our project, therefore, addresses the priority area of “Animal Health and Disease” under the program area of “Animal Health and Production and Animal Products”.

**Effect of Toxoplasma Gondii Gra10 Protein on Ovine Immune Response to Infection**
Dr. William H. Witola, Tuskegee University

Toxoplasma gondii is a widely prevalent obligate intracellular zoonotic protozoan parasite that is of great economic significance in sheep production in which it causes abortions, fetal malformations, pre-term deliveries, stillbirths and neonatal deaths. Infected sheep meat is also a source of *T. gondii* infection in humans. There is currently no medicine to eliminate *T. gondii* infections in sheep and the live vaccine that is available has serious short-comings because of its short shelf life and safety concerns for those handling it. Thus, there is need for a non-infectious vaccine that would be safe and effective. Therefore, deciphering functionally significant *T. gondii* molecular mechanisms that lead to modulation of host cell responses to infection would be fundamental in designing new effective therapies and vaccines against *T. gondii*. The main aim of this proposed project is to undertake a detailed and thorough genetic, molecular, immunological and cellular biological analysis of the role of a *T. gondii*-secreted protein (herein called GRA10) in modulating ovine host cell defense responses to *T. gondii* infection and establish how this relates to the parasite’s development and survival in the cells. Ultimately, our goal is to elucidate molecular mechanisms that would be crucial in developing new effective therapies and/or vaccines against *T. gondii* infections in sheep, leading to increased productivity and profitability of the sheep industry and safer sheep meat for human consumption.

**Maternal Lactocrine Programming of Female Reproductive Tract Development**
Dr. Frank (Skip) Bartol, Auburn University

For newborn mammals, human and animal, consumption of first milk (colostrum) soon after birth delivers milk-borne factors (MbFs) to infants that can affect the way reproductive tissues develop and function in adults. Little is known about these MbFs and how they affect development. Delivery of MbFs from mother to infant via nursing is called lactocrine transmission. In the pig, failure of colostrum consumption shortly after birth disrupts female reproductive tract (FRT) development. This includes the uterus. Disruption of uterine development in infants can have long-term consequences, including infertility. This project will test the lactocrine hypothesis for maternal programming of FRT development, with emphasis on the uterus. Using an established experimental system involving the domestic pig, proposed studies will identify: (i) the period of time within 48 hours of birth when uterine tissues are sensitive to lactocrine signaling; (ii) components of colostrum that affect uterine development during this period; (iii) elements of the uterine developmental program that are lactocrine-sensitive; and determine (iv) how colostrum consumption by infants affects uterine function in adulthood. It is expected that lactocrine signaling within 48h of birth will be required for normal uterine development, and that disruption of this process will decrease adult uterine capacity to support pregnancy. Results will be applicable to the improvement of health and reproduction in both pigs and humans. Proof of
the lactocrine hypothesis could change animal husbandry practices affecting reproductive management as well as recommendations for improving care of human infants.

Visualized Surface Plasmon Nanophotonics Biochemical Sensor For Food Safety Monitoring
Dr. Jungpeng Guo, UAH

Nanoscale sensor technologies provide enormous potentials for chemical and biological sensing applications in US agriculture and food systems. Low cost, realizable, and easy-to-use nano-sensors are very desirable in food processing industry for fast detection of contaminant chemicals and pathogens in liquid foods, such as juices and milks. In this project, Prof. Junpeng Guo and his students will investigate new surface plasmon nanophotonics sensor technologies for cost-effective detection of chemical contaminants in liquid foods. The objective of the project is to demonstrate a visualized surface plasmon nanophotonics sensor that can be easily used by workers in food processing production lines. Proposed visualized biochemical sensor uses surface plasmon resonance as the sensor transduction mechanism for fast detection of chemicals and pathogens on nanostructure surfaces. The surface plasmon resonance will be measured by a low cost CCD in a newly invented spectrometer sensor platform. The shift of surface plasmon resonance due to bonding of contaminant chemicals can be captured by a CCD and visualized on a display monitor. Therefore, workers in the food processing production lines can see when contaminant chemicals are present in the processed foods. The research effort in this project will lead to new nano-sensor technologies that will improve the safety of U.S. agriculture and food systems.

OBJECTIVES: The goals of the project are: (1) demonstration of a visualized plasmonic nanophotonics chemical sensor potentially used for liquid food safety inspection; (2) developing new knowledges and technologies and disseminating new knowledges and technologies through publications; (3) training students and prepare them to work in nanotechnology area in the agriculture and food industry after their graduation.
Type 2- Collaborative Research-Migration of Agricultural Production Back to the Southeast as a Climate Change
Dr. Richard McNider, UAH

The purpose of this project is to assess whether agricultural food, fiber and bio-fuel production can be sustained in the U.S. through a migration of production back to the Southeastern U.S. under an irrigation assisted rain-fed agricultural system. Migration of production back to the Southeast, if sustainable, would be an adaptation strategy to climate change and provide additional capacity for long-term food, fuel and fiber security. The assessment of this option requires the use of climate change projections, crop models and assessment of available water. The remarkable U.S. agricultural production from irrigation in arid climates in the 20th century may contract substantially in the next century, and thus might affect US food security as a whole. At the same time during the last century grain production became concentrated in a few states in the deep water holding soils of the upper Midwest. This concentration leaves U.S. food and bio-fuel production vulnerable to long-term or severe mid-west regional drought. In the last century, the Southeast (SE) with sporadic growing season precipitation and poor water holding soils could not compete economically with the highly efficient production in the West and Midwest and lost substantial agricultural production. The result is that many rural areas in the south have no economic base aside from timber production or programs which pay land owners to take land out of production. Neither of these activities provide the economic impact of agricultural production. Some areas are near third world in poverty, infant mortality, health care and illiteracy. The Southeast may be in a unique position relative to climate change and population growth compared to other parts of the country. While regional precipitation changes are uncertain, the IPCC concluded that dry areas are likely to become drier and wet areas wetter. It is also a hydrologic irony, that with the large water consuming natural vegetation in the SE, suburban and urban growth and land use change may actually reduce evapotranspiration so that population growth does not necessarily reduce water availability. This is a truly interdisciplinary effort.

Additionally, it is becoming recognized that substantial energy is being used to transport food and grains across the country from the West and Midwest. This proposal will assess energy savings of moving production closer to consumption. The team will include engineers, ecologists, hydrologists, agriculturalists, climatologists, political scientists and economists. It also includes collaboration with USDA Forest Service climate change program which focuses on water use and availability in the SE and the Southeast Climate Consortium studying the impact of climate variability and change in the SE. The research proposed here addresses a critical societal issue regarding how the U.S. can sustain its food, fiber and bio-fuel needs in the future through the use of expanded irrigated agriculture in the SE US.

The overall objective is to use linked Earth System models to determine whether there are economic, environment or water resource issues that might hinder increasing agricultural production in the Southeast under expanded irrigation. Goals: 1. Evaluate viability of the economics of irrigated agriculture in the humid SE. 2. Determine total water availability for the SE and the impact added irrigation will have on this resource under climate variation/climate change scenarios. 3. Determine impacts on ecosystems of water withdrawals for irrigation. 4. Evaluate water quality impacts due to expanded irrigation.
Sabbatical Leave on Behavioral Economics: Nudges at Client Choice Pantries
Dr. N. Wilson, Auburn University

The long-term goal of the proposed project is to apply behavioral economics to change food environments and combat obesity through the increased purchase and consumption of healthier foods. The objectives of the sabbatical leave are the following: (1) to implement a collaborative research project with David Just and the Cornell Center for Behavior Economics and Child Nutrition (BEN); (2) to follow a course on behavioral economics; and (3) to apply for grants based on behavioral economics. The proposed project for the sabbatical leave is to use behavioral economics to assess the choice architectures of client-choice food pantries in New York. The objectives of the analysis are the following: (1) to determine the effects (immediate and lasting) of three low-cost interventions (attractive names, convenience and mental accounting) at client-choice food pantries; (2) to evaluate the efficacy of these interventions based on socioeconomic factors (food security status and SNAP participation) and anthropometric measures (BMI, skin fold, waist circumference); and (3) to share findings with Feeding America and local food banks and pantries.

The project will build on the work in school lunchrooms by Just and BEN. However, the proposed project goes beyond the school work because the analysis will focus on adults. The analysis will collect socioeconomic and anthropomorphic data to evaluate the effectiveness of interventions on different client groups.

The long-term goal of the proposed project is to apply behavioral economics to change food environments and combat obesity through the increased purchase and consumption of healthier foods. As an EPSCoR sabbatical leave, the immediate purpose of this proposal is to enhance research capacity in the area of behavioral economics. The objectives of the sabbatical leave are the following: 1. To implement a collaborative research project with David Just and the Cornell Center for Behavior Economics and Child Nutrition (BEN). 2. To follow a course on behavioral economics. 3. To apply for grants based on behavioral economics. The objectives of the research project are the following: 1. To determine the effects (immediate and lasting) of three low-cost interventions (attractive names, convenience and mental accounting) at client-choice food pantries. 2. To evaluate the efficacy of these interventions based on socioeconomic factors (food security status and SNAP participation) and anthropometric measures (BMI, skin fold, waist circumference). 3. To share findings with Feeding America and local food banks and pantries.
A jurisdiction is eligible to participate in the NSF EPSCoR Research Infrastructure Improvement Grant Program (RII) if their most recent 3-year level of NSF research support is equal to or less than 0.75%.

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Grand Total: $5,966,805, 20,635

Recent 3-year level of NSF research support is equal to or less than 0.75%.

The sum of the Amt $s for all states is $17,104,446, which is 59.201% of the Grand Total.

The total Amt $ for Other states is $370,803, 1,322.

The total Amt $ for US Total is $5,600,809, 19,450.

The total Amt $ for Other states is $95,251, 118.

The total Amt $ for US Total is $15,009,195, 59,083.

The total Amt $ for Other states is 99.44% of the Grand Total.

The total Amt $ for US Total is 100.00% of the Grand Total.

Utah: $33,880

Iowa: $44,002

Tennessee: $40,751

Connecticut: $55,150

Oregon*: $67,137

Minnesota: $78,593

Washington*: $11,358

Georgia: $105,534

Wisconsin: $97,377

Ohio: $101,550

New Jersey: $123,198

Maryland*: $117,960

Indiana: $132,420

Florida: $142,819

North Carolina*: $134,082

Michigan: $152,332

Arizona: $165,050

Texas: $176,559

District of Columbia: $205,668

Pennsylvania: $221,266

Virginia*: $315,044

Colorado: $349,199

Illinois: $299,965

Massachusetts: $350,799

New York*: $368,415

California*: $645,667
Developed from significant and numerous stakeholders across Alabama at the directive of Governor Robert Bentley, the “Accelerate Alabama” strategic plan guides economic development in the state over the next several years to recruit new industry, maintain those already in Alabama, and create jobs from entrepreneurship, commercialization and research and development. As part of the implementation of Accelerate Alabama, the State created the Alabama Innovation Fund (AIF).

The purpose of this fund is to maximize the use of the State’s resources by leveraging annual research and development expenditures by public institutions of higher education to generate resources which can be used to support economic development initiatives to create jobs for the State. A vital component of this job creation plan relies on using brainpower at Alabama research universities, specifically those seven Ph.D. granting research universities that constitute the Alabama Experimental Program to Stimulate Competitive Research (Alabama EPSCoR, see www.ALEPSCoR.org). (Alabama A&M University, Auburn University, Tuskegee University, The University of Alabama, University of Alabama at Birmingham, University of Alabama in Huntsville, and the University of South Alabama).

In 2012, the State initiated the AIF with two programs, the Renewal Program and the Research Program. Looking to the future, in order to add to the intellectual firepower within the State, the AIF supports the recruitment of outstanding faculty Commercialization Scholars to Alabama EPSCoR institutions. The FY2015 Department of Commerce budget identified $4.5 million for the AIF, to be matched one-on-one by participating Alabama EPSCoR universities, which provides tangible recognition by the State of the important role its institutions play in economic development and job creation.

These new faculty Commercialization Scholars must be nationally recognized leaders in their field and recruited from outside the State. It is expected that those new individuals:
1. Either bring with them a substantive research funding portfolio that in itself within one year adds jobs to Alabama’s economy; or
2. Have a documented and demonstrated track record of utilizing their respective intellectual property to create successful new companies and/or licensing agreements. This Commercialization Scholars program has the potential of leading to substantial economic growth and job creation in the State by bringing people that either already have a substantial research funding portfolio or that have a proven track record of spinning off successful high tech companies. Similar programs in Georgia (the Georgia Research Alliance) and the award winning program in Kentucky (Bucks for Brains) have proven extremely effective in providing economic growth and high tech job creation in those states. A few success stories from the AIF Renewal and Research Program are highlighted on the following pages.

**Mechanical Engineering Energy Impact Lab**

Dr. Dean Sicking, UAB School of Engineering

Dr. Dean Sicking was heavily recruited from the University of Nebraska at Lincoln with a dual appointment in UAB’s School of Engineering, Department of Mechanical Engineering and as Assistant Vice President for Product Development under the Vice President for Research and Economic Development. Dr. Sicking’s body of scientific work includes more than 30 patents issued, primarily in roadside and highway safety devices, worth more than $1 billion. Support from the AIF enabled Dr. Sicking to pursue his globally recognized roadside and highway safety R&D. Additionally, he expanded research in football helmet testing methods and standards, plus the development of all new football helmets.

- Roadside/Highway Safety Devices - In partnership with George Barber and the Barber Motorsports Park, Dr. Sicking opened the Barber Laboratory for Advanced Safety Education and Research (BLASER) for the research and reconstruction of automotive crash testing devices. This BLASER research and testing facility has already paid dividends through a sponsored research and product development contract with a locally based Birmingham company. The economic development outcome will be highway safety devices
researched, designed, manufactured, marketed, and
distributed in Birmingham throughout the U.S. and globally.  

Football Helmet Testing Methods and Standards - Dr. Sicking has immersed himself, his Post Doctoral Fellows, Graduate students and colleagues at UAB in determining the need and solution for new football helmet testing methods and standards for the future reduction of traumatic brain injuries on the playing field. The growing epidemic of football related concussions, a form of traumatic brain injury (TBI), are currently front-page headlines across the US where leading research universities and industry are rapidly working towards injury reducing solutions.

At the indoor BLASER facility, Dr. Sicking has designed and manufactured a state-of-the-art testing apparatus, along with patent-pending technologies to determine the probability of head injury risks through recreation of real, on-field helmet impacts. Dr. Sicking’s preliminary results are already drawing the attention of the National Football League, the National Football League Player’s Association and several leading athletic conferences.

UAB’s School of Engineering is gaining in national prominence through the recruitment of commercialization scholars like Dr. Dean Sicking and the groundbreaking R&D body of work they bring to our community, region and state of Alabama. The sophistication of research being conducted and the potential for technology based economic development returns real dollars to the state of Alabama in both impact and job growth. Dr. Sicking’s use of Alabama Innovation Fund support is a prime example of state investment with real national and global revenue generating outcomes.

Appalachian Regional Commission Center for Entrepreneurship and Energy Innovations

Vicki P. Hawsey, Wallace State Community College

Wallace State-Hanceville and its private partner, ZeroRPM were awarded a $200,000 Alabama Innovation Fund grant to establish the Appalachian Regional Commission Center for Entrepreneurship and Energy Innovations. Through this funding, Wallace State has supported ZeroRPM in successfully launching their business in 2012. Through the strong support of Governor Robert Bentley and the Business Incubator program at Wallace State Community College, ZeroRPM has since filed patents covering 9 new inventions and begun exporting environmentally sound products nationwide. Utilizing creative innovation and engineering expertise, ZeroRPM is bridging the gap between foreign oil dependence and a clean energy future with the jobs that will sustain the economy and environment of Alabama.

ZeroRPM president Lance Self, began with what started as a cool idea a few years ago, powering a car without activating the engine, which snowballed into a tech start-up company announced statewide by Alabama Gov. Robert Bentley. Self’s company has created the IMS 100 idle mitigation system, which can power a vehicle and the air-conditioning for several hours via high-capacity batteries. His initial target market was law enforcement, with hopes to cut down on gas and carbon emissions while idling, but the company has since expanded their product line to include potential at every level of the automotive industry and beyond. Products now include the Power Module, a complete power management solution for demanding service and military applications, where engine starting and deep cycle energy are required; the Energy Module, a complete energy management solution for demanding service and military applications, where engine starting and high continuous power deep cycle energy are required from the same compact solution, and the Independence Power (i-Power) system, a generator without an engine.
which provides 1250 watts of power through a 500 watt inverter. These are just a few of the products with several more in development and testing.

ZeroRPM Idle Mitigation Systems cover a broad range of applications including insurance, police, utility, ambulance, SWAT, fire, over the road and armored vehicles. Vehicles in these industries idle three to six hours per shift. Idle Mitigation Systems (IMS) enable a vehicle to have all the comfort and power support of a vehicle that is idling except the engine off. A vehicle with an IMS only uses the internal combustion engine to move the vehicle and the IMS takes care of the rest resulting in typical fuel savings of $3,000-$6,000 per year per vehicle. The initial production run of the IMS was expected to create 54 new jobs, and the company has partnered with Bremen-based Hired-Hand technologies for their manufacturing.

The company spent the first several months housed on the campus of Wallace State Community College in Hanceville, as part of a new green-business incubator currently in development. College President Vicki (Hawsey) Karolewics has been focused on developing an incubator project for years, though it took some seed money from the State of Alabama and Appalachian Regional Commission (ARC) to finally get it off the ground. When the prospect of ZeroRPM arose, the college made room and moved Self and his team into some empty office space, allowing him to use the college’s resources for early level research and development.

“We welcomed the opportunity to leverage Wallace State’s resources, even before the incubator was fully a reality,” Hawsey said. “The project aligned perfectly with Gov. Bentley’s plan to create new job growth, and we are proud to have ZeroRPM as our first incubator tenant.”

Center for Clinical and Translation Science Innovation

Robert Kimberly, MD
UAB Division of Clinical Immunology and Rheumatology
Phase I Clinical Trials Unit

Through a coordinated effort between the UAB’s Center for Clinical and Translational Science (CCTS) and Comprehensive Cancer Center (CCC), the CCTS has expanded its clinical research capacity by adding a 7,950 square foot Phase I Clinical Trials Unit. The Center enhances the expertise and skills of our faculty and expands scientific capacity through partnerships to enhance research translation and to promote the potential for innovation-based economic development.

The CCTS Network connects investigators to essential resources and services to promote the efficient translation and implementation of biomedical discoveries toward the improvement of human health and health care delivery on behalf of our communities.

Support from the Alabama Innovation Fund has enhanced the CCTS’ ability to deliver leading-edge translational research and enhance patient outcomes. The Center has engaged key stakeholders and has assembled research teams with the expertise necessary to establish programs in a variety of disciplines, including:

Exercise Medicine – Exercise reduces the risk of multiple chronic illnesses, including heart and various metabolic diseases. The CCTS has helped to establish a major national consortium in Exercise Medicine, with the first annual conference held at UAB in February, 2014. Through this conference and continuing work by the CCTS, exercise medicine has been elevated to the level of the Office of the Director of the NIH, which has planned a small, invitation-only workshop in October, 2014, to outline strategic funding opportunities. This workshop will be co-Chaired by a UAB CCTS investigator.
Traumatic Brain and Spinal Cord Injury – Nervous system injuries affect over 90,000 people annually and developing new strategies for effective rehabilitative therapy and neural regeneration is a pressing need. The CCTS has been instrumental in supporting the ‘first in man’ study of spinal cord regeneration in response to therapy after traumatic injury by partnering with Auburn, a CCTS Partner Network, and developing new capacity in magnetic resonance imaging.

Biomarkers in Colon Cancer - Recent studies have demonstrated the presence of non-coding RNA molecules, including microRNAs, in the blood of patients with a variety of cancers that are not found at similar levels in the blood of healthy patients. Detecting microRNA specific to cancer and with stability in blood to make them excellent candidates for early-detection biomarkers may be able to identify patients with colon polyps or early-stage colon cancer. In partnership HudsonAlpha Institute for Biotechnology, CCTS investigators are working to define such a molecular signature as a less invasive, highly sensitive and specific molecular assay for colorectal cancer.

Environmental Impact on Health – In the Spring 2010, an explosion of the offshore oil rig, Deepwater Horizon, resulted in the largest oil spill in U.S. history, releasing an estimated 4.9 million barrels (210 million US gal) of oil into the Gulf of Mexico. The Gulf of Mexico Research Initiative seeks to investigate the impact of the oil, dispersed oil, and dispersant on the local ecosystems. In response, the CCTS and investigators from the University of South Alabama have proposed an epidemiologic assessment to understand the impact of hydrocarbons and climate on respiratory function over time.

Drug Discovery – The CCTS/ADDA (Alabama Drug Discovery Alliance) supports drug discovery and development through a robust program of investigator education and support and pilot funding designed to support the development of high throughput assay systems, library screens and medicinal chemistry. Working in close partnership with Southern Research, the CCTS has generated significant momentum in this domain with the support of target identification, screening assay development and supervision by project management teams, designed to review progress and eliminate barriers to success. This highly effective management strategy is being exported to a number of related initiatives.

Bioethics in Translational Research – In collaboration with Tuskegee’s National Center for Bioethics in Research and Health Care, the CCTS engages scientific investigators, the community and ethics experts to explore the issues that underlie research and medical care, especially as it pertains to underserved populations. This initiative has heightened awareness and underscored the need for trust and respect in the implementation of clinical trials, translational research and medicine.

With building momentum, the institution is well positioned to take advantage of its research strengths and unique regional attributes to make great strides in understanding the impact of exercise, neural plasticity, genetic and genomic variation and the environment on human health. The development of an advanced research infrastructure, including robust capacities in informatics, drug discovery, clinical trials and bioethics, allow the CCTS to compete successfully for federal grants and to support the most innovative research in Alabama while contributing to the growth of a knowledge-based economy for the State.

The facility has already resulted in Novartis Oncology (a subdivision of Novartis AG) selecting UAB and the CCTS/CCC as a preferred Phase I site in March of 2014.

Development and Testing of the Charger Facility for Deep Space
Fusion Propulsion Research
Dr. Jason Cassibry, UAH Mechanical and Aerospace Engineering

The University of Alabama in Huntsville (UAH) was awarded a $300K 1 year grant in August of 2012 to develop our fusion propulsion research lab. Current technologies with chemical or nuclear propulsion require a year and a half or two years to send humans to Mars and back. With fusion propulsion, humans can travel to Mars and back in 6 months, about the same time they spend on the space station. UAH leveraged
the AIF funding to assemble our research facility and build collaborations with NASA Marshall Space Flight Center, the Boeing Company, and other national labs. We are now developing the next generation propulsion technologies which will enable rapid human piloted exploration of the solar system. Additionally, with this new fusion facility, we are becoming a national competitor for research in fusion for terrestrial power. We recently submitted a $15M, 5-year proposal in collaboration with Sandia National Laboratories, Y-12 National Security Complex, and Voss Scientific to the Department of Energy to conduct fusion research which may lead to safer nuclear power plants which may make better use of nuclear waste. We are also working with the Navy Research Laboratory on an award funded by Advanced Research Projects Agency-Energy (ARPA-E) on a yet another fusion experiment which may lead to the rapid development of fusion for terrestrial power using frozen fibers of deuterium (heavy hydrogen), of which the world’s oceans contain a nearly inexhaustible supply.

Smart Network Backplane for Fast Analytics of Big Data

Dr. Weikuan Yu, Associate Professor
Computer Science and Software Engineering
Auburn University

One grand challenge faced by society is a deluge of digital data, so called Big Data. According to the 2011 International Data Corporation (IDC) report, a total of 1,220 exabytes of data was created on Earth in 2010. Cloud computing has been widely leveraged as a new paradigm of computing to tap the power of parallel data processing for Big Data. It has been ranked as one of the leading emerging technologies in Gartner technology’s hype curve for three consecutive years. IDC estimated that the volume of digital data would continue to grow at an annual rate of 50%, i.e., the amount of data is expected to reach more than 8 zettabytes by 2015. More and more cloud systems are being deployed to serve many users’ data-intensive analytics applications.

MapReduce has emerged as a popular and easy-to-use programming model for numerous organizations to process explosive amounts of data and extract critical knowledge for business intelligence. Many MapReduce jobs can show up on a system with conflicting resource requirements. In addition, system components are becoming more and more diverse and increasingly hierarchical. The lack of network intelligence causes MapReduce unable to cope with increasingly complex and hierarchical systems.

This project created a software-based smart network system that speeds up data transfers inside MapReduce for the processing very large volumes of commercial and scientific data. It also transferred successful technologies to the industry, by collaborating with industry, strengthening research partnerships, and cultivating opportunities for technology transfer to the commercial sector. Furthermore, this project also increased the number of jobs and stimulated the economical growth at Alabama, and trained new employees for lead customers.

Since November 2012, this project has helped Auburn University to secure contracts of $265,000 from Intel, Scitor, and DOE laboratories. In addition, research results from this project have helped Auburn University to receive three grants from National Science Foundation for a total of $1,284,106. These research projects employ 10 or more graduating research assistants per year for the development of efficient technologies for big data analytics. In addition, one postdoctoral researcher was hired at Auburn’s College of Engineering in March 2014, and one more is yet to be identified.

This project has helped established the reputation of Auburn University in developing big data technologies. Strong collaborative partnerships have been developed with Intel, IBM, Scitor, and Huawei from China. No spin-off companies are established yet, but potential stimulation opportunities are being actively explored.
Commercialization of UAB Research Innovations in Cybersecurity
Dr. Anthony Skjellum, UAB

The Center for Information Assurance and Joint Forensics Research (“the Center”) is the locus on the UAB campus for basic and applied interdisciplinary research in information assurance and forensic science, broadly defined, as well as business development, innovation, and entrepreneurship. Organized around seven pillars including cybercrime/computer forensics, data science, geospatial imaging, information assurance, health informatics, intelligence analytics, and workforce development, the Center partners with business, industry, and government to 1) identify opportunities for funded research and 2) convert those opportunities into grants, contracts or gifts. The end result of these activities is to advance relevant disciplines represented in the Center, create new IP which can be leveraged into opportunities for startup companies, and contribute to greater economic development in Birmingham and the State of Alabama.

The mission of the Center is to create and promulgate innovative solutions to rapidly emerging and enduring threats to global, domestic, and regional commerce and safety, based on state-of-the-art research and advanced development activities of Center personnel. Center members include faculty affiliates from multiple departments across and outside UAB. A majority of faculty affiliates come from the College of Arts and Sciences, followed by the Collat School of Business, and the School of Health Professions. A recruiting initiative is currently underway with the School of Engineering to identify faculty members who are interested in becoming affiliated with the Center and include them.

Business development:
• Center is in final stages of negotiations to create a “Business Roundtable” in which a minimum of 10 Fortune 500 companies would participate and from which new R&D opportunities would arise. Entry fee would be a minimum of $50K annually.
• Center is pursuing new opportunities to develop partnerships with companies operating in the retail sector. Recent meeting with 20 CISOs of major retail chains including Best Buy, Home Depot, and others leading to further talks.

Workforce development:
• Center finalizing negotiations with several companies to sponsor scholarship opportunities for GR/UGR students majoring in computer science, criminal justice, and information systems who are interested in cybersecurity/computer forensics. Minimum scholarship would be $5K per academic year.
• CFSM program: Have graduated six students to date (program begun in 2011-2012); all have found employment in the field
• Approval of BS in Digital Forensics

Research partnerships:
• Center is pursuing teaming agreement with Pacific Northwest National Laboratory (PNNL) to pursue BAAs from DHS, DOD, and other relevant agencies.
• Center to partner with AU and Tuskegee on NSF proposal to create cybersecurity center at HBCUs; UAB to be sub on this grant
• Alabama Power (Southern Company), NASA, MARTA connections made and projects being pursued

Recent Accomplishments:
• National Security Agency/Department of Homeland Security designated CIA/JFR as Center for Academic Excellence in Research (CAE-R) (1st renewal; 1 of 53 in US) Center spearheaded development of Alabama Cyber Research Consortium (ALCRC) which consists of the 7 Ph.D. granting institutions in Alabama
• NSF STC grant ($22K) to ALCRC for conference on ethics and digital forensics; Center to administer the grant
• Center is member of NSF EPSCoR team (USA/UAB/AU); if funded will bring ~ $0.5M per year to UAB, Center, and affiliated faculty members for 5 years ($2.5M total)
• Anonymous donation of $25K to Center (July 16, 2014)

Projects:
• Small device security and new forms of password protection
• Cloud security and document provenance
• “Insider threats” – security threats to organizations created by human-computer interaction
• Social media and cybercrime/security – development of tools to expedite use of open-source intelligence in cybercrime investigations
Alabama Start-up Seed Fund Program

Dr. Richard Swatloski, The University of Alabama Office for Technology Transfer

The University of Alabama’s Office for Technology Transfer, under the direction of Dr. Richard P. Swatloski, received funding from the Alabama Innovation Fund to support the Alabama Start-up Seed Fund Program. Several entities were supported—some of which include:

- MagnnPro
- 525 Solutions
- e-Electricity, LLC
- Bidsters
- 2B-electronic

MagnnPro

Dr. Yuping Bao, UA Associate Professor of Chemical and Biological Engineering, was tinkering with a common chemical compound and discovered that tiny balls (nanoparticles) of iron oxide might make MRIs (Magnetic Resonance Images) safer for certain segments of the population. Dr. Bao was provided AIF funds to found Magnetic Nanomaterial Products, or MagnnPro, LLC. MRIs use an agent known as gadolinium-based contrast solution for parts of the body to be seen using a MRI scan. This once-celebrated chemical contrast is the subject of many FDA tests and is potentially harmful to those with kidney or liver disease. Human blood contains iron oxide, making Dr. Bao’s discovery potentially a much safer alternative. MagnnPro is in the process of developing two additional products. AIF funds provide support to conduct cost feasibility and scale up studies. MagnnPro is the only company with this patented technology.

525 Solutions

According to the American Diabetic Association, 25.8 million people in the U.S. suffer with diabetes and the problem is growing. Numerous diabetics suffer from diabetic ulcers and as a result undergo amputations. A naturally occurring compound, chitin, found in shrimp shells has been extracted to develop bandages that heal diabetic ulcers faster. 525 Solutions, a start-up company at UA, was given AIF support to develop these bandages. In addition to chitin, researchers are also using alginate, a compound found in seaweed to produce a fiber that will be woven into the bandages. 525 Solutions won a $ 150K NSF SBIR (Small Business Innovation Research Fund) award to further the research and bring it to market. Dr. Gabi Gauau, UA alumna is the company’s CEO. Dr. Robin Rogers, Robert Ramsey Chair of Chemistry at UA, is an owner/founder.

e-Electricity

e-Electricity, LLC was provided AIF funds to develop the first generation/proof-of-concept (patent pending) wireless energy harvesting device that could revolutionize charging of mobile devices. Dr. Jaber Abu-Qahoug, UA Associate Professor of Electrical and Computer Engineering, developed the technology. Dr. Abu-Qahoug is now serving as a scientific advisor to e-Electricity which is being led by Will Sanders, a recent graduate from Mobile, Alabama. Dr. Whitney Hough, UA Venture Development Associate, helped mentor this company in it early stages. During the 2013 Launchpad Competition (http://alabamalaunchpad.com/about-us/) e-Electricity placed and won $ 23,500 to develop prototypes for wireless harvesting. Wireless harvesting would provide a way to recharge devices (hybrid and electrical vehicles, cell phones, etc.) wirelessly using radio waves, eliminating the need for an electrical outlet. The e-Electricity team has also submitted six proposals for additional support.

Bidsters

Bidsters, LLC is an interactive database to help manage the construction bid process. UA Civil Engineering alumna, Ben Bidkerstaff, learned during a construction co-op position the inefficiencies of bidding on construction work. Ben, with help from AIF funds and the Alabama Launchpad Program, developed and launched his database and website.
2B-Electronics

2B-Electronics, LLC is a company that strives to help physical therapists determine the recovery of muscle following injury or surgery. It was developed by Brandt Hendricks, a UA Kinesiology student along with Physics and Astronomy Associate Professor Patrick LeClair. AIF funds were used to refine a working prototype and perform customer research in preparation to enter the summer 2014 Alabama Launchpad competition.

Commercial Development of Millimeter Wave Peripheral Perfusion Monitor

David Nelson, Professor and Chair
Department of Mechanical Engineering
University of South Alabama

Millitherm, Inc., in partnership with the University of South Alabama (USA) is developing and commercializing a handheld Millimeter Wave Peripheral Perfusion Monitor for clinical use. This new medical device uses Millitherm’s patented Millimeter Wave technology to diagnose and assess the severity of Peripheral Artery Disease (PAD). The incidence of PAD is increasing rapidly in the U.S., due to rising rates of adult obesity and Type II diabetes. If not treated, PAD can have serious complications including diabetic foot ulcers that may lead to amputation.

Current screening methods for PAD are slow, cumbersome and inaccurate. A survey of clinicians (physicians, nurses, podiatrists) found that most do not routinely screen for PAD because the procedure is so time-consuming (Mohler, 2004 827 /id). Millimeter Wave flow measurement will allow a nurse or physician to measure a patient’s skin blood flow in a fraction of the time that is required by current methods. This will increase screening and diagnosis of PAD, improve patient care and lower health care costs. Millitherm’s vision is that Millimeter Wave Flow Measurement will become as routine as blood pressure measurement.

With support from the Alabama Innovation Fund, Millitherm and USA have developed a second-generation prototype and developed methods for testing and calibrating the device. A novel flow chamber was designed and fabricated on a 3D printer and used with a tissue-equivalent (rabbit ear, see photo) material to demonstrate the new prototype can accurately measure flow rates in a model of human skin. Millitherm and USA also developed a method for independently measuring blood flow in the skin of a laboratory animal. That capability will be needed in studies planned to demonstrate safety and efficacy of Millimeter Wave flow measurement as part of the FDA approval process.

A grant proposal has been developed and submitted to the National Institutes of Health to support animal studies that are needed prior to testing the device on human subjects. Millitherm also has secured an exclusive licensing agreement Millimeter wave flow measurement and is completing an update of our market survey.

Ultra High Thermal Conductivity Catalyst Carriers For Mobile & Scalable Fischer Tropsch Platforms for Fuel Production from AL Biomass Resources

Bruce Tatarchuk, Charles E. Gavin III Professor and Director of the Center for Microfibrous Materials Manufacturing
Department of Chemical Engineering
Auburn University

This project involves the catalytic conversion of gasified biomass or stranded natural gas to high quality liquid fuels and chemicals. Auburn University and its commercialization partner/subcontractor (IntraMicron Inc. of Auburn, Alabama) have completed a scale up effort to convert syngas (CO + H2) into liquid fuel using a proprietary Fischer Tropsch catalyst obtained from Chevron Energy Technology of California.
This catalyst was entrapped within a sinter-locked network of micron diameter copper fibers (manufactured in Auburn, Alabama) that permits the exothermic heat of reaction to be removed 250-fold faster than current state-of-the-art chemical reactor approaches. This enhanced heat removal capability was shown to significantly reduce deleterious temperature excursions within the catalyst bed and greatly improve product selectivity (and resulting process economics) to desired fuel and chemical products.

A reactor vessel has been fabricated, loaded and shipped to the DOE-National Carbon Capture Center in Wilsonville, Alabama that is operated by Southern Company Services. The efficacy of this reactor is currently being evaluated and demonstrated on a slip stream of syngas that is produced from a large scale co-gasification of coal and biomass (so as to lower the associated carbon footprint and generation of greenhouse gas emissions). The Auburn University and IntraMicron Team is monitoring the performance of this demonstration reactor to produce desired liquid fuel products.

Additional efforts have been performed by our team to suggest that our approach is well-suited to efficient and cost-effective scalable energy conversion of smaller raw energy sources such as isolated biomass, landfill gas, animal digester wastes, and stranded gas that is co-produced from small oil wells. Given the pending no-flaring Oil and Gas Production regulations that will be enforced starting in January, 2015, and the harmful impact of methane emissions into the atmosphere, our approach appears to provide a particularly attractive approach for producing large levels of cheap non-traditional energy at a greatly reduced carbon footprint.

The thermally conductive copper fiber materials being used, as well as the equipment that places them into a sinter-locked web, have all been invented, patented and established here in Alabama through collaborations between Auburn University and its technology transition partners located within the State. All indications continue to suggest that our team is progressing this promising technical approach toward a beneficial energy outcome for the energy security of the U.S., and one that will lead to significant job creation in Alabama.

Partnering with AL Nucor Steel in Development Microalloyed precipitation Strengthened Steels for the Transportation and AG based Industries

Greg Thompson, UA

Lighter, Stronger Steels for Alabama’s Manufacturing Industries

Professor Gregory Thompson, University of Alabama-Tuscaloosa, was a recipient of an Alabama Innovation Fund to work with Nucor Steel – Decatur in developing next generation low alloy, high strength steels. Working with Dr. Ron O’Malley, chief metallurgist of Nucor, figure 1(a), they completed a comparative study of different steels and processing temperatures to determine how different atoms cluster together to control strength. UA is the only university in the southeast that has a local electrode atom probe, a microscope capable of reconstructing a material in three dimensions atom-by-atom, figure 1(b). Using this tool, the team was able to identify several different phases and determine the sequence of how they formed based on processing and alloying elements added. The Alabama Innovation Fund has supported the science necessary to develop next-generation steels which serve as the raw materials for several of the state’s manufacturing industries. In doing so, the joint university-industry endeavor helps to secure Alabama’s economic competitiveness.

Figure 1: (a) Drs. Monica Kapoor (left), Ron O’Malley (center), and Gregory Thompson (right) viewing a data set of atoms from a steel sample. (b) Atom map of different elements clustered together in a steel.

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