Alabama Institute for Manufacturing Excellence
2006 Annual Report

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AIME Vision: The vision of AIME is to enhance the culture of high technology research and development at The University of Alabama by innovation, mentoring and entrepreneurship.

AIME Mission: The mission of AIME is to identify and facilitate value added innovation and foster entrepreneurship leading to commercialization of intellectual property.

The University of Alabama stands on the threshold of a new era in its service as the flagship university of the State of Alabama. As global competitiveness becomes a dominant theme for the 21st century, the University is transforming itself into an engine for high technology economic development and a source for the workforce of tomorrow. A key component in this transformation is the Alabama Institute for Manufacturing Excellence (AIME). As demonstrated by its vision and mission, AIME is dedicated to bringing about local, regional, national and global competitiveness by providing an integrated and synergistic program to add commercial value to the knowledge and intellectual property created by faculty and students through innovation, mentoring and entrepreneurship. To achieve this vision and mission, AIME developed a Prospectus to serve as a working plan to realize its full potential. The Prospectus is enclosed as part of this annual report and comments are invited.

AIME has continued to enjoy considerable success during the past year. In particular, we are providing highlights and accomplishments for seven strategic focus areas, as defined below.

1. UNDERGRADUATE STUDENT TRAINING IN ENTREPRENEURSHIP AND INNOVATION

- Fourteen undergraduate students participated with AIME under the AIME Triage Model. This model of entrepreneurship and innovation allows students to work in the area of technology development and enhancement. Students participate in such activities as marketing analysis, development of preliminary business models, interviewing inventors, assisting inventors in preparing intellectual property disclosures, and performing prior art patent searches.
• As part of the training of entrepreneurs, AIME clustered students into four business model teams and submitted business plans based on UA IP to the Alabama Launchpad competition. Each team had their plans reviewed by mentors from the business school prior to submission, plus received feedback from reviewers. The resultant plans are available for potential business teams to start a high technology company.

2. GRADUATE STUDENT TRAINING IN ENTREPRENEURSHIP

• Five graduate students from the AIME research teams have taken the lead in the formation of business plans to assist incubating companies to attract venture capitalist funding. This opportunity offers these students the potential for employment as business and technical officers in UA based start-up companies.

3. FORMATION AND IMPLEMENTATION OF STRATEGIC PARTNERSHIPS WITH INDUSTRY

• **Development and Implementation of a Technical Resource Information Exchange.** AIME developed and implemented a technical resource information exchange service to allow industry, governmental agencies and the university to work together on special projects designed to enhance the introduction of industry products into the local community.

• **Economic Growth and Development.** It is a goal of AIME to contribute to the economic growth and development of the City of Tuscaloosa, Tuscaloosa County and the State of Alabama. AIME works with these governmental agencies to foster relationships and grow companies both small and large by providing technical and business information. AIME has also provided service this year to the Chamber of Commerce, Southern Alliance for the Utilization of Biomass Resources (SAUBR), Tuscaloosa County Industrial Development Authority, Alabama Forestry Association, Senator Bobby Singelton, Alabama Cooperative Extension Systems and the Pine Chemical Association.

• **BASF Contract to Fund Research to Enhance Ionic Liquid Technology.** The level of this funding to the Cen-
ter of Green Manufacturing in AIME is $185,000 annually for the next two to three years. This research is being carried out by two undergraduate students, three graduate students, and three post doctoral students. Hosting several meetings with BASF to review this work has given the University and its students a chance to share and receive industrial feedback on the business models. It has also allowed students and staff to work closely with BASF for potential career growth.

- **AIME Business Model/Plan Development.** AIME has developed several business models/plans based on the University’s Intellectual Property using technologies in which our partners are interested in licensing. The two partners targeted in 2006 are BASF and DaimlerChrysler. AIME is sharing these plans with other potential clients who have also expressed interest in use of this technology for start-up companies. These other potential clients show a willingness to work with UA partners.

- **Insuresoft Agreement.** Insuresoft, a leading provider of insurance policy administration software, and the University, through AIME, entered into an agreement to pursue cooperative projects relating to data warehousing and predictive modeling. The initiative will advance the mission of UA’s Bama Technology Incubator, created to help promote sustained local economic growth by boosting the number of tech companies in Alabama, administering programs to assist those companies, and facilitating access to technologies developed in UA’s laboratories.

- **Licensing to BASF.** BASF has licensed five patents from The University of Alabama, solidifying their commitment as a strategic research partner with UA.

- **DaimlerChrysler Research Contract.** DaimlerChrysler (DC) has a research contract through AIME, on modeling of Noise Vibration and Harshness (NVH) in components for vehicular cab noises, for $230,000 for three years. AIME recently finished the installation of an anechoic chamber that will allow this program to develop into the experimental and testing phases. Also DC has approached UA to help them in the development of an onboard information system. AIME has three concepts/inventions it is
sharing with them.

- **DuPont Funding.** DuPont has given a gift of $260,000 to accelerate the licensing of donated IP. This offers a good experience for our students, who have developed the business model and are assisting in the marketing of the IP. In addition, DuPont and AIME are working on licensing of UA Intellectual Property involving paints and coating technology.

- **Lubrizol Major Equipment Donation.** The Lubrizol Corporation donated a $200,000 engine dynamometer to AIME. The engine dynamometer will enable the faculty of Mechanical Engineering to conduct engine experiments in combustion and emission of fuels. This testing capability will be a strong attractant to industrial sponsors in the fuel and power business.

4. **STRATEGIC PARTNERING WITH THE STATE OF ALABAMA ECONOMIC DEVELOPMENT PARTNERSHIP OF ALABAMA (EDPA) AND OTHER ALABAMA UNIVERSITIES IN THE DEVELOPMENT AND IMPLEMENTATION OF A STATE-WIDE BUSINESS PLAN COMPETITION.**

- The University of Alabama has united with five other state universities and the Birmingham-based Economic Development Partnership of Alabama (EDPA) to develop the Alabama Launchpad Business Plan Competition. This four-phase business plan competition is unique in that it is the first of its kind to involve multiple universities.

- Personnel from AIME were instrumental in the formation of this competition and have served on the Board of Directors and various working groups that included the design of the Launchpad web site.

5. **RECRUITMENT OF VENTURE CAPITALISTS TO VISIT AND MEET WITH UA OFFICIALS AND FACULTY INVENTORS.**

- Venture Capitalists from Randar Corporation (Tuscaloosa), Greer Capital (Birmingham) and On Point (the U.S. Army) met with UA faculty interested in incubating in BTI. Several presentations were made both at AIME and in Bir-
mingham to these Venture Capitalists. AIME is actively involved in assisting our companies within the incubator to attract funds from the above firms.

6. VALUE ADDED PRODUCT ENHANCEMENT OF UA INTELLECTUAL PROPERTY

- One page summaries of several IP offerings are provided in this annual report of the research projects AIME has undertaken to enhance the value of UA IP. The one page summaries are shown, but the full publication has a brief description of the inventors biographical information. These one pagers are used for both internal and external marketing contacts at the inventors presentation and technical meetings.

The above six initiatives have been developed by AIME and the Office of Research over the past three years.

Following the Prospectus, we provide in this report an introduction to AIME administration, technical summaries from ongoing AIME innovation projects, and disclosures from several entrepreneurial teams.

AIME personnel are proud of our accomplishments from the past year and look forward to serving The University of Alabama in the future.

Daniel T. Daly, Ph.D.
Director, Alabama Institute for Manufacturing Excellence
Alabama Institute for Manufacturing Excellence at The University of Alabama

II. AIME Administration

- Daniel T. Daly
  Director

- Renae D. Sullivan
  Administrative Specialist

- Whitney M. Swatloski
  Innovation Coordinator

- Scott K. Spear
  Research Scientist

- Richard P. Swatloski
  Research Scientist

- W. Matthew Reichert
  Research Scientist

- Megan B. Turner
  Research Scientist

AIME Triage Students:

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<tr>
<th>Graduate Students</th>
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<tr>
<td>Brack Hudson</td>
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<td>Leah Bovell</td>
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<td>Milton Ellis</td>
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<td>Kristin Rogers</td>
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Creating a thriving environment at The University of Alabama that will foster the growth of intellectual property while meeting the changing needs of our state and nation in the area of economic development is an important task for the 21st century. The University of Alabama through its AIME Center is striving to reconfigure itself to meet the challenge posed by the 2006 American Competitiveness Initiative (ACI) of President George W. Bush. This new initiative has focused the attention of the nation on the issue of global competitiveness. ACI follows on the heels of many reports in Washington including “Rising Above the Gathering Storm” by the National Academies and the book “The World is Flat” by Thomas Friedman. The gist of this new approach to competitiveness is a strong coupling of university research through innovation and the commercialization of intellectual property as well as increasing the pipeline of American students in science, technology, engineering and math (STEM) for the workforce. This new approach compliments the Governor of Alabama’s delegation, of which UA is a member, which went to Israel in 2005 and China in 2006 for the purpose of creating economic growth in Alabama through increased trade.

A key component of this new approach to competitiveness is the emerging role of entrepreneurship as the key driving force for growth and global competitiveness through the formation of wealth. In a summative sense the sequence of the words research, innovation, commercialization, STEM workforce and entrepreneurship capture the essential ingredients of the ACI concept.

Universities have traditionally played major roles in research and the development of the STEM workforce, but lesser and even non-existent roles in innovation (defined as adding commercial value to generated knowledge), commercialization and entrepreneurship. Recently (2006), Carl Schramm’s article “The Broken M.B.A.” published in The Chronicle of Higher Education discussed the changes needed in business education and the requirement for an entrepreneurial education in the modern world. Universities have begun to pay attention to innovation and commercialization as a result of the changing dynam-
ics in the late twentieth century through the formation of offices of technology transfer and more recently with business incubators and research parks. While such changes are essential in universities, they tend to confront the ACI concept in a rather piecemeal manner instead of an integrated approach. At The University of Alabama, we believe in an integrated approach that plays to our vision of a student-centered research university as well as a vision of enhancing the life of Alabama residents which is at the core of our mission.

THE CHANGING ROLE OF AIME

To realize the goal of an integrated approach to American competitiveness, The University of Alabama has formed an Office of Research (OR) headed by the Vice President for Research. Within OR, both the Office of Technology Transfer and the Bama Technology Incubator were formed in 2004 and 2005 to handle parts of the ACI equation. The missing components of innovation and entrepreneurship were delegated to a revitalized Alabama Institute for Manufacturing Excellence (AIME).

The initial plan for AIME was to serve as an experiment to learn how best to implement innovation and entrepreneurship. As a result of this experiment and our increasing understanding of the needs of the ACI concept in universities as well as our desire to play strongly to the vision and mission of UA, the Office of Research is proposing a new and more expansive role for AIME. To fit this role, we propose changing the name to the Alabama Innovation, Mentoring and Entrepreneur Center, thereby preserving our acronym while capturing the new role.

A number of factors locally, nationally and globally lead OR to propose a change. These factors are:

- Shift from state supported to state assisted for university budgets drives the need for new funding streams.
- Bayh-Dole Act and other government policies require universities to commercialize IP.
- Corporations and industry will continue to invest less in early stage development due to market pressures to show a profit, forcing universities to engage in developmental or innovative research.
- Industry is not likely to license IP that is not developed to a commercial stage leaving universities with untapped IP.
- Venture capital rarely invests in startup companies for the purpose of bringing IP to a commercial stage making it hard for universities to spin off IP into startup companies. Biotechnology and IT are often exceptions to this rule.
- Universities need to become competent in build-
ing a compelling case for corporations to invest in our inventions (license game) and/or encourage entrepreneurs to invest their efforts in our inventions (startup company game).

- Innovation, the act of adding value to new knowledge or intellectual property, presumably for commercial purposes, requires a sustainable innovation ecosystem.

- The innovation ecosystem in a university requires people (faculty, staff and students) who already are part of the infrastructure as well as physical infrastructure.

- The mission of universities is to educate and train students in all facets of the competitiveness agenda in an integrated manner. Through our Entrepreneurship training, CEOs and CTOs will emerge to be integrated into these locally established start-up companies.

Universities traditionally are the principal generators of new knowledge and early stage IP. A conclusion to be drawn from the above facts is that they need to fill the innovation gap and position themselves higher on the commercial value chain by forming innovation research centers and engaging in R&D to add commercial value to IP. Such innovation centers should be in addition to an office of technology transfer and a business incubator and form part of an integrated system known as the innovation ecosystem. However, to carry out the broader vision of The University of Alabama as a student-centered research university, it is important that students and their education be an integral part of the innovation ecosystem. How can we accomplish these multi-faceted goals at UA?

NEW AIME

The proposal of OR is that we reconstitute AIME and significantly enhance what is already being done, but emphasize and develop an innovation ecosystem driven by the involvement of both undergraduate and graduate students. Our plan is modeled on the thinking behind the “moot corp” program at The University of Texas at Austin, but takes a rather different form (see: http://www.mootcorp.org/). The plan also involves a modification of the strategy behind DARPA.

The “moot corp” program at UT involves running a business competition for funding new startup ventures. At UA we want to start with intellectual property that has been disclosed to UA, build an entrepreneurial team composed of faculty and students around a given IP, develop an innovation and marketing plan for the IP, compete the IP before a moot “venture capital (VC)”
board composed of students and faculty, and send the winning IP into the innovation center labs (or other university labs as appropriate) for research development as well as legal, marketing and business development. We will then utilize the DARPA concept. This concept is one where a person or team gathers around a specific new concept and seed funds universities and others as part of a broad team to bring the concept to fruition for eventual military use. In AIME we will form similar teams to carry out research to add value to UA IP chosen by the moot VC process. Each team will also conduct the legal, marketing, and business analysis. The teams will be comprised of faculty, students and staff at AIME. The ultimate goal of these teams is to add value to the IP and to commercialize it through licensing.

Student involvement in AIME will be driven eventually through a new multi-disciplinary and multi-college entrepreneurial curriculum and program to be developed at UA. Major players will be the College of Commerce and Business Administration, the College of Engineering, and the College of Arts and Sciences. Student participation in AIME will include, but is not limited to, marketing research prior to investment in IP development (independent work or classroom projects), mock investment decision games on AIME investment in IP development (moot corp game), part-time research staff member, and marketing and sales of IP to the business and venture capital communities. The overall goal is to train UA students on how to start his/her own company or become a participant in these companies.

Students will learn how to protect intellectual property, form business models and recruit funding. They will be exposed to the companies in BTI and could provide an entrepreneurial team for a given company. We will have venture fellows brought into the university to help the incubating companies in BTI obtain funding. Students will work with these fellows. As part of their training, they will participate in writing SBIR/STTR grants and assist the incubated companies in presenting business models/plans to venture capital and angel investors. Students will also be asked to participate in the moot corp exercise used by AIME to choose projects and to join entrepreneurial teams associated with the projects. There is an expectation that the students could join BTI companies since startups are always in search of business executives or form new startups from AIME developed IP.

Some of the outcomes expected from the new AIME are:

- Generate resource/in-
come from IP for UA through commercialization of IP.

- Provide experiential learning for students through entrepreneurial activities (marketing studies, moot corp, etc.) and research laboratory experience.
- Enhance UA research image.
- Foster local economic development (particularly if AIME creates, as opposed to incubates, startup companies).
- Develop Alabama-centric entrepreneurs.
- Attract industrial sponsored research and partnerships.
- Attract quality faculty because of existence of AIME.

ACHIEVING A CULTURE OF HIGH TECHNOLOGY ENTREPRENEURSHIP AT UA

To achieve these outcomes, UA will adopt for AIME an overall strategy of initially investing in AIME in order to assist it in its new mission and then in future years using some of the resulting increased royalty stream to grow the enterprise. Initially, we will invest limited resources and efforts targeted at the development work necessary to take our early stage IP with the highest probability of success to commercialization by adding value. As we become more successful at this, then we can take on larger funding and higher risk areas. We define value added as having IP developed to the point that there is a promise of commercialization in 2-3 years. This could include a market research document and business model/plan document for the specific IP. The vision of AIME will be “a culture of high technology entrepreneurship at UA.” The mission will be "to identify and facilitate value added innovation and foster entrepreneurship leading to commercialization of intellectual property."

THE FUTURE

The University of Alabama through a revitalized AIME is poised to make significant advances in the commercialization of university IP and the startup of new high technology companies in Tuscaloosa and the State of Alabama. The plan presented herein is a roadmap to guide UA in the start of this new venture. The future begins now.
The partnership developed with BASF has dictated much of the initial development work carried out within AIME. This is a direct result of the licensing deal in which BASF licensed five of The University of Alabama’s ionic liquid processing of cellulose technologies. Since these technologies were in the very early stages of development, we have attempted to leverage the UA/BASF relationship by constructing several business models utilizing the licensed technologies. These business opportunities were then presented to BASF for feedback, and potential commercialization. To support the positive industrial feedback loop, AIME researchers carried out the necessary developmental work to establish the technical feasibility of the proposed applications. In the following pages, we provide technical summaries of seven projects.
Objective: To develop our patented encapsulation technology into marketable products by encapsulating functional polymers which would allow attachment of different technologies for several applications. The applications developed include:

- Slow Release Pharmaceuticals
- Bandages
- Wetting Agents
- Polymeric Coatings

This added functionalization takes advantages of the solvation properties of the ionic liquid technology and alleviates activation of cellulosic surface sites.

Results: Initially we developed the technology of nano size bead formulation by spraying a solution of ionic liquid and cellulose into water.

We were then able to encapsulate dendrimers into these cellulose beads which allowed us to attach a variety of compounds to the beads.

We continued the development of this technology to films with embedded functional polymers which lead to the construction of a molecular architecture scaffolding. This scaffolding allowed much flexibility so many different applications were achievable.

Samples of prepared materials have been examined using infrared (IR) spectroscopy to confirm both the presence of functional surface groups necessary for attachment as well as the presence of the

Material Functionalization Scheme
therapeutic molecule itself. Subsequent NMR analysis of the hydrolyzed products from the benzylamine attached materials confirm the presence of the molecule substantiating the validity of our experimental methods to both attach and selectively release molecules from the surface of these materials.

Objective: To develop the Ionic Liquid-Cellulose technology to allow cellulose to be more accessible to the $20$ billion thermoplastic industry. Currently, cellulose is overlooked as a fiber due to its incompatibility with the petroleum based polymers. Thus we explored many different compatilizers to increase the binding between cellulose and polypropylene.

Experimental Plan: In this work we demonstrate the potential for use of a hydrophilic/hydrophobic block copolymer as coupling agents for cellulose/polypropylene composites.

Current Results: Several films were made. The films tested were pure cellulose, cellulose with a few different $20\%$ block copolymer of a polyether and Maleic Anhydride Polypropylene (MAPP). They were looked at under the microscope to make sure the polyether did not crystallize out of the film and that the amines appear to be evenly distributed in the film. The IR spectrum showed there to be some water
still present in the films, but no other major discrepancies were observed.

Compared to the plain cellulose, the Maximum % Strain was almost 4x higher for the Polyetheramine-MAPP blockcopolymer in Cellulose.

**Making Cellulose/Jeffamine Fibers for Cell-Growth Scaffolds:** Fibers were successfully made from a cellulose with 20% Jeffamine D-230. Studies of these fibers await completion.

**Publications:** Haque, A.; Daly, D. T.; Rogers, R. D.; Mobley, C.; Swatloski, R. P. “Effects of MAPP as Coupling Agent on the Performance of Cellulose /Polypropylene Laminated Composites”, Proceedings of 3rd International Conference on Eco-Composites, Royal Institute of Technology, Stockholm, Sweden, June 20-21, 2005
Objective: The Sponsored Research Agreement under Dr. Robin Rogers is focused on the production of novel cellulosic fibers in ionic liquids. As a component of this study, the final formulations are sent to BASF for optimization. To improve the quality of fiber formulation sent to BASF, AIME researchers developed an automatic method of fiber formulation and testing of the strength of these fibers.

Results: The fiber extrusion setup uses an electric syringe pump with an extrusion rate of 0.3 ml/min. The heated solution of cellulose and an ionic liquid was placed into a syringe and excess air was removed. A heating jacket was used to maintain the solution at 70°C. The fibers were prepared by extruding the extrusion dope through an air gap into a coagulation bath. The fiber was drawn over a series of two godets in a water bath operated at a range of 10 – 200 rpm and collected by a spooler. Several different fibers were made using this set-up for the BASF project.
Fiber Extrusion

Scanning electronic micrograph (SEM) images of plain fiber surfaces and cross-sections

13% MCC  13% MCC  4% peach  4.5% Pulp

Stress strain curves for plain fibers
Porous Cellulose Materials

Scott K. Spear¹, Daniel T. Daly¹, Richard P. Swatloski², and Robin D. Rogers²

Alabama Institute for Manufacturing Excellence¹
Department of Chemistry and Center for Green Manufacturing²
The University of Alabama, Tuscaloosa, AL 35487

Objective: The High Performance film market in the US is currently $3.6 billion per year. There is an increasing need for engineering and specialty polymers in the market. To explore the use of the cellulose films in this market, porous cellulose films were made.

Results: Porous cellulose films were made in a feasibility study to explore the use of these films in size-exclusion filtration. Cellulose was dissolved in 1-butyl-3-methylimidazolium chloride (10 % w/w). To the cellulose-IL solution calcium carbonate was added and vigorously stirred. The solution was poured onto a glass surface and the cellulose-calcium carbonate regenerated with water. The films were allowed to air dry over night to produce cellulose films with homogeneously dispersed calcium carbonate particles. The calcium carbonate was removed by soaking the cellulose film in a dilute hydrochloric acid solution (1 % v/v). Initially, the films were looked at with Scanning Electron Microscopy (SEM) to assess the pore structure on the surface of the films. In the figure, it is shown that calcium carbonate suspended in a cellulose framework can be removed with dilute acid to leave behind a porous cellulose structure. Excellent results can be obtained from freeze-drying as well.

SEM of 10 % w/w Calcium Carbonate/Cellulose (top) and 50 % w/w Calcium Carbonate/Cellulose films before (left) and after (right) dilute acid treatment.
Objective: To develop a polymeric coating for wood using the Ionic Liquid technology. The real intent was to develop a coating that could be applied to wooden structures to increase their strength and resistance to damaging floods and high winds.

Results: In this work the processibility of polymeric materials dissolved in ILs has been investigated in order to use these materials as reinforcing coatings in wood. To improve compatibility of the resins and wood, solvent and solvent-less regeneration procedures were explored. This was done to achieve optimum stress transfer at the interface. Initially, the structure, thermal and mechanical properties of the wood are determined as baseline data of the constituent materials. Then the tensile failure strength, failure strain and modulus of coated wood composites are determined at room temperature. In the figure, it is shown that stress-strain properties of wood are significantly enhanced (34% in breaking point) by coating wood with kermel resin.
Combustion Performance of Liquid Bio-fuels in a Swirl-Stabilized Burner

Daniel Sequera¹, Ajay K. Agrawal¹, Scott K. Spear², Daniel T. Daly²

Department of Mechanical Engineering¹
Alabama Institute for Manufacturing Excellence²
The University of Alabama, Tuscaloosa, AL 35487

Objective: The Southern Company expressed an interest in developing a fuel for reduced emission, since the power plants in rural Alabama will not be fit with emission reducing technologies due to the cost of installation. The Southern Company would be forced to close these plants if they can not lower their emissions resulting in a loss of employment in rural Alabama.

Results: AIME researchers developed several fuel formulations to lower emissions. Fuels produced from renewable sources offer an economically viable pathway to curtail emissions. Low emission fuels including biodiesel and vegetable oil ethanol derived from soy, corn or other food crops. In recent years, significant effort has been devoted to identify alternate feedstock sources and conversion techniques to diversify the bio-fuels portfolio. In this study, we are interested in characterizing flames produced from several bio-fuels blended with diesel. The experiments were also conducted by varying the airflow split between the injector and the co-flow swirler. Results show a significant reduction in emissions as the fraction of total air fed into the atomizer was increased. Large amounts of atomizing air produced blue flames, reminiscent of lean premixed combustion and low emissions of nitric oxides (NOx) and carbon monoxide (CO). In general, the emissions from bio-fuel flames were comparable or lower than those from diesel flames.


Daniel Sequera, Ajay Agrawal, Scott Spear, and Dan Daly, University of Alabama.
The University of Alabama has united with five other state universities and the Birmingham-based Economic Development Partnership of Alabama (EDPA) to develop the Alabama Launchpad Business Plan Competition. This four-phase business plan competition is unique in that it is the first of its kind to involve multiple universities.

Competing teams are comprised of university students, faculty, staff researchers, alumni of no more than five years, and former university faculty of no more than three years. Winning competitors will receive up to $100,000 in cash prizes as well as in-kind services.

“This is an exciting business-university alliance that will help entrepreneurs at these institutions get their companies and ideas off the ground,” says Alabama Launchpad Director Glenn Kinstler. “There is so much ground-breaking research being conducted at all of the participating institutions. Getting these ideas into the marketplace will undoubtedly strengthen the state’s economy. Other communities like Boston, Silicon Valley and Raleigh, N.C. have done this successfully for years.” Kinstler graduated from The University of Alabama College of Communication and Information Sciences in 1995 with a Bachelor’s in Public Relations.

Dr. Daniel T. Daly stated that “the level of interest in entrepreneurial endeavors at The University of Alabama is extremely high. I am confident that our faculty, staff and students will participate in this state-wide business plan competition.” Dr. Daly is on the Alabama Launchpad Board of Directors.

The Alabama Launchpad Business Plan Competition website can be seen at www.alabamalaunchpad.com. The website was designed and is maintained by Whitney Swatloski, a staff member in AIME.

Results: Sixty-one total teams registered to participate in Alabama Launchpad. Seven of those teams are from The University of Alabama. Of those seven, four teams are from AIME.

The four AIME team business plans will be made available to any start-up company that wishes to explore these opportunities. Working closely with the Office for Technol-
ogy Transfer, we will encourage the use of these plans for high technology start-up companies.

Other participating universities include: Alabama A&M University, Alabama State University, Auburn University, The University of Alabama at Birmingham and The University of Alabama in Huntsville.
V. Non-Confidential

Invention Summaries
"The most frequent illness among workers exposed to heat stress...is heat exhaustion which is likely due to dehydration," says T.E. Bernard, professor of Environmental and Occupational Health at the University of South Florida.

This problem came to the attention of Dr. Phillip Bishop in 1986 as he served as a Visiting Scientist with the United States Air Force. At the time, the military sought a way to keep military personnel cool and hydrated in the intense desert sun while wearing protective clothing. The solution: a "drinkable vest." Ice filled, the vest is designed to keep its wearer cool. But that is only part one of its novelty. As the ice begins to melt, the vest fills with water that the wearer can then drink through a straw built into his gas mask. The vest’s ability to keep an individual cool and hydrated can lead to an increase in productivity of more than 25 percent. Because the vest provides hydration as well as cooling, it is superior to competing vests. It can be comfortably worn underneath other protective equipment such as air tanks or bullet resistant garments.
This new cooling system provides tetherless cooling for up to three and a half hours as was demonstrated in 100°F lab temperatures. The vest is engineered to be compliant with NIOSH.

There are a number of potential industrial applications for this vest. Some of those applications include emergency first responders, shipbuilding and repair, aircraft manufacturing, chemical plant maintenance, hazmat work, roofing, fire fighting, etc. But in truth, the sky is the limit for such innovation.
SmartSpeed is a continuous, passive decision support system for vehicles that recommends a ‘smart’ driving speed given the current conditions surrounding the automobile. This smart driving speed would effectively reduce the risk of having an accident due to the external conditions surrounding the vehicle.

The core feature of Smart Speed is its ability to indicate on the speedometer the current ambient speed limit of the road on which the vehicle is operating. SmartSpeed eliminates speed limit ambiguity and increases speed limit awareness by passively notifying the vehicle operator, vehicle operator directly on the vehicle’s speedometer by lighting up the speed limit. SmartSpeed’s audible notification consists of a tone triggered when the vehicle passes a given speed threshold above the speed limit (or the speed limit itself) for a given period of time (or instantaneously). This tone may only repeat once the automobile’s speed drops back below both the threshold and/or speed limit and again passes the threshold and remains above the threshold for a given period of time. The details of this functionality will be amended as research and testing continues.

In addition to notifying the vehicle operator of the ambient speed limit, SmartSpeed also communicates speed recommendations directly on the speedometer for a variety of...
conditions surrounding a given vehicle. These recommended speeds effectively reduce the risk of operating a vehicle under the given ambient conditions. The conditions that are entered in the SmartSpeed algorithm which calculates the recommended speed include weather conditions, road dynamics, and special conditions.
Rapid hydrolysis of small protein samples is an important step in many procedures of current interest, including determination of amino acid content in protein food sources and automated proteome analysis. Current protein hydrolysis procedures are a severe bottleneck in the time line of automated proteome analyses. The hydrolysis step requires several orders of magnitude more time than other steps in the complex sequence leading to the final result.

Conventional acid hydrolysis techniques require incubation of protein in 6N HCl for 7 - 24 hours at 110°C, or a comparable period for protease hydrolysis. Microwave techniques can reduce hydrolysis time to about 15 minutes, but these methods also require an additional period of 15 minutes or more for vacuum centrifugation to remove the HCl from the hydrolyzed liquid sample. We have developed a laser technique for rapid hydrolysis (seconds to minutes) of the peptide bond in small samples. The technique not only reduces the incubation time by a large factor, it also eliminates the necessity for subsequent HCl removal. The CO2 laser used in our procedure operates at an infrared wavelength near 10μm.

During a typical experiment an aqueous solution of dipeptide in 6.0 NHCl is placed in the well of the sample tube and irradiated with the CO2 laser beam. The laser power is largely absorbed within ~20μm of the sample surface. The water vaporizes and condenses on the upper cell wall and is ultimately collected in the lip by centrifugation of the sample tube. Heat is also transferred to the portion of the sample that remains in the well, rapidly raising its temperature to an equilibrium value of approximately 50-60°C.

As this process continues, the concentration of the sample increases due to its decreasing volume, and hydrolysis proceeds throughout the tube at a rate determined by the instantaneous sample concentration and the bulk temperature. However, a very thin region near the sample surface is heated to a much higher temperature, and the hydrolysis rate is much higher there. Surface effects contribute to rapid hydrolysis near the top of the sample. No turbulence is observed in the cell, but a uniform concentration appears to be maintained throughout the sample by thermal convection. The fractional
hydrolysis, \( H \) (defined as the number of peptide bonds in the original sample that have been broken), increases monotonically during this phase of the run.

Near the end of the run, as the sample surface approaches the bottom of the cell, there are dramatic changes. The mix of peptide and amino acid molecules which had previously cycled in and out of the rapid reaction layer are now confined to that region. As the volume continues to shrink each molecular component begins to crystallize as its saturation value at the now prevailing temperature is reached. At the end of the process only a pile or film of crystals of dipeptide and daughter amino acids remains in the well. The crystals can be dissolved in water for analysis and calculation of fractional hydrolysis. In some cases, the final reaction-rate surge actually doubles \( H \). Note that the HCl has also been removed by the evaporation process. Laser power and beam structure largely determine the duration of a hydrolysis run and the final value of \( H \). Using both experimental and computer modeling techniques we are continuing to study these and other experimental parameters in order to optimize the procedure. Our immediate goal is to achieve >90% hydrolysis of 10\( \mu \)l peptide samples in less than 1 minute. Future studies will also be expanded to include larger peptides and proteins.
The universal laser-doppler velocimetry (LDV) probe was designed to make measurements in tunnels with thick side walls, where the walls affect the laser beams such that the optical length traveled by each beam might be different. In a conventional LDV system for such an application, different optical path lengths traversed by each of the LDV beams result in the beam waists to be in different spatial locations from each other. If the separation between the beam waists is not large so that portions of the beams within the Rayleigh range overlap with each other then the uncertainty in the measured velocity increases due to the broadening effects. However if the beams waists do not overlap then the velocity can not be measured with such a system. In the current design each of the beams of the LDV system are controlled separately to make sure that the beam waists overlap with each other after they pass optical walls.

A frequency-domain processor used together with this probe, TSI-Flow-Size-Analyzer (FSA)-4000, measures particle passing frequencies up to 175MHz. The maximum data acquisition rate of the unit is 800 MHz and the minimum particle transit time that can be analyzed is 50 nanoseconds. The unit can be used to measure three-simultaneous frequencies.

The probe can be oriented in such a way that it can be used to measure velocities within the 0 to 2300 m/s range. In this case the fringe spacing would need to be 9.3 mm. Velocity measured along the 1st unit vector
would be $-0.707 \ U_{\text{jet}}$ and the velocity value along the 2\textsuperscript{nd} and 3\textsuperscript{rd} unit vectors would be $0.5 \ U_{\text{jet}}$. Such an arrangement would be needed if the probe sees a velocity range of 2300 m/s. This condition is actually highly unlikely since at a measurement point the instantaneous values should not vary more than 630% of the mean value measured at that point, unless there is flow separation.
Multi-Functional Ionic Liquid Compositions For Overcoming Polymorphism And Imparting Improved Properties For Active Pharmaceutical, Biological, Nutritional, And Energetic Ingredients

Dr. Robin D. Rogers

The subject matter disclosed herein generally relates to ionic liquids and to methods of preparing ionic liquid compositions of active pharmaceutical, biological, nutritional, and energetic ingredients. Also the subject matter disclosed generally relates to methods of using the compositions described herein to overcome polymorphism, add functionality, and improve ease of use and manufacture.

The inadvertent production of an undesired polymorph (or pseudopolymorph), or the spontaneous transformation from the desired crystalline form to an undesired form, can result in crystalline forms of a drug that are less effective or even toxic. Thus, the existence and control of polymorphism and pseudopolymorphism can be the biggest challenge to obtaining a drug product of constant quality with the desired solubility and bioavailability.

The idea of multifunction IL formulations started when we were working on adding a ionic liquid sweetener to an existing ionic liquid component that had anti-bacterial properties. It soon became apparent to us that by adding specifically designed IL to ionic formulas to balance the charges we could make IL formulations with many different desirable features, such as:

- Controlled release
- Controlled delivery
- Biological impact
- Taste
- Physical properties (stability, toxicity, melting point, etc)
- Melting point
- Methods to overcome polymorphism
- The ability to deliver liquid forms would have immediate acceptance in the following markets:
  - Drugs
  - Pesticides
  - Oral Care
  - Cosmetics and Health Care
  - Vitamins

Since pharmaceuticals represent a huge market, an attractive feature to this area would be compounds whose patent life was about to expire and this could be a possible means of extending patent life. In additional, many APIs fail due to inadequate solubility or bioavailability in addition to other...
issues. Our approach will allow the fine-tuning of such major attributes as rate of dissolution, bioavailability, in addition to enhanced and controlled functionality. It will also be possible to prepare cocktails of active ingredients based upon complementarity and balance of charges within the liquid salts. We will also be able to pre-select the active functionalities in preparing our ILs.