Contact: Diana Gonzalez

REQUEST TO CREATE NEW CENTER AT IOWA STATE UNIVERSITY: CENTER FOR BIOPLASTICS AND BIOCOMPOSITES

Action Requested: Consider recommending approval of the request by Iowa State University to establish the Center for Bioplastics and Biocomposites in the Center for Crops Utilization Research.

Executive Summary: The purpose of the proposed center is to develop high-value biobased products from agricultural feedstocks. This proposal was reviewed by the Board Office and the Council of Provosts and is recommended for approval. Board of Regents Policy §6.08 requires that all centers and institutes be approved by the Board. This request addresses the Board of Regents Strategic Plan priorities to provide "educational excellence and impact" and "economic development and vitality," Goal #7 - "Iowa's public universities shall contribute to the expansion and diversification of the Iowa economy," and Goal #8 - "Iowa's public universities and special schools shall be increasingly efficient and productive."

Background:

- Description of proposed center. The proposed Center for Bioplastics and Biocomposites (CB^2), will be a National Science Foundation (NSF) Industry and University Cooperative Research Center (I/UCRC) that will focus on developing high-value biobased products from agricultural feedstocks. The proposal submitted to NSF has been recommended for funding by NSF.

  As an NSF I/UCRC, the CB^2 is a true public-private partnership. The I/UCRC program at NSF has been in place for over 35 years and is often cited as one of the most successful programs at NSF. Its main purpose is to foster industry/university collaborations in research and education that are critical to the productivity of the nation. Currently, there are more than 60 NSF I/UCRC centers nationally.[1]

  CB^2 is a collaborative effort by the Biopolymers and Biocomposites Research Team at Iowa State University, the Department of Plastics Engineering at the University of Massachusetts Lowell, the Composite Materials and Engineering Center at Washington State University (WSU), and industry members to conduct commercially relevant research.

  ISU, UMass Lowell (UML), and WSU are in a unique position to successfully develop and operate a bioplastics center. Iowa State is an established leader in the area of biobased products, UMass Lowell is a known leader in the field of polymer processing, and WSU has a strong history of research and inventions in natural fiber polymer composites. By bringing together their expertise, the proposed center will be able to successfully transfer ideas, results, and technology to the U.S. plastics industry.

  The overall structure includes the following:

  - ISU is the lead institution.
  - WSU is a center site and UML is an affiliated site.
  - NSF funds cover administrative costs for the center's operations.
  - Industry funds will be directed to support research.

[1] (http://174.143.170.127/iucrc/publicCenterListServlet.

- Proposals will be submitted by principal investigators (PIs) and researchers from the various institutions to industry members for review.
- Industry members (Industry Advisory Board – IAB) vote to direct the center's focus areas and funded projects.

As directed by NSF, the proposed center was vetted by a panel of peer reviewers prior to being recommended for funding to provide assurance that:

- The institutes have existing facilities to conduct the proposed research.
- The institutes have existing faculty/researchers to conduct the proposed research.
- There are no other centers of this type currently in existence.
- There is sufficient industry support for the proposed center.

The goals of this center are threefold: (1) to improve the basic understanding of synthesis, processing, properties, and compounding of bioplastic and biocomposite materials; (2) to develop reliable material characteristics data for industrial partners; and (3) to support large-scale implementation of renewable materials. In order to achieve these goals, the activities will focus on:

- Collaboration with industry to develop fundamental knowledge of bioplastics and biocomposites.
- Dissemination of this knowledge through publications, workshops, and tradeshows.
- Education of future researchers, engineers, and scientists in the field of bioplastics and biocomposites in the classroom.

The PI has assembled a diverse team of researchers with expertise covering all research aspects of the bioplastics and biocomposites value product chain. These researchers form a collaboration of three separate institutions: Iowa State University (ISU) as lead institution, Washington State University (WSU) as a center site, and University of Massachusetts Lowell (UML) as an affiliate.

◈ Need for proposed center. The United States uses approximately 25% of the world's petroleum, 42% of which is imported. Concerns about greenhouse gas (GHG) emissions, fluctuating supply, and volatile price swings have focused attention on possible alternatives. Approximately 3% to 5% of the petroleum in the United States is used by the polymer industry to produce 60 billion pounds of new synthetic and non-biodegradable polymer products a year. Several sources indicate that the bioplastics industry is growing at an annual rate between 10% and 20%. Ford Motor Company produces a majority of their car seat foams from soybeans and Coca-Cola uses one-third renewable resources to produce their PlantBottle™. These examples attest to the fact that materials from renewable resources are gaining market share and will continue to be part of U.S. manufacturing. The transition to domestic sources for polymers, in particular renewable and biodegradable plant-based oils, carbohydrates, and proteins, will reduce environmental impact and create new businesses and markets within the agricultural economy.

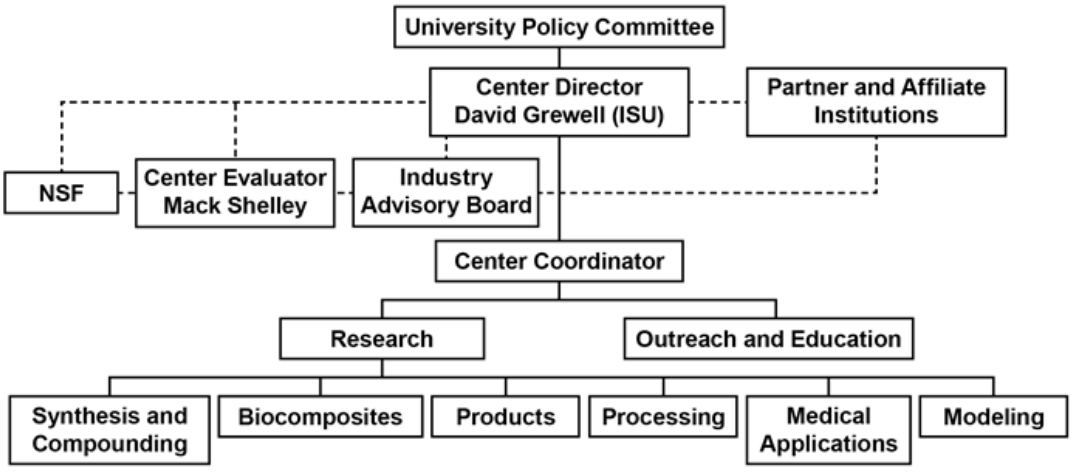
To achieve commercial-scale production and realize potential environmental benefits, further research is needed in formulating plant-based materials to optimize their thermo-mechanical properties, service life, processing and manufacturing potential, and lifecycle costs. Furthermore, their ease of use, manufacturing potential, performance and viability, and cost effectiveness have not been sufficiently demonstrated for large-scale industrial adoption and consumer use. The proposed center will be instrumental in overcoming

these current shortcomings. The former Biodegradable Polymer Research Center (BPRC), headed by UML, resulted in several successful research partnerships, some of which exist today; however, the market for bioplastics was not yet mature enough to support continuation of the industrial effort. The proposed center will focus more broadly on bio-derived plastics in general, and will attract a wider range of bioplastics producers as well as traditional plastics processors and feedstock suppliers.

- Proposed center activities and objectives. The Center functions according to the guidelines established by the NSF I/UCRC program. Faculty and students work on research projects of shared value to industry members and the universities. Every six months, all university sites and members of the Center participate in an Industry Advisory Board (IAB) meeting where projects are presented, feedback and evaluation is obtained, new projects are selected, and workshops with industry that capture on-going and new challenges are discussed. Between IAB meetings, in addition to project work, universities and members pursue a variety of funding sources for added resources to support the work of the Center.

  The objective of the proposed CB^2 will be to develop fundamental knowledge related to bioplastics and biocomposites and disseminate this knowledge to industry to promote sustainability and educate future scientists and engineers. The vision of the center is to develop the knowledge that will allow the production of an array of high-value products, including plastics, coatings, adhesives, and composites, from agricultural feedstocks that are compatible with current industrial manufacturing systems and thereby promoting rural development as well as national economic growth.

  To achieve these goals, the overall center organization is detailed below. ISU will be the lead institution and responsible for overall operation of the center. Each institution will have a co-director who will be responsible for administration of all research, budget, outreach, and related activities at their institution. The PI, Dr. David Grewell, has over 12 years of industry experience and administers a large research group at ISU, giving him a unique perspective of academia and industry and assuring a strong and healthy relationship among both the center institutions and between industry and academia. In addition, Mack Shelley, an experienced, independent center evaluator, who meets all NSF requirements, has agreed to serve as the CB^2 evaluator. The center activities will be supported by industrial memberships in accordance with NSF eligibility requirements for a multi-university I/UCRC.



Intellectual property and contract related issues will be administered by each institution, but there will be a general agreement with the center to resolve differences. It is anticipated that the work will focus on pre-competitive technologies; however, the handling of intellectual property rights is detailed in the membership agreement. Each institution will also hire administrative staff to support budgeting, reporting, and operating activities. It is important to note that the center's organization will be nimble and lean in order to maximize its impact with minimal NSF/industry investment. This will be achieved by leveraging current infrastructure investments, such as through the Center for Crop Utilization Research (CCUR) and the College of Agriculture and Life Sciences at ISU, as well as at the other sites. This investment will include resources such as staffing, facility, and administrative support.

ISU and WSU have obtained 24 letters of commitment from industry members. Each institution will be responsible for engaging their respective industry partners to fulfill the obligations of membership as set forth in the membership agreement. These recruited members have been selected because they encompass a broad spectrum of the supply chain for bioplastics and biocomposites. For example, the commodity boards represent the initial feedstock component, companies such as Laurel Biocomposite and Creative Composites represent compounding companies, and 3M and Newell Rubbermaid represent manufacturers. These partners will meet during the kickoff meeting to finalize the projects, refine the agreements, and formalize their interest in the center. While it is anticipated that industry partners will only be members of one institution (ISU or WSU), there will be provisions to allow a company to split its membership as well as engage in multiple memberships at each institution independently.

Internal review boards (IRB) which include three independent reviewers from each institution will be solicited to "serve as a university policy committee that facilitates the operation of the center within the policies of the universities." Board members will include faculty members at the level of full professor and department chair. They will review the activities at each institution on an annual basis and supply a letter detailing the level of compliance. The center will have three months to respond to compliance issues. Where applicable, one IRB can review the activities of the sister institution.

An annual call for proposals will be developed covering six to eight topics based on recommendations from the Industry Advisory Board (IAB) and distributed three months prior to each IAB meeting. The IAB will consist of one selected employee from each member company of the center. Projects will be expected to have a two- to three-year duration with a review during the annual IAB meeting to assess the viability of each project and continuation of funding. Center staff and the IAB will prepare detailed criteria for the review of proposals with a weighted scale in order to score proposed projects. Prescreening of all proposals at each institution (independently, with consultation from the center director) will be completed by blind voting of the PIs and the IRB to accommodate a number of projects commensurate with current center membership levels, as agreed upon by the IAB.

One month prior to the semi-annual IAB meeting, the IAB will be provided 20 to 30 two-page proposals (7 to 10 from each institution) for review. It is important to note that only center members (i.e., companies that signed an agreement) will have full privileges, namely reviewing and voting rights. It is anticipated that three to four projects at each institution will be funded based on the number of continued projects, funding level, membership level, and project attrition.

Once the center is established, two IAB meetings per year will be scheduled. A two-day fall meeting will be held at a center site, rotating between ISU and WSU. New proposals will be presented and current projects will be reviewed at the fall meeting. A one-day spring meeting will be held to review projects as well as the general state of the center. The spring meeting will be held at an airport hub for ease of travel for IAB members. The dates and locations will be selected based on IAB voting to maximize IAB participation. During each meeting, the center evaluator will review the center activities and prepare a report.

The advisory board will function in a consultative capacity and will provide advice to the director as he or she leads the Center in furtherance of its objectives. The advisory council itself is not a governing body, and it has no independent personnel or financial authority because the Center is a unit of Iowa State University. The director of the Center will be an employee of the university, and as such, he or she will abide by university policies and report to the Provost's Office through the College(s).

The University Policy Committee, which consists of senior leaders from all Center universities, has the responsibility to ensure that the Center's activities are consistent with academic policies and procedures of the universities.

- Relationship of proposed center to University's Strategic Plan. The proposed center is aligned with the mission, vision and strategic plans of the university and the college in advancing research in critical areas of national need and transferring this knowledge to industry to support economic development of the state and the nation. CB^2 will bring important research aspects of bioplastics together in a synergetic fashion. One goal of the Center is to prepare the next generation of students, capable of multi-disciplinary research and thinking, to develop new technologies, methods and materials, and to engage in collaborative research in a global economy. The NSF I/UCRC program provides a proven framework for the success of the Center's public-private partnership. Students working on research supported through the funding of the Center receive practical education as they work in collaboration with industry members to solve important industrial problems. The three institutions geographically cover the entire United States, giving the bioplastics industry easy access for direct and immediate technical support. In addition, all three institutions have expertise in techno-economics, including feedstock logistics at ISU, natural-based composites at WSU, and healthcare biopolymers at UML

- Relationship of proposed center to existing centers/institutes at ISU. ISU's Biopolymers and Biocomposites Research Team (BBRT), established in 1995, promotes research in the development of biorenewable polymers from Midwest crops, encourages the use of bioplastics and biocomposites in industry, and works toward new formulations and processing techniques. The BBRT, currently chaired by the PI, consists of a wide range of interdisciplinary researchers, including chemists, material scientists, engineers, architects, and agricultural scientists. The group is composed of undergraduate and graduate students, postdoctoral research associates, scientists, and 21 professors, several of which are co-PIs and senior personnel involved in this proposal. The BBRT, supported by the ISU Center for Crops Utilizations Research (CCUR), has a long history of developing and commercializing bioplastics. The BBRT was supported by CCUR as well as the College of Agriculture and Life Sciences through support staff as well as financial support. Resources from the CCUR and BBRT will be leveraged to optimize the performance of CB^2 as well as to enhance the impact of both organizations. For example, the group has collaborated with SoyWorks to formulate and commercialize protein-derived plastics and with Creative Composites for beta-site and scale-up testing of soy oil/soy protein-based lubrication sticks.

The BBRT and the proposed CB^2 will also work closely with CBiRC (Center for Biorenewable Chemicals), an ISU NSF/ERC, and leverage the development of renewable chemicals for bioplastics. The teams are already partnering to develop bio-based terephthalic acid so that bottles produced from polyethylene terephthalate, many of which are one-third biobased, can be produced fully from renewable resources. Other opportunities for the collaboration between CB^2 and CBiRC include the development of renewable additives such as flame retardants, plasticizers, and reinforcing fillers.

- Existence of proposed center at other Iowa institutions. The National Science Foundation does not create competition between I/UCRC centers. The NSF requires that a university interested in forming a center with a similar mission and objectives join an existing center. No other centers or institutes focused on research and educational training in bioplastics/biocomposites exist at other universities in Iowa nor the nation as detailed in the original proposal to NSF. The University of Iowa and the University of Northern Iowa have provided letters of support. The proposed center will continue to work with the CCUR and build a stronger relationship with CBiRC (Center for Biorenewable Chemicals) an ISU NSF/ERC center. In addition, when applicable the proposed center will work with CIRAS (Center for Industrial Research and Service) at ISU to help commercialize and support extension activities.

- Unique features of Iowa State University to support the proposed center. The BBRT, currently chaired by the PI consists of a wide range of interdisciplinary researchers, including chemists, material scientists, engineers, architects, and agricultural scientists. The group is composed of undergraduate and graduate students, postdoctoral research associates, scientists, and 21 professors, several of which are co-PIs and senior personnel involved in this proposal. The BBRT, supported by the ISU Center for Crops Utilizations Research (CCUR), has a long history of developing and commercializing bioplastics. As a world leader in bioplastics, BBRT has secured millions of dollars in research grants from the National Science Foundation (NSF), Department of Energy (DOE), Department of Defense (DOD), Department of Agriculture, industry, and commodity boards. It is important to note that the proposed CB^2 will primarily focus on pre-competitive research, allowing individual members to further develop concepts into competitive commercial technologies.

- Inter-institutional and collaborative efforts with other entities. The BBRT and the proposed CB^2 will work closely with, and leverage the developments of renewable chemicals for bioplastics. The teams are already partnering to develop bio-based terephthalic acid so that bottles produced from polyethylene terephthalate, many of which are one-third biobased, can be produced fully from renewable resources. Other opportunities for collaboration between CB^2 and CBiRC include the development of renewable additives such as flame retardants, plasticizers and reinforcing fillers. In addition, the inter-institutional aspects of the proposed center will assure pollination of collaboration between institutes and other centers.

- Personnel. As required by NSF, the proposed center has all required major personnel already in place. Leveraging the BBRT, currently chaired by the PI, which consists of a wide range of interdisciplinary researchers, including chemists, material scientists, engineers, architects, and agricultural scientists. The group at ISU only is composed of undergraduate and graduate students, postdoctoral research associates, scientists, and 21 professors, several of which are co-PIs and senior personnel involved in this proposal.

The center will hire one full-time support staff to cover administrative duties and provide general support for the center's administration. The following are key administrative positions. Dr. David Grewell, professor of agricultural and biosystems engineering, will serve as Director of CB^2. Prior to joining ISU in 2005, he worked for 12 years in industry at Emerson Electric in their Advanced Engineering Group. He has 14 patents and has managed research groups around the world. He also holds a courtesy professor position in the Department of Polymer Processing at the Friedrich-Alexander-University of Erlangen-Nuremberg, Germany. He has been the chair of the ISU BBRT for five years and is a Fellow of the Society of Plastics Engineers, the largest plastics professional society.

The co-director at WSU will be Dr. Michael Kessler, the Berry Family Director and Professor in the School of Mechanical and Materials Engineering at WSU. Prior to joining the faculty at WSU in August 2013, he held faculty positions at ISU, where he was most recently the Wilkinson Professor of Interdisciplinary Engineering, and at the University of Tulsa. Professor Kessler's research group focuses on bulk polymers, coatings, and composites from agricultural oils. He has served as PI and co-PI on grants and contracts totaling over $10 million from federal, state, and industrial sources. His honors include the Army Research Office Young Investigator Award, the Air Force Office of Scientific Research Young Investigator Award, the NSF CAREER Award, and the Elsevier Young Composites Researcher Award from the American Society for Composites. He has over 115 journal papers and 1,500 citations, holds six patents, edited a book on the characterization of composite materials, presented nearly 200 talks at national and international meetings, and serves as a frequent reviewer and referee in his field.

Co-PIs Dr. Eric Cochran and Dr. D. Raj Raman both have received previous NSF funding, including a NSF CAREER award and served as co-PIs for an NSF Engineering Research Center and as an Educational Director, respectively. Together with the third Co-PI, Dr. Darren Jarboe, who has extensive experience in industry-university collaboration and techno-economic analysis, the leadership team is well rounded and covers all of the important aspects of the center, including organization, marketing, and technical leadership and mentoring.

Co-PI Dr. Jarboe is program manager for technology commercialization, marketing, and communications at ISU's CCUR and BioCentury Research Farm. His work focuses on aligning industry and faculty research objectives to commercialize technology in the food, feed, and biorenewables sectors. Dr. Jarboe was Co-PI on the NSF CB^2 planning grant and integral to the highly successful center planning meeting. He has served as project director (two years) and project administrator (11 years) for the Iowa Alliance for Cooperative Business Development, a USDA rural cooperative development center. Dr. Jarboe has 24 years of experience in successfully engaging industry in an academic setting, and decades of management experience in growing university programs that serve industry and the public.

- Facilities. As required by NSF, the proposed center has all required major facilities and equipment in place at three world leading institutions in bioplastics and biocomposites technology: ISU, WSU, and UML. All three institutions have unique capabilities that will be synergetic between the three sites. ISU's long history of developing biobased products and 21 faculty members conducting research in the area of bioplastics gives ISU the ability to bracket the entire science and engineering of bioplastics. UML has a long history of polymer processing, with one of the leading research facilities in the area, and a strong history of chemistry and polymer synthesis and processing. WSU has expertise in natural fiber-based composites and biorenewable resins with an existing WSU sponsored center, the CMEC, which has a long history of collaborating with industry to develop large scale

biocomposites. The combination of these capabilities will assure that CB^2 can meet the needs of industry. This, along with the fact that geographically the three sites cover the nation (East and West Coasts, and Midwest), gives industry easy access to leading experts.

The BBRT at ISU has access to a wide range of polymer processing equipment, including but not limited to numerous extruders, injection molding machines, and thermoforming systems. In addition, the BBRT has extensive thermal and mechanical characterization equipment for polymers and composites available. The BBRT also has novel fiber processing equipment for the production of graphite fibers. Because the BBRT is administered by the CCUR, it is well positioned to develop solutions for many of the problems faced by the bioplastics industry, including feedstock logistics, economic limitations, and supply chain issues. The CMEC facilities at WSU have resources spanning from composite materials characterization, product development, and process improvement to product testing. CMEC is an IAS accredited testing laboratory that meets the highest international quality standards. The 28,000 square foot facility houses equipment for biomass processing; sorting, drying, blending and forming; consolidation; physical and chemical property analyses; materials and structural testing; nondestructive evaluation; and computer-based modeling and analysis. The BSEL at WSU consists of a $24 million, 57,000 square foot research and teaching laboratory that was dedicated in May 2008. BSEL features the Biorefinery and the Combinatorial Catalysis Research Lab, plus a variety of laboratories and classrooms. The Plastics Engineering Department has the largest academic collection of plastics processing equipment available in the United States, including a wide variety of extrusion lines, blow molding, blown film, thermoforming, sheet coextrusion, roll mills and rubber molding equipment, and standard and liquid silicone injection molding machines. Many of the instruments were donated by major industrial manufacturers and industry partners that regularly seek out UML for research partnerships because of the availability of comprehensive laboratory facilities. In addition, a wide array of testing and characterization equipment is available. Collaborators who specialize in fermentation technology, toxicity and environmental health, lifecycle assessment, and materials chemistry are also readily available at ISU, WSU, and UML.

- Equipment. As required by NSF, the proposed center has all required major equipment in place across campus. The BBRT at ISU has access to a wide range of polymer processing equipment, including but not limited to numerous extruders, injection molding machines, and thermoforming systems. In addition, the BBRT has extensive thermal and mechanical characterization equipment for polymers and composites available. The BBRT also has novel fiber processing equipment for the production of graphite fibers.

- Expected need. The proposed center has been funded for five years with a renewal after five years. NSF will conduct a peer review of the performance and impact of the center to determine whether funding for the center should be renewed.

- Communication with existing campus structures. The concept of the proposed center was reviewed and approved by the appropriate campus committees and authorities.

- Cost. The cost of the proposed center at ISU will be $361,667 in Years One and Two and $355,000 for Years three to Seven. The total cost (including WSU) will be $539,714 for Years One and Two and $533,047 for Years Three to Seven.

The annual budget is included on pages 10-11. Each institution will support the proposed center through relief time for the PIs and matching funds for support staff. In addition, UML may receive research funds based on the IAB project selection. These funds will be reduced from the budgets of the two primary institutions – ISU and WSU.

- Funding sources. There are two external sources of funds – industry funds (membership fees) and NSF funds for five years (2014-2019) with the possibility for renewal after five years. The industry funds are support research projects directed by the IAB; the NSF funds support the center's administrative costs. Based on the current member list, the external funds for both sites include the following:

  - Industry funds = $450,000/year ($300,000 at ISU)
  - NSF center funds = $182,500/year ($117,500 at ISU)
  - NSF additional funds = $20,000/year ($20,000 at ISU)

  If the NSF funds were lost, the center would need to recover the funds through a special request to the colleges to offset the funds. If the industry funds were lost, the center would no longer be viable. It is important to note that there is a marketing plan to sustain and expand the membership for the center.

- Marketing plan for continued membership growth. The three CB^2 institutions have a history of successfully working with the bioplastics and biocomposites industry. The team will aggressively engage new members through a wide range of membership recruitment activities including, (1) preparing a website (linked to the highly ranked ISU BBRT website) detailing CB^2's work and partnerships, benefits of center membership, and how to join; (2) placing advertisements, news releases, and expert articles in trade publications, websites, and popular press; (3) establishing a communications program for current and potential members; (4) visiting key companies onsite and hosting them at ISU, WSU, and UML; and (5) conducting workshops and attending tradeshows and conferences on bioplastics and biopolymers. The team has successfully conducted these types of activities for programs for their respective universities; thus this marketing plan is expected to translate into successful marketing of CB^2. The team built a data base of over 3,000 potential industry collaborators, including names, phone numbers and email addresses. An expanded marketing plan is attached in the supplemental documents, detailing the activities that will assure sustained membership as well as those that have already proven successful in securing membership, such as tradeshows and company visits.

TOTAL COSTS	SOURCE(S) OF FUNDS					TOTAL NEW COSTS			
Year 1	**Income**	**ISU**	**WSU**	**CB2**		**Expenses**	**ISU**	**WSU**	**CB2 Total**
	Membership (full)	30,000	30,000	30,000		PI and Co-PI	11,049	7,100	18,149
	Members	10	5	15		Support Staff	48,230	25,845	74,075
	membership Income	300,000	150,000	450,000		Marketing/Travel	17,388	10,100	27,488
	NSF Base Funding	117,500	65,000	182,500		Evaluator	15,000	0	15,000
	NSF yearly request	20,000	0	20,000		Cost/project/year			
	Total Annual Budget	437,500	215,000	652,500		(average per site)	270,000	135,002	405,002
	Indirect (10%)	75,833	36,953	112,786		**Total Expenses**	**361,667**	**178,047**	**539,714**
	Available Funds	361,667	178,047	539,714					
Year 2	**Income**	**ISU**	**WSU**	**CB2**		**Expenses**	**ISU**	**WSU**	**CB2 Total**
	Membership (full)	30,000	30,000	30,000		PI and Co-PI	11,380	7,241	18,621
	Members	10	5	15		Support Staff	49,677	26,362	76,039
	membership Income	300,000	150,000	450,000		Marketing/Travel	15,609	9,442	25,051
	NSF Base Funding	117,500	65,000	182,500		Evaluator	15,000	0	15,000
	NSF yearly request	20,000	0	20,000		Cost/project/year			
	Total Annual Budget	437,500	215,000	652,500		(average per site)	270,000	135,002	405,002
	Indirect (10%)	75,833	36,953	112,786		**Total Expenses**	**361,667**	**178,047**	**539,714**
	Available Funds	361,667	178,047	539,714					
Year 3	**Income**	**ISU**	**WSU**	**CB2**		**Expenses**	**ISU**	**WSU**	**CB2 Total**
	Membership (full)	30,000	30,000	30,000		PI and Co-PI	7,814	7,386	15,200
	Members	10	5	15		Support Staff	51,168	26,890	78,058
	membership Income	300,000	150,000	450,000		Marketing/Travel	11,018	8,769	19,787
	NSF Base Funding	107,500	65,000	172,500		Evaluator	15,000	0	15,000
	NSF yearly req.	20,000	0	20,000		Cost/project/year			
	Total Annual Budget	427,500	215,000	642,500		(average per site)	270,000	135,002	405,002
	Indirect (10%)	72,500	36,953	109,453		**Total Expenses**	**355,000**	**178,047**	**533,047**
	Available Funds	355,000	178,047	533,047					
Year 4	**Income**	**ISU**	**WSU**	**CB2**		**Expenses**	**ISU**	**WSU**	**CB2 Total**
	Membership (full)	30,000	30,000	30,000		PI and Co-PI	8,049	7,532	15,581
	Members	10	5	15		Support Staff	52,701	27,428	80,129
	membership Income	300,000	150,000	450,000		Marketing/Travel	9,250	8,085	17,335
	NSF Base Funding	107,500	65,000	172,500		Evaluator	15,000	0	15,000
	NSF yearly request	20,000	0	20,000		Cost/project/year			
	Total Annual Budget	427,500	215,000	642,500		(average per site)	270,000	135,002	405,002
	Indirect (10%)	72,500	36,953	109,453		**Total Expenses**	**355,000**	**178,047**	**533,047**
	Available Funds	355,000	178,047	533,047					

Year 5	**Income**	**ISU**	**WSU**	**CB2**		**Expenses**	**ISU**	**WSU**	**CB2 Total**
	Membership (full)	30,000	30,000	30,000		PI and Co-PI	8,289	7,683	15,972
	Members	10	5	15		Support Staff	54,282	27,978	82,260
	membership Income	300,000	150,000	450,000		Marketing/Travel	7,429	7,384	14,813
	NSF Base Funding	107,500	65,000	172,500		Evaluator	15,000	0	15,000
	NSF yearly request	20,000	0	20,000		Cost/project/year			
	Total Annual Budget	427,500	215,000	642,500		(average per site)	270,000	135,002	405,002
	Indirect (10%)	72,500	36,953	109,453		**Total Expenses**	**355,000**	**178,047**	**533,047**
	Available Funds	355,000	178,047	533,047					
Year 6	**Income**	**ISU**	**WSU**	**CB2**		**Expenses**	**ISU**	**WSU**	**CB2 Total**
	Membership (full)	30,000	30,000	30,000		PI and Co-PI	8,537	7,836	16,373
	Members	10	5	15		Support Staff	55,910	28,537	84,447
	membership Income	300,000	150,000	450,000		Marketing/Travel	5,553	6,672	12,225
	NSF Base Funding	107,500	65,000	172,500		Evaluator	15,000	0	15,000
	NSF yearly request	20,000	0	20,000		Cost/project/year			
	Total Annual Budget	427,500	215,000	642,500		(average per site)	270,000	135,002	405,002
	Indirect (10%)	72,500	36,953	109,453		**Total Expenses**	**355,000**	**178,047**	**533,047**
	Available Funds	355,000	178,048	533,047					
Year 7	**Income**	**ISU**	**WSU**	**CB2**		**Expenses**	**ISU**	**WSU**	**CB2 Total**
	Membership (full)	30,000	30,000	30,000		PI and Co-PI	8,793	7,992	16,785
	Members	10	5	15		Support Staff	57,587	29,107	86,694
	membership Income	300,000	150,000	450,000		Marketing/Travel	3,620	5,946	9,566
	NSF Base Funding	107,500	65,000	172,500		Evaluator	15,000	0	15,000
	NSF yearly request	20,000	0	20,000		Cost/project/year			
	Total Annual Budget	427,500	215,000	642,500		(average per site)	270,000	135,002	405,002
	Indirect (10%)	72,500	36,953	109,453		**Total Expenses**	**355,000**	**178,047**	**533,047**
	Available Funds	355,000	178,048	533,047					

- Implementation. After obtaining Board approval, the Center for Crops Utilization Research will be prepared to implement the Center for Bioplastics and Biocomposites immediately.

- Companies that have supplied letters of commitment for the proposed center. The minimum required membership fee defined by NSF is $300,000/year.

	Company	Amount	Site
1	3M	$30,000	ISU
2	ADM	$30,000	ISU
3	Aspen Research	$30,000	ISU
4	Bemis Company Inc	$30,000	WSU
5	Berry Plastics	$30,000	WSU
6	Bioplastics Magazine*	$15,000	WSU
7	Branson Ultrasonics	$15,000	ISU
8	Braskem	$30,000	ISU/UML
9	Creative Composites Ltd	$15,000	ISU
10	Dixie Chemical Company	$15,000	WSU
11	Dukane Ultarsonics	$15,000	ISU
12	EcoProducts	$15,000	ISU
13	Inland Labels	$15,000	WSU
14	Laurel Biocomposites LLC	$15,000	ISU
15	M-Base	$15,000	ISU
16	Minnesota Corn Research & Promotion Council	$15,000	ISU
17	Powder Coating Research Group*	$15,000	WSU
18	RheTech	$15,000	ISU
19	Newell Rubbermaid	$30,000	ISU/UML
20	Siegwerk USA	$15,000	ISU
21	Solvay	$30,000	WSU
22	SuGanit Systems Inc	$15,000	ISU
23	Taylor Technologies	$30,000	ISU
24	USDA-ARS-NCAUR*	$30,000	ISU
	Total	$510,000	
	Total W/O Inkind	$450,000	

◈ Selected equipment available to proposed center at ISU.

CCUR

A recent $15 million investment in the Center for Crops Utilization Research (CCUR) and the affiliated laboratories of the Department of Food Science and Human Nutrition provided funding for the state-of-the-art laboratory, processing, and training facilities. CCUR, established in 1987, is a multi-disciplinary research, development and technology transfer program that focuses on new products, processes, and markets for soybeans, corn and other Midwest crops. About 35,000 square feet of pilot plant processing and support space is available for wet processing, dry processing, fermentation, extraction and processing with hazardous solvents, fats and oils refining and conversion, preparatory-scale protein chromatography, industrial product processing, consumer food preparation, and sensory testing. There are only two other institutions, Texas A&M University and the POS Pilot Plant in Canada, in North America with similar oilseeds pilot plant processing capabilities. A full description of the center's unique processing capabilities and a listing of its extensive processing equipment can be found at the center's web site http://www.ccur.iastate.edu. CCUR also has a modern test kitchen and sensory testing facility as well as two 12-person panel rooms.

The adhesive resin formulation facility is part of the Crop Products Pilot Plant and is equipped with two lab-scale reactors, a 2-gallon reactor, and necessary mixing equipment. The lab consists of six laboratory benches and two fume hoods. The equipment needed for hydrolysate analysis (gel electrophoresis units, viscometer, and ovens) is available in this laboratory. Additional facilities, such as an NMR unit, a MALDI-TOF analysis unit, and a sequencing unit are available through the pay-per-use service facilities on campus. In order to test resin strength, board-manufacturing equipment, such as a fiber-resin mixing drum, pilot plant-scale press and computerized testing equipment, are available in the Crop Products Pilot Plant and in the laboratories of the Department of Natural Resources and Ecology Management.

Highlight of equipment in CCUR:

- Extruder, twin screw barrel L:D 20:1 (diameter D = 18mm), throughput 0.2-40 kg/hr, Leistriz Group
- Extruder, single screw lab scale, barrel size L: D 18 (diameter 20 mm), throughput 0.5-5 kg/hr, max temp 300-450 °C, Brabender
- Extruder, counter rotating twin screw barrel L: D 16:1 (diameter 25mm), throughput 0.5-60 kg/hr, Brabender
- Extruder, single screw with string extrusion die or sheet extrusion die, sheet take off device L:D = 25 (screw diameter 30 mm), throughput 0.5-15 kg/hr, max temp 300-450 °C, Brabender
- Extruder, fully-intermeshing twin screw, Leistritz Group ZSE-27
- Extruder, co-rotating twin screw with main throat feed and downstream "side stuffer" feed 40:1 barrel l:d, throughout 20 kg/hr, screw speed 300 rpm, up to 500 possible, Leistritz ZSE-27
- Extrusion system, single and two stage PC controller, barrel L: D 25 (diameter 20mm), Brabender
- Compression mold, both plates heated and cooled, plate size 0.5m×0.5m, 150 tons, Wabash

- Compression mold, both plates heated and cooled, plate size 0.25m×0.25m, 20 ton, Wabasch
- Compression molding machine, 50 ton
- Injection molding machines, 22 ton, Boy Machines, Inc. (2)
- Injection molding machine, table top, multi-press
- Reactive casting
- Vacuum thermal forming equipment, C.R. Clarke Vacuum Former 1820
- Blow molding machine, Flex Blow Molder
- Plastic notcher, Ceast Notch VIS
- Blow film tower, Brabender
- Rotational molders (2)
- Pelletizer, Brabender
- Pelletizer, Sheer Bay Company
- Vibrating screen, Prater
- Glue spreader, Black Bros. Co.

Highlight of ABE equipment

Bio-Processing research

- Corrosives storage cabinet
- Vented gas hood (2)
- 3300 W 20 kHz continuous flow ultrasonic pretreatment system
- 2200 W 20 kHz batch mode ultrasonic pretreatment system
- 800 W 20 kHz ultrasonic pretreatment system
- 400 W 40 kHz ultrasonic system
- Lab freezers (2)
- Optical microscopes (2)
- Abrasive cut off saw

Polymer Processing Laboratory

- 22 ton Boy injection molding machine
- Film blow extrusion lab equipment
- CW Brabender single and two stage extrusion system-PC controller
- Two rotational molders
- Table top injection molding machine
- Compression molding machine
- Reactive casting
- Vacuum thermal forming equipment
- 2200W 20 kHz Ultrasonic system
- Instron testing machine
- Anaerobic test cell
- Aerobic test cell

Major Equipment and Instrumentation Available in the ISU Chemistry Department:

- Perkin-Elmer DSC/TGA, Waters GPC with light scattering detector, Glove Box and IR are available.
- A complete polymer analytical laboratory containing thermal and mechanical analytical instruments is located in the Material Science and Engineering Department in the same building as the Chemistry Department. We have complete access to this facility.
- A staffed TEM and SEM facility within the Ames National Laboratory adjoining the Chemistry Department is available.
- NMR in the Chemistry Department – Bruker DRX-400 NMR; Tecmag AC-200 NMR; Varian VXR-300; Varian VXR-400; Anasazi EM-360 NMR (2); Bruker ER-200 EPR; Bruker DRX-500 NMR (Biological NMR Facility); Bruker Avance-600 solids/solution; Bruker Avance-700 solution (Biological NMR Facility).
- Mass Spectrometry – Finnigan TSQ-700 Triple Quadrupole GC-LC-MS; Finnigan MAGNUM Ion Trap GC-MS; Finnigan LCQ Ion Trap LC-MS-MS; Kratos MS-50 Magnetic Sector MS; Bruker Proflex II MALDI-TOF MS; Micromass GCT Accurate mass GC-MS; Shimadzu LCMS-2010 Electrospray / APCI MS.
- Spectrophotometry – Agilent 8453 diode array UV-Vis; Bruker IFS-66v FT-IR; JASCO J-710 CD spectrophotometer.
- Elemental Analysis – Perkin Elmer 2400 Series II CHN/S analyzer.
- XS-Ray Diffraction – Bruker SMART 1000 CCD single crystal; Scintag XDS-2000 powder diffractometer.

General/Sample Prep Laboratory equipment:

- Research machine shop and glass shop
- Grinding and polishing equipment (Buehler)
- Computer monitored dry argon atmosphere glovebox
- Cleanroom Class 100 with a chemical hood (CCP, 2000)
- Nanopure water supply unit (Nanopure, 1998)
- Two spin coaters (Headway Corp.,1994, 2004)
- Carver Model 3912 Hydraulic Press
- Ultrasonic Welding System (Branson 2000 Series, 2200 Watts, 20 kHz, for dispersion of carbon nanotubes in prepolymer, 2005)

Microscopy/Diffraction Facilities equipment:

- Local Electrode Atom Probe (LEAP) microscope (Imago Scientific, 2007, one of only three such instruments in American academic institutions).
- JEOL JSM-606LV Scanning Electron Microscope (SEM)
- Aspex Personal SEM
- JEOL 1200EX scanning/transmission electron microscope (STEM with elemental analysis and image analysis systems)
- Scintag XGEN -400 X-ray Diffractometer (XRD)
- X-ray diffractometer, Miniflex (Rigaku, 2004)
- Auger Electron Spectroscopy, X-ray Photoelectron Spectroscopy

- Zeiss Axioplan II compound microscope equipped with AxioCam HRC digital imaging system, stereo and dissecting microscopes
- Zeiss optical stereo microscope, fluorescence, and inverted microscopes
- Scanning confocal microscopes (Leica TCS NT and Prairie Technologies allowing 3D reconstruction of confocal images generated with the confocal microscope)
- AFM microscope NanoscopeIIIa - Multimode (Digital Instrument, 2001)

Materials Characterization Equipment:

- Hystrion Nano Indentor (Automated precision testing, staging and sample positioning allows maximum throughput of samples.)
- Micro Hardness Testers
- Various load frames, load cells, and loading fixtures (Instron and Shimadzu)
- Custom-designed instrument for contact angle measurements (Edmond Scientific, 2003)
- Multiangleellipsometer (IonMtech, 1998)
- Quartz Microbalance (Maxtek, 2004)
- Thermal stage, fluid cells, air tables, acoustic hoods, dry boxes
- Dielectric Thermal Analyzer (DETA)
- Roper micro-Raman spectroscopy (Roper, 2003)
- UV-VIS Spectrometer 1601 (Shimadzu, 1998)
- FTIR Spectrometer 8301 (Shimadzu, 2000)
- NMR (500 MHz, 400 MHz)
- Mass Spectrometry (MALDI-TOF, ES, FAB, FD)
- Bruker IFS 66V FT-IR
- Hewlett-Packard HP-8453 Diode Array UV-Vis
- Cary 100 Bio double beam UV-Vis
- Jasco J-710 circular dichroism spectrophotometer
- PANalytical XRD system
- JOEL 5910LV scanning electron microscope
- Philips CM 30 transmission electron microscope
- FEI-Tecnai G2 F20
- PHI 5500 XPS,
- JOEL JAMP-7830 Auger Microprobe
- Wide-bore 600 MHz NMR for solid-state work
- Cryoprobe-equipped 500 and 700 MHz instruments
- Finnigan Magnum ITD GC-MS
- Shimadzu LCMS2010
- Finnegan LCQ LCMS
- Agilent 6540 Q-TOF LC MSMS
- Bruker APEX II CCD and SMART 1000 single-crystal diffractometers equipped with low-temperature devices and Scintag XDS-2000
- Rigaku Ultima 4 powder diffractometers

NanoImaging Facility Equipment

- JEOL 1200EX Scanning/Transmission Electron Microscope with light element energy dispersive X-ray spectrometry, with ancillary equipment for sample preparation. Maximum resolution is 1.4A.
- JEOL 5800LV Scanning Electron Microscope, with ancillary equipment for sample preparation. Maximum resolution is 38 A.
- Complete complement of optical microscopy facilities.

ABE Facilities

The PI's laboratories in ABE include approximately 2,500 square foot of laboratory space dedicated to bio-fuel pretreatment research. In addition, the PI has two laboratories in the Food Science Building with approximately 1,000 square feet. Additional shared departmental research labs are available in the new, state-of-the-art buildings, Gilman Hall and Hoover Hall.

Chemical and Biological Engineering and Chemistry

- Lab space includes 110 linear feet of hood space, equipped with glove box, Schlenk lines, and Parr pressure reactor for conducting air sensitive chemistry, high pressure reactions, and other standard wet chemistry procedures.
- E. Cochran equipment includes a Mettler-Toledo RC1e reaction calorimeter.
- Iowa State University operates an electronic and machine shop on a fee-for-service basis and provides state-of-the-art analytical instrumentation, including electron beam characterization and scattering techniques.
- Access to the Iowa State University Chemical Instrumentation Facility and the Iowa State University glass shop is available on a fee-for-service basis. Services available to the research community through the ISU Chemical Instrumentation Facility include the following:
- Magnetic Resonance – Eight NMR spectrometers of varying frequencies from 300 to 700 MHz are available. A wide-bore 600 MHz NMR dedicated to solid-state samples is available.
- Mass Spectrometry – The mass spectrometry lab is equipped to provide both low- and high-resolution GC-MS and LC-MS.
- X-ray Diffraction – An X-ray diffraction laboratory provides instrumentation for the study of the molecular structures of small molecules and powders.
- Spectrophotometry – A variety of spectrophotometers is available for routine use in the facility. These instruments provide fingerprint spectra for characterizing and identifying compounds.
- Elemental Analysis – A Perkin-Elmer Model 2400 Series II CHN/S elemental analyzer is available for sample submission or for investigator use. Normally, the instrument is configured for carbon, hydrogen and nitrogen, but sulfur also can be analyzed upon special request.
- E. Cochran and J. Chen have access to facilities managed by the Department of Materials Science & Engineering at Iowa State University, including: DSC, DTA/TGA, GPC, DMA, MALDI
- E. Cochran has access to a Rheometric Scientific Instruments ARES strain-controlled rheometer.

- E. Cochran has access to a Thermal Analysis AR2000ex rheometer.
- E. Cochran and J. Chen have access to various Instron machines.
- Courtesy of Dr. Burghardt at Northwestern University, the group has access to a specialized rheometer with cone-and-plate shear cell that allows in situ small-angle X-ray scattering of the flow/gradient plane.
- Courtesy of the University of Minnesota Institute of Technology Characterization Facility, the group has access to a Thermal Analysis Dynamic Mechanical Analysis instrument modified for use with in situ SAXS/DMA experiments.
- Courtesy of the University of Minnesota Institute of Technology Characterization Facility, the group has access to a Rheometrics MINIMAT that can be used for in situ SAXS/mechanical analysis experiments.
- Williams has access to a fully equipped asphalt characterization lab, complete with: dynamic shear rheometer, rolling thin film oven, Brookfield viscometer, high shear mixer, pressure aging vessel, bending beam rheometer, and gyratory compactor.
- E. Cochran has access to a Molecular Metrology Small Angle X-Ray Scattering system.
- E. Cochran has access to the Microscopy and NanoImaging Facility at Iowa State University.

Materials Science and Engineering

Co-PI S. Madbouly supervises two labs in Gilman Hall 3305 and 3113 (approximately 1,300 square feet of laboratory space), which include two large fume hoods and ample bench space. Additional shared departmental research labs in the new state-of-the-art building, Hoover Hall, will also be used throughout the research. The labs include state-of-the-art equipment; a Universal Testing Machine for tensile, compression, and flexural testing of polymers and composites (Instron Corp., Model 5569) with an environmental testing chamber (for testing from -70 to 350 °C); a high-resolution video extensometer to measure both lateral and transverse strains; a gel permeation chromatography system with light scattering (Waters Breeze), rheometer (Rheometrics ARES); cone and plate viscometer (Brookfield), Labronco rotary evaporator; Mettler microbalances; and a drop tower instrumented impact machine (Dynatup). S. Madbouly was also recently awarded a $176,000 Defense University Research and Instrumentation Program (DURIP) grant from the Army Research Office to purchase and set up a new thermal analysis characterization lab for polymers and composites. This new lab has just been completed and set-up with six new thermal analysis instruments all from TA Instruments: two differential scanning calorimeters (DSCs) including a modulated DSC system with an autosampling robot (Q20 and Q2000 from TA Instruments), a dynamic mechanical analyzer (Q800), a thermomechanical analyzer (Q400), a thermogravimetric analyzer (Q50), and a controlled stress rheometer (AR2000ex with an environmental temperature control oven.