Final Report Summaries as of January 2014 - #11 Projects

#11-01 C5-C7 Value-Added "Montana Specialty Alkanes"
Ron Colwell - Montana Refining Co., Inc. - Great Falls
$189,927
Final report approved: April 2011 [Project withdrawn by company]

Summary
Mr. Ron Colwell, Principal Investigator of this project and Engineering Manager for Montana Refining Company, notified MBRCT on January 21, 2011, that the company had decided to terminate the project. The primary reason for terminating was that new market data suggested the project is not economically feasible and would result in a moderate gross return on investment and a neutral net return. As "wise stewards of the Board's funds", Mr. Colwell indicated it was in everyone's best interest to cancel the project and return the unspent funds. The principals have been excellent to work with and their early recognition of an end result that likely would not measure up to expectations is appreciated.

Work was conducted from November 2010 through the end of January 2011 and a report was submitted to cover that period of time. An initial disbursement was made 12/06/10 in the amount of $47,482. Funds expended totaled $37,184.25. The company returned $10,297.75. In addition, matching funds expended totaled $13,112.32, or 27% of the total project cost of $50,296.57.

#11-05 Commercialization of Optical Analog Waveform Generation (OAWG) Hardware
Kristian Merkel – S2 Corporation - Bozeman
$83,706
Final report approved: August 2012

Summary
S2 Corporation best used the award money for advancement and commercialization of its Optical Arbitrary Waveform Generation (OAWG) approach, which is relatively simple and elegant in design, and far exceeds other competing approaches. The funding was intended to seize an emerging opportunity to create a product for defense and commercial applications. The new approach for OAWG builds on prior and existing R&D efforts at S2 Corporation and MSU, funded internally, followed by the Defense Advanced Research Projects Agency (DARPA) and the U.S. Army, both under the SBIR program. The approach exploits the unique spectral storage capabilities of a regenerating optical ring cavity. The collaborative support provided several opportunities: (1) technology protection, (2) undertake a market study of competing technologies from vendors, Agilent and Tektronix, in order to support S2's contention that optical generation of wide bandwidth signals has a competitive edge, (3) prepare documentation that is used for marketing and future proposal writing. MBRCT aided the push forward in the competitive edge of the OAWG conceptual technology. Specifically, it enabled filing a full U.S. patent application to protect intellectual property for OAWG design advances. Dialogue was initiated with a market leading test and measurement company. Two proposals were written for additional technological improvements, one of which is still pending.
Commercialization

- **Product description**

Portable, rugged photonic hardware system

- **Target market including size**

Military and commercial applications including: electronic countermeasures where incoming signals are jammed until a falsified signal is generated and returned to confuse the observer, tailored spectrum waveforms to fill open space but avoid co-site interference, collision avoidance range-Doppler waveforms; and optically mixed pre- or post-compensation of high VW phase distortions from high-grain RF antennas with poor intrinsic phase response.

- **Commercialization strategy**

1) Protect S2 IP via U.S. patent applications
2) Identify technology transition partners
3) Have fully functioning prototypes
4) Perform high level demonstrations for increased commercialization potential, with comparisons made to existing market products
5) Seek support from customers and partnerships with all potential players in market, as possible, but push for IP protection and first to market stronghold

- **Production or manufacturing plan**

Production of the OAWG will be cost effective as it is based on reliable parts drawn from telecommunications technologies. Components consist primarily of commercial-off-the-shelf items. Early sales units will be set to price at approximately $250,000. A goal of four units will be set for sales in the first year following completion of the NSF Phase II effort. Future production will be carried out either by a manufacturing division within S2 or by spinning out a new company with IP to address manufacturing where S2 retains rights to the technology.

Economic Impacts

- **Awarded and Submitted Proposals**
  - Successful DARPA Phase I ($150K) and Phase 2 ($150K) Proposals for OAWG technology
    Successful Army Phase I ($750K) Proposal on Application of OAWG to RF Signal Generation

    Economic Impact: $1.05 million of federal funding to support local research efforts in Montana.

  - Two new NSF proposals written for improving performance in Signal-to-Noise Ratio and boosting system bandwidth to 25 GHz bandwidth via an innovative design for new electronic control optical input system technology: 1 declined, 1 pending.

    Economic Impact: Potential $150K Phase 1 SBIR proposals, pending review

- **Patents Filed:**
  - One patent application written and filed June 9, 2011, for covering innovations of this technology (“Method and Apparatus for Generation of Arbitrary Waveforms with Large Bandwidth and Long Time Apertures”)

- **Economic Impacts**
    - Protection of intellectual property
    - Future contract R&D
    - Future sales
    - Future licensing potential

#11-11 Second Phase Clinical Trials of a Lypolytic Compound
Jeff Golini – All American Pharmaceutical - Billings
$25,000
Final report approved: November 2011

Summary
The purpose of this project was to determine if a lypolytic compound was safe for humans, lowers cholesterol and triglyceride levels and helps overweight people loose body fat. New FDA guidelines came into effect after the grant was awarded. These guidelines required additional studies before FDA approval to move forward to a Full Double Blind Clinical Study with humans. The studies performed under this grant include:

(1) Evaluation of the hypolipidemic activity of Lyzme5® in Wistar Rats
(2) Lyzme5® Pre-Clinical Study in Humans
(3) Double Blind Clinical Study in Humans (started in July 2011 and will continue at least through February 2012)

Findings: Thus far the lypolytic compound has proven to lower cholesterol and triglycerides and reduce body fat.

Commercialization:
Change in FDA requirements has resulted in the need to write a new commercialization plan based on submission of the final results to FDA. FDA will make the determination as to whether the drug can be marketed as an over-the-counter or prescription drug. This will make a difference in how the product is marketed.

Economic Impacts:
Economic impact cannot be determined at this time; but, it can be theorized that once the product is on the market, All American Pharmaceutical will need to hire more people and build more buildings, which will result in additional taxes and revenue for the company, for Billings and for Montana.

#11-16 Intelligent Proppant (iProppant™) – Activation of Solid State Reaction Mechanisms in Ceramic Proppant Material as a Method to Modify Fracture Path Flow
Hank Rawlins – *e*Process Technologies - Butte
$50,000
Final report approved: November 2011

Summary

The purpose of this project was to develop a new stimulation fracture proppant to enhance recovery of oil and gas reserves. The proppant's unique characteristics would be designed to provide a tailored response operating at the typical conditions of an oil & gas reservoir. All tasks were fully completed and finish the theoretical portion of the project. The tasks include:

- Full IP review of patents, technical papers, and commercial information regarding engineered proppants and related technology. This included research into 36 companies, 40 patents, and 94 technical papers. The main focus was on proppants, but additional work on well-foaming agents was also conducted per a discussion with Shell Exploration and Production Company (SEPCO).
- Discussions with SEPCO, Carbo Ceramics, Insight Petroleum Consulting, and the Department of Petroleum Engineering at Montana Tech resulted in defining the boundary conditions for the research, manufacture, use, and deployment of intelligent proppant. In addition, SEPCO identified the need for a reactive proppant to remove water from gas wells. This was added to the research portfolio.
- Using a theoretical thermodynamic and crystallographic approach of 340 reactions, 20-25 material/reaction combinations most favorable for making the proppant product were identified.
- Samples of three expandable mortars and two foaming agents were obtained.

Commercialization Potential

The global market for engineered proppant is estimated at approximately $900 million. This market is growing rapidly in the U.S., which has 20% of the global value, due to rapid increase in gas fracturing in Pennsylvania and Texas and oil fracturing in North Dakota. The commercial potential for a specialty proppant to provide an engineered response is estimated at 10% of this market, yielding $20 million in domestic sales and $100 million in global sales. Market information obtained during discussions with oil production and service companies indicates the need for proppant removal technology, for which eProcess Technologies was able to re-develop an older technology to result in substantial equipment sales in Southeast Asia within this calendar year. These sales will result in establishing a North American sales and marketing effort in 2012, which is anticipated to bring in $1-2 million in equipment sales.

The company considers this project to be medium-long term with high-risk/high-return. The Commercialization plan anticipates completion of the development in the **next 1-2 years**.

Product description

Reactive proppant for use in the oil and gas industry that would present a significant and revolutionary advanced in product technology.

Target market including size

The world market for ceramic based proppants is nearly $1 billion. A small, achievable 10% penetration in the short to medium term returns a potential revenue stream opportunity of around $100 million. Major suppliers of ceramic proppants are Carbo Ceramics and Saint-Gobain Proppants.

Marketing strategy

There are two possible marketing approaches that might be taken:

(1) Approach existing suppliers of ceramic products and sell the technology to them

(2) Undertake the marketing and support roles to identified clients

Production or manufacturing plan
The manufacturing plan would vary depending on the marketing strategy used. Regardless of how that plan develops, the company will need to establish and grow:

(1) A Technical Facility in Montana with laboratory and offices for ongoing research and development of the technology
(2) A Pilot Plant Facility in Montana for ongoing research and development of the technology and, if the company manufactures its own product, for initial short run production.

Business risk assessment
A SWOT analysis is presented on pages 11-12 of the Final Report. The PI acknowledges that the company's strength and comparative advantage is the ability to keep ahead of its competitors with future technological advances.

Economic Impacts
The major immediate economic impact of this project has been sales of wellhead desander technology in Southeast Asia resulting in approximately $110,000 worth of design and testing work for the Butte office in 2011. Based on current and growing sales of the wellhead desander technology, a U.S. base in Butte has been set up. Several new products based on the proppant and solids removal technology have been identified and will be developed, tested, and designed in Butte. Equipment sales are expected to be a substantial part of 2012 sales and the majority of future work. The goal is to staff up to 3-4 fulltime engineers and 3-4 technicians for the Butte laboratory within the next 1-2 years. Reactive proppant technology will continue to be developed, as well as a range of other ideas, in growing the business.

#11-17 Development of Ammonia Based Fuels for Environmentally Friendly Power Generation
David Micheletti – Montana Aerospace Development Association – Butte
$111,500
Final report approved: June 2012

Summary
Ammonia is a very promising, environmentally friendly energy carrier. The molecular structure of ammonia (NH_3) does not contain carbon atoms, which means there are no CO_2 emissions generated when oxidized. In addition, ammonia has a high hydrogen density and is easy to transport and store. Commonly used for fertilization and refrigerant applications, industrial practices for the safe handling and operation of equipment using ammonia are already in place. The wide-use of ammonia in industry drives a demand for large levels of production, worldwide 153 Mtons were produced in 2008.

During this research program a new ammonia fuel combustor was developed and tested by the Montana Aerospace Development Association (MADA) and Space Propulsion Group, Inc. (SPG) at the Butte AeroTec Facility located near Butte, Montana. This new testing facility is co-located with the Butte AeroTec Facility Solid-Fuel Ramjet test facility, which was developed during a previous MBRCT project. Both facilities use a General Electric J-79 turbojet engine (see Fig. 1) to supply high pressure, non-vitiated air flow to the desired test

fixture. The test fixture uses the compressor bypass flow of a J79 afterburning turbojet, which is capable of providing up to 30 kg/s of compressor bypass flow. Control of the air flow rates during testing was completed by throttling the J-79 engine, which in turn throttles the combustion process.

The research has the potential to lead to significant business opportunities for Montana, MADA, and SPG. Successful commercialization could result in a new multi-billion dollar market in the energy sector.

Commercialization

Numerous steps remain prior to commercialization of the technology, including technology development and pilot plant development over more than five years. Results of successful research could create a new industry in the energy sector and many high-paying energy-related jobs.

Target market including size

Target Market 1: Lightweight and Micro Gas Turbines – *Ammonia is an economically viable option for oil fired lightweight gas turbine systems and natural gas or oil fired microgas turbines used for distributed power generation. This market exists currently and does not require the development of new production/distribution/storage technologies for ammonia.*

Target Market 2: Heavy-duty Gas Cycles – *Since most of these plants currently utilize natural gas, switching to ammonia is not economically viable; however, using CO_2 sequestration would make ammonia a viable alternative to natural gas even for the heavy-duty combined cycle power generation plants.*

Target Market 3: Distributed Renewable Energy Generation

- *Most of the renewable energy sources have low capacity factors which require a backup power system.*
- *Instead of connecting to the grip for which utilities companies would charge, the excess power could be used to produce ammonia that can be stored and burned in a micro turbine to generate electricity and heat when needed.*
- *This requires the development of an efficient synthesis technology for ammonia (from water and air).*
- *Since ammonia is a widely used fertilizer, its use in electricity generation in rural/agricultural areas makes perfect economical sense.*

Target Market 4: Enabling Technology for Stranded Renewable Energy Source

- *Stranded Renewable Energy Sources: Most of the renewable energy sources such as solar, geothermal, or wind are not accessible by the existing electric grid system.*
- *Extending the grid to remote areas is not economically feasible – it is politically difficult, if not impossible.*
- *Ammonia as an energy carrier has the potential to solve the Stranded Renewable Energy problem.*
- *Using a synthesis method, ammonia can be produced at the stranded site from water and air.*

- *The produced ammonia can be shipped via trucks, railway, or pipeline to the power generation plants to generate electricity.*

Production or manufacturing plan
Technology Development Path
Phase 1 – Feasibility (Completed during this project)
Objective: Evaluate the feasibility and economical/technical viability of the technology/concept
- *Conduct feasibility studies: Modeling of ammonia combustion, testing in combustors, and design of fuel nozzle for J85 and J79 engines.*

Phase 11 – Technology Development
Objective: Develop the necessary technologies to implement the concept
- Work includes: Fuel formulation and laboratory testing, engine cycle analysis, extensive engine testing, and development of fuel control systems

Phase III – Pilot Plant Development
Objective: Implement the concept on a small gas turbine power generation plant
- Work includes: conversion of the existing facility to an ammonia-fired gas turbine and evaluation of the economical viability of the concept.
- Partner with an energy company

Phase IV – Implementation/Commercialization
Objective: Convert existing gas turbine power generation facilities to burn ammonia and develop new ammonia-based gas turbines
- Partner with a gas turbine producer

Job Creation
Successful implementation of the project will create significant job opportunities, potentially in the thousands and mostly in the high-paying energy sector.

The industry would be composted of the following five segments:
1) R&D for the first 3-5 years
2) Manufacturing and installation of conversion kits for the existing gas turbines
3) Manufacturing of ammonia fuel support equipment
4) Manufacturing of ammonia based micro gas turbines
5) Installation of self sustained ammonia based power generation systems

#11-21 Dose Optimization of Methamphetamine as a Neuroprotective Treatment for Traumatic Brain Injury
David J. Poulsen – University of Montana - Missoula
$60,000
Final report approved: November 2011

Summary
The initial goals of the project were: (1) Identify the lowest effective dose of methamphetamine that provides efficacy as a neuroprotective agent following severe traumatic brain injury in a rat model: (2) Using the lowest effective dose established in (1), determine the maximum window in

which methamphetamine can be administered after traumatic brain injury in a rat model and achieve therapeutic efficacy; (3) Using the lowest effective dose established in (1), determine if treatment with methamphetamine can be used to reduce the incidence of seizures that develop following traumatic brain injury.

The project received a significantly lower award than the original request; therefore, only the first two objectives were completed. The third objective is currently underway supported through the Department of Defense grant used as matching funds for this project. The PI anticipates that the seizure studies will be completed in the first half of 2012.

Objectives 1 and 2 have been completed and it was determined that 0.5mg/kg/hr is the lowest effective dose and that treatment can be delayed until 12 hours after injury. This is significant because it represents the longest time therapeutic window of any neuroprotective agent tested to date.

Commercialization
The product of this technology is use of methamphetamine and novel route of administration in stroke and traumatic brain injury.

Target market including size
The U.S. biotechnology industry grew at a rate of 13.3% during 2005 and reached the value of $68.6 billion. The industry is forecast to grow at a compound annual growth rate of 14% and, by 2010, approached $131.8 billion in revenues.

The target market for this product for stroke is the 630,402 people who arrive with stroke to U.S. Emergency Departments. This technology could dramatically reduce the societal cost by lowering the expense associated with the various aspects of care during the post-stroke phase. Additionally, the technology should be ideal for the treatment of stroke victims in other countries, particularly those with low-technology health care systems.

The target market for this product for head injury is the 1.1 million Americans who annually seek treatment for these types of injuries. Sinapis Pharma will target any of the 200 worldwide pharmaceutical firms willing to license its intellectual property. The top 20 are becoming increasingly dependent on licensing and the trend is expected to continue with firms averaging 26.1% of sales from licensed products.

Business Model
Sinapis Pharma intends to operate as a drug discovery and development company with initial efforts focusing on development 0f and repositioning intravenous methamphetamine as a neuroprotective agent in the treatment of stroke and/or traumatic brain injury. The company expects to sublicense the technology to a major pharmaceutical company after proof of concept is established for stroke. Steps for developing proof of concept include: completing pre-clinical studies, phase 1 clinical trial and phase 2 clinical trials.

Business risk assessment

The report discusses competition risk factors in depth and concludes that, although competition is growing, a new method of stroke treatment developed from methamphetamine would give Sinapis Pharma a competitive advantage and a strong point of differentiation. Methamphetamine is off-patent, inexpensive to manufacture, stable, easy to handle, and can potentially be administered up to 16 hours or longer after a stroke occurs. In addition, toxicity is expected to be low and side effects minimal.

Other risks include: no operating history, ability to obtain additional financing, no ready market for shares, dependence up and need for key personnel, no guarantee that full patent protection will be granted, negative reputation of methamphetamine as a recreational drug, unexpected toxicity, failure to demonstrate efficacy in further testing, competitor drugs, failure to license technology, regulatory risk/failure to obtain FDA approval, and management.

Economic Impacts
MBRCT funding has led to major steps forward in the development, and eventual commercialization, of this technology, and has had a "profound" economic impact on the development of future biotechnology in Montana.

New businesses created or expanded
Funding by MBRCT has lead to the development of a new company, Sinapis Pharma, Inc.

Increase in employment levels
MBRCT funding has provided employment for four people: the PI, a post doctoral fellow, and two technicians.

Patents applied for or granted
An international patent was filed on August 15, 2007, naming David Poulsen and Thomas Rau as the inventors. A second international patent was filed on March 1, 2010, also naming David Poulsen and Thomas Rau as the inventors. Additional patent applications directed to improvements to the inventions have been filed. In addition, development of the technology has resulted in an FDA approved investigational new drug (IND) application.

License agreement
Sinapis Pharma has signed a license agreement with the University of Montana for exclusive worldwide rights to the set of patents surrounding development of the technology. The ideal client for the intellectual property would be a large pharmaceutical firm.

#11-22 Enhancement of Applied/Translational Research in Biomedicine
Richard J. Bridges – University of Montana - Missoula
$161,344
Final report approved: October 2012

Summary
This report marks the conclusion of the two-year performance period for the seventh MBRCT award

to the NIH Center for Biomedical Research Excellence (COBRE) in Structural and Functional Neuroscience (CSFN). The overall goal of the COBRE award was to establish *CSFN* for the purposes of increasing critical mass of researchers and providing the needed infrastructure to increase the competitiveness of biomedical research efforts in Montana. The overall goal of the MBRCT award was to supplement the COBRE effort in a manner that would positively impact economic development in Montana within the area of applied biomedical research. The project also involved St. Patrick Hospital and Health Sciences Center and the Montana Neuroscience Institute in Missoula, as well as collaborative efforts with emerging biotech companies in Montana.

Significant progress has been made to enhance applied biomedical research efforts in the state, including success in the original goals of: increasing critical mass of scientists engaged in applied research (Aim I), supporting shared instrumentation (Aim II), training students (Aim III), enhanced training and opportunities for tech transfer (Aim IV), and increasing opportunities for private sector collaboration and IP commercialization (e.g., SBIR awards, university-private sector collaborations) (Aim V). This grant overlapped MBRCT #10-23 and both reports share some of the same benchmarks and accomplishments.

Significant accomplishments made during the award period are:

- Almost **$10,000,000** in total new funding was awarded to CSFN Investigators and a total of more than **$59,200,000** in grants were submitted by CSFN researchers, many of which are still pending a funding decision.

- Federal research contract dollars contribute to the salaries of about 50 employees, including approximately 30 students. Significantly, as these dollars came from federal research contracts, they represent new dollars coming into Montana and have been estimated to have a "Business Activity Multiplier" of almost 2-fold.

- Clinical research trials at the Montana Neuroscience Institute (MNI) have reached a total of about 25 projects and marked increase of access of Montana patients to the newest therapeutic strategies.

- CSFN investigators continue to increase the number of ongoing collaborative ties established with emerging Biotech companies in Montana, especially with companies in the immediate vicinity of UM and MSU. In particular, these companies include four new "spin-off" companies directly started using CSFN related IP: TranSynaptic, ATERIS, GT Pharma/Rio Pharmaceuticals, and Sinapsis Pharm. (These companies have been reported in previous Final Reports.)

- Provisional patent applications began for four new pieces of intellectual property.

- Seventeen students from four universities participated in the Summer Undergraduate Research Fellowship program, receiving hands-on experience in biomedical and translational research.

Collectively, this project is intended to have a long-term positive impact on Montana's economy by first increasing jobs through the acquisition of federal research grants and contracts, secondly by enhancing collaborations with private sector companies, and lastly by developing (and protecting) intellectual property that can be commercialized through existing or new companies. It is within this last mechanism that there is the greatest potential for the direct commercialization of technology. During this award period, continued progress was made in each of these areas.

Path to Commercialization

The report differentiates the strategy best suited for the role that the University should play in economic development as one that increases the critical mass of scientists and projects directly associated with applied research and enhances the opportunities to develop appropriate projects via collaborations with biomed/biotech companies. In this respect, the project is more focused on enhancing discovery, capturing it as intellectual property, and transferring it to the private sector than on the commercialization of a single technology or product.

Put another way, the **most successful projects have relied on the academic environment of the *CSFN* to help develop the product/technology and on the collaborating private sector company to commercialize it.** The development of a commercialization plan only occurs after collaboration has been initiated and then, the commercialization plan is developed by the corporate side of that collaboration, rather than the academic side. The strength of this strategy is exemplified by the fact that a number of recent seed projects have developed to the point where they have spun off new companies or partnered with existing companies to apply for and/or attract independent SBIR and MRBCT support, that is in part reliant upon the companies' competitive commercialization plan (as demonstrated by Sinapis, ATERIS, Rio Pharma., ADVR, etc.). Thus, commercialization plans are developed for each of the different projects at the appropriate time as dictated primarily by funding needs, such as SBIR grants or investments proposals to angel investors or venture capital groups.

Economic Impacts

Economic impact of the project is long-term and focused on capturing IP developed by CSFN investigators and then effectively transferring it to the private sector via collaboration and tech-transfer. Each of the Specific Aims inherently has an economic impact.

Aim I Enhance the critical mass of competitive neuroscientists and projects within Montana that are actively engaged in applied research related to the development of novel diagnostics, pharmaceutical reagents, devices, processes, and/or therapeutic agents related to the treatment of brain injury and disease… The $10 million in extramural grants garnered by CSFN investigators during the award period has had a significant impact on Montana's economy. Further, it is estimated that the "Business Activity Multiplier" for NIH awards in Montana has been determined to be between 1.9 and 3, translating into a minimal total impact of close to $20 million. As about 60% of grant funding is typically directed toward salary for staff, students and faculty, this funding has helped create and/or maintain numerous jobs. This is an important consequence of research funding given the current status of the economy and unemployment in Montana.

Aim II Enhance the ability of applied and basic researchers on and off campus to access needed high-cost, high-tech shared instrumentation facilities… Equipment in the instrumentation cores has been used by both university and private sector researchers. In the instance of collaboration with emerging Montana companies, this access has saved the companies the cost of acquiring such instrumentation, which would often be unobtainable. Further, access to this equipment is often an important factor in determining the competitiveness of grants submitted by CSFN investigators. This effort has also been advanced by the development and use of the Translational Incubator lab.

Aim III Enhance "hands-on" technical training for undergraduate and graduate students in applied and basic research… Although long-term, the student training opportunities supported by this project contribute to developing a stronger bio-tech work force. Further, collaborations with private sector companies have also contributed to new job creation for students involved in the projects.

Aim IV Enhance training and opportunities for technology transfer and commercialization based upon the recognition, development, and protection of intellectual property emerging from the laboratories of the neuroscientists within the CSFN…

Aim V Utilize the results of Aims I-IV to develop and/or strengthen ties with emerging biomed/biotech companies in Montana with the goal of commercialization…Enhancing university/private sector collaborations as a way to increase economic development has been a major goal of this project. The two most important outcomes of this project have been a marked increase in the generation of intellectual property and the creation and or continued collaboration with new Montana-based biotech companies, such as TranSynaptic, ATERIS, Rio, Sinapis, and Fluorescence Innovations Inc. These efforts and companies represent a critical step in the development of the bio-tech sector in Montana. Overall, the design and implementation of this project represents one of best ways in which university-based research can be leveraged and directed toward economic development in Montana.

#11-24 MEMS-Based Micro Zoom Lens for Cell Phone Cameras
Brant Kaylor – Bridger Photonics - Bozeman
$100,135
Final report approved: November 2011

Summary

The purpose of this project was to transition and develop a MEMS (micro-electromechanical system) deformable mirror technology toward commercialization, specifically a zoom lens for cell phone cameras. Bridger Photonics, Inc. partnered with Montana State University to develop the mirror for zoom and imaging systems. The effort has led to the completion of a compact zoom camera using flexible MEMS mirrors.

The three primary objectives of the project were: (1) develop drive electronics for the MEMS mirror and provide a user interface; (2) improve device manufacturing; and, (3) demonstrate a zoom lens and design a commercial prototype. Bridger successfully completed all the tasks originally proposed, including development of multiple user interfaces that allow the user to operate a single mirror as

well as multiple mirrors. A low-power high-voltage source was utilized to successfully operate the mirrors using power from a standard computer USB port.

Manufacturing, undertaken by Bridger Photonics and MSU, improved the output as well as reduced the cost per device.

Bridger Photonics successfully demonstrated three different zoom lens configurations. The final zoom demonstrator utilizes off-the-shelf components and two MEMS mirrors to produce an optical zoom compound lens system that fits into a package about the size of a sugar cube. The demonstrator and the new design have the potential for commercial distribution in the camera cell phone market.

The technologies developed during the project will help Bridger Photonics pursue the camera cell phone market and explore opportunities with OEM suppliers in relation to its standalone products. The commercial potential of the zoom demonstrator has shown to be substantial and in line with the goals of the company. Bridger Photonics will seek further external funding to advance the system to a production-ready prototype for the lucrative cell phone camera market.

Commercialization

The key objective is to continue commercialization of the product for the camera cell phone market and the medical imaging and optical industries. The commercialization plan dovetails with the current mission of Bridger Photonics, which is to become a world market leader in precision LADAR and LIDAR metrology and advanced imaging products.

Bridger Photonics will pursue further external funding through either private or commercial sources. Bridger personnel recently met with its first potential venture capitalist. When VC funding is acquired, Bridger intends to focus on hiring people who can take the system to the production-ready prototype level. In order to enter the cell phone market with a viable product, Bridger Photonics will hire experts in the MEMS industry as well as experts in camera phone lens design. By utilizing the demonstrator developed during this project, Bridger Photonics is confident in its ability to acquire necessary funding, estimated between $3million and $5million, to take the micro zoom lens to the commercial market. Market size is estimated at $1 billion. Once a production-ready prototype is achieved, Bridger Photonics plans to license the rights to produce the lens to a cell phone camera manufacturer.

The project has continued to help grow and diversify the regional optoelectronics industry. The micro mirrors that were further developed during this project have created not only an opportunity in the cell phone camera market but have provided devices that have been utilized in many more areas.

Economic Impacts

The economic impacts have included progress towards a commercial micro zoom lens for a cell phone camera. The micro zoom lens has the possibility of becoming a very lucrative product for both Bridger Photonics and its licensee.

The project has helped to decrease the manufacturing cost of the devices by increasing the yields and refining the steps necessary for production. This price reduction will play a substantial role in the future of zoom lens. The technology will also enable Bridger Photonics to move forward on future standalone products that will fit into niche markets. Bridger Photonics expects to release the first of

many standalone focus control units in the 1st quarter of 2012. Along with the standalone product release, Bridger Photonics has been working with OEM suppliers to build relationships to supply devices for their systems. Many of the devices that were built using the technology developed during the course of the project have been passed onto various organizations to utilize in biomedical imaging applications. The project not only resulted in more products for Bridger Photonics, but motivated the development of intellectual property to ensure that the technology does not dissipate.

The economic impact has not only been limited to Bridger Photonics. MSU has also benefited from the project through use of the clean room at the MSU Montana Microfabrication.

Accomplishments during the course of the project:

- Designed, built and demonstrated compact zoom lens with no moving parts. Device footprint is 3cm x 3cm x 1.7cm
- Developed next generation design to fit within 1 cm^3
- Proved feasibility of MEMS-based zoom concept
- Developed compact electronics for zoom demonstrator
- Developed software interface for device control

#11-26 Applications for Inhibitors of Fungal Morphogenesis
Kurt Toenjes – Montana State University Billings
$100,000
Final report approved: November 2011

Summary

This project continued a previous effort funded by MBRCT to develop an anti-fungal agent with commercialization potential as a laboratory reagent and a new line of fungicidal drugs. *Candida albicans* is an opportunistic fungal pathogen which grows as yeast and as filamentous fungus. Small organic molecules that inhibit this growth transition may ultimately lead to new anti-fungal therapeutic targets and drugs. BH3I-1 is an inhibitor of the yeast-to-filamentous growth transition. BH3I-1 also inhibits growth or morphogenesis of a number of different pathogenic *Candida* and *Aspergillus* species. The effort proposed to investigate BH31-1 as an antifungal agent through two objectives: (1) Continue work to identify potential BH3I-1 target proteins; and, (2) Take advantage of the established mouse model of hematogenously disseminated candidiasis to test toxicity and therapeutic effects of BH3I-1. Progress on these objectives has gone well. The second objective was completed and additional work will continue through collaboration with Robb Cramer, Assistant Professor of Fungal Pathogenesis at Montana State University. The discovery that BH3I-1 is tolerated by mice and appears to have some activity *in vivo* “has every one very excited”. The first objective is also well underway and the technical challenges have been solved. Analysis of the soluble and membrane fractions of *grr1* and *cdc4* mutants is almost complete.

Commercialization

The long-range commercialization goals are to develop BH3I-I as a commercially available chemical inhibitor of *C. albicans* filamentous growth for *C. albicans* research and to begin to explore its potential as therapeutic agent. This is being accomplished by focusing on

determining the mode-of-action of BH3I in fungi and determining BH3I-I's therapeutic efficacy. These steps are required for use of the molecule in a laboratory setting and as an anti-fungal agent, and in order to obtain additional funding from NIH and Big Pharma. If BH3I-I does not show therapeutic efficacy, then it will be used as an important tool to elucidate the Programmed Cell Death pathways and to develop other therapeutic approaches.

Potential markets and applications:

- An important tool utilized by research labs to control the growth patterns in *Candida*, *Aspergillus*, and *Saccharomyces* species. There are thousands of university-based labs that study these organisms. Although this could take several routes to final product, the most direct route would be to supply the molecule as part of a lab kit for use by researchers. This is the shortest path to market with the least investment, i.e. a 5-7 year timeline and $2 to $4 million.

- Specific anti-fungal prophylaxis on intimate-contact products. Bausch & Lomb's interest in preventing colonization of contact lenses leading to fungal infections in the eye would be the most immediate and compelling market given the scale of contact lens use. Feminine hygiene and contraceptive products, diapers, baby wipes, bandages and medical instruments are possible applications that may interest companies such as Johnson & Johnson and Procter & Gamble. These companies may be interested in a testing and licensing opportunity to gain competitive advantage in consumer products purchased without prescription. The required human trials and further refinements at research hospitals would likely necessitate a minimum of 10 years to market and investment of tens of millions of dollars. Given the potential for widespread applications, this is a compelling market since it avoids some of the pitfalls from internal use for human infections.

- Anti-fungal products for in-hospital use to reduce deaths from fungal infections obtained in critical care, intensive care, oncological care, obstetrics, and general surgery wards. Products might include therapies administered to infected patients, prophylactics provided for high risk patients, follow-up care protocols, or possibly environmental applications. Likely partners would be companies focusing on in-hospital products with testing and delivery design hurdles, i.e. BaxterTravenol. The human trials and further refinements at research hospitals makes this a minimum of a 10-year to market path and requires a Big Pharma investment of hundreds of millions of dollars, but a compelling market that the FDA might expedite approvals for.

- Integration into existing cancer treatment regimens as part of a drug cocktail for chemotherapy patients. Logical partners would be the National Cancer Institute, the American Cancer Society, Big Pharma, and FDA, and would likely require a minimum of a 10-year path to market.

Economic Impacts

Increase in employment levels

Grant funds were used to support two technicians, two undergraduate students per year who worked up to 35 hours a week in the summer, and summer support for two faculty.

Patents applied for or granted
A patent for BH3I-I was filed for previously to the submission of the grant. The patent was issued November 2nd, 2010.

Development of intellectual property
Initial findings indicated that mice tolerate BH3I-1 and evidence of an *in vivo* effect greatly increased the value of the patent on BH3I-1 as an antifungal agent. Additional funds are being sought to take these experiments to the next level and attract the interest of the pharmaceutical industry.

#11-33 Manufacture of Wavefront Guided Progressive Multifocal Contact Lens
Stephen Dunn – WaveSource, Inc., Whitefish, MT
$87,633
Final report approved: September 2011

Summary
This project was designed to complete the development of WaveSource multifocal progressive lens design and simplified objective fitting system, in preparation for human clinical studies. The research objectives were completed with the exception of development of the metrology system, which was conducted by MSU. The flat surfaces of the lenses were successfully mapped mathematically, but the scanning system was not able to create a mathematical map on curved surfaces. This will require additional work and resources. The flat phase plates clearly showed that the surface geometry designed by the ASADv1 software was replicated on the surface of the phase plate. This indicates that WaveSource has good control over its machining process. WaveSource planned on moving into human clinical trials this fall, but will need additional funding before this will occur.

Commercialization
There is a significant unmet need for a multifocal design lens that allows comfortable vision at both near and far distances. The wavefront guided progressive contact lenses represents an opportunity to address this need for a global aging demographic. Human clinical trials are pending additional funding and commercialization is dependent on results of the human clinical trials.

Economic Impacts
Commercialization of wavefront guided progressive contact lenses will bring a new technology sector to the Flathead Valley. Skilled labor will be required to manufacture and distribute the lenses. In addition, support jobs will be created in customer service, technical support and sales and marketing.

#11-37 An Integrated Platform for Cell-Based Drug Discovery
Anne Marie Quinn
$99,935
Final report approved May 2012

Summary
The challenge of this project was to develop a drug discovery platform capable of making accurate and reproducible measurements of fluorescence with the speed required for live cell high throughput screening applications in the pharmaceutical industry.

The results show that it is possible to detect an *irreversible* elimination of FRET produced by the Casper3-GR sensor in living cells with the NovaFluor plate reader using the optimized conditions for cell culture, media handling and transfection that were developed during the project. *Reversible* changes in FRET were not accurately detected on the NovaFluor. The instrument does not feature the necessary combination of drug dispensing robotics and control software to capture the *reversible* response. The studies were unable to establish any significant advantage of lifetime measurement over intensity measurements in the context of measuring FRET sensors in living cells. Several technical improvements were identified that might improve the NovaFluor performance in live cell FRET assay applications.

A cell-based diacylglycerol assay product that is easy to use is relevant for drug discovery and cell signaling research because there are no other commercially available live cell assays that monitor changes in diacylglycerol that are robust enough for HTS or in-vivo model systems. As a first step in addressing this market opportunity, Montana Molecular filed a provisional patent application in March 2012 to describe and protect an innovative diacylglycerol assay technology. Montana Molecular is actively engaged in developing industrial partnerships to commercialize this technology. The company has received substantial follow-on funding from Phase 1 SBIR program awarded by the National Institutes of Health that is expected to continue in a Phase 2.

Commercialization
A provisional patent describing the technology has been filed and the company is pursuing industry partnerships to commercialize the invention for use on conventional intensity-based plate readers. Montana Molecular has contracts with three fully equipped, high throughput screening facilities to evaluate the technology. Phase 1 SBIR project will culminate in sensors packaged in stable cell lines for testing on the industry-standard, intensity-based plate reader. A manuscript describing the assay is being prepared for a peer-reviewed publication for submission in May 2012. MBRCT support will be acknowledged.

Montana Molecular was accepted in to the NIH Niche assessment program in December 2011 under which a comprehensive market analysis confirmed strong market interest in easy-to-use diacylglycerol assay products. An unmet need for easy-to-use assays that work with industry-standard fluorescence intensity plate readers was an important fact uncovered by this analysis.

Product description
Montana Molecular is actively pursuing commercialization of its diacylglycerol assays, which are newly designed products similar to its original FRET sensors. These assay products are relevant for drug discovery and cell signaling research because there are no other commercially available live cell assays that monitor changes in DAG that are robust enough for HTS or in-vivo model systems.

Target market including size

The primary market for these assay products is cell-based drug screening. The global cell-based drug screening market was estimated to be $700M in 2007. A second market is the preclinical research market focused on studying cell signaling pathways, especially in model organisms such as the mouse.

Business risk assessment
The most significant barrier to entry will be assay validation in a high throughput industrial screening environment. Contract agreements have been established with three collaborating facilities to help mitigate this risk.

A second barrier to market entry is educating end users about the assays. Montana Molecular will exhibit at annual industry events in order to establish contacts with people engaged in high throughput screening.

Estimate of sales revenues for five-year period into the future
With an estimated annual growth rate of 12%, market size over $1.5B is forecasted in five years.

Economic Impacts
Increase in employment levels
The project enabled two young Montana scientists to make substantial contribution to the research and development of new intellectual property.

Patents applied for or granted
A provisional patent describing the technology was filed.

#11-45 Nanoparticle-Bacteriophage Cocktails to Combat Infectious Disease
Marisa Pedulla – Montana Tech - Butte
$113,050
Final report approved: December 2011

Summary
This project investigated a novel approach to combat antibiotic-resistant bacteria with significant potential for biomedical market commercialization in that infections from antibiotic-resistant bacteria represent an enormous challenge to the biomedical and pharmaceutical communities and this challenge poses tremendous opportunity for new commercial medical products.

Experiments conducted during the course of this project increased the knowledge base which had previously demonstrated that a synthetic nanoparticle, (iron-doped nano apatite) enhances viral infections of bacteria *in vitro*.

Results:

- Results statistically showed that ONLY iron-doped nano apatites improved infectivity. This creates a unique opportunity for the commercialization of these particles for improved phage infectivity *in vitro*.
- Iron-doped NPs did not increase the effectiveness of commercially available antibiotics, which disproved the original hypothesis that NPs may act as an adjuvant for anti-bacterial treatment employing antibiotics.

- *In vitro* experiments were carried out to study the enhancement of infectivity on *Staphylococcus* proved inconclusive. Experiments will continue to try to gain more meaningful and significant results.
- Experiments with mice models indicated that iron-doped NPs enhanced recover ~30-40% faster from MRSA skin infections when compared to no treatment., and the phage treatment alone showed improvements of about 20%. The combination of phage and NP, however, did not yield the additive effect observed for singular treatments. The finding that treatment with NPs only ameliorated *S. aureus* skin infections warrants further investigation. Since preliminary studies also demonstrate that NPs caused no visible adverse reactions, their use as an immune adjuvant to enhance other therapeutic treatments may also be a viable commercial pursuit.

Commercialization
MBRCT funding has enabled procurement of an automated synthesis reactor, which is a critical instrument for formulation and synthesis of different nanoparticles under controlled and reproducible conditions. This is a necessary benchmark toward any future commercialization. The reactor is used to automate the reproducible synthesis of the iron-doped HA nanoparticles. Results from the preliminary investigation conducted during this effort support pursuit of further studies to address therapeutic uses of nanoparticles and phage for treatment of recalcitrant bacterial infections.

Product description
Potential products include bandages containing ointments harboring nanoparticles and phage cocktails.

Target market including size
Potential markets include medical and veterinary markets, i.e. bacterial infections of livestock, including mastitis in dairy cows, costing billions of dollars for U.S. agricultural industry.

Marketing strategy
Funding sources to conduct a marketing study will be sought during 2012-2013. Potential sources include MBRCT, NIH SBIR and STTR, and philanthropic organizations such as the Bill & Melinda Gates Foundation. Expertise at MSU School of Business will be employed to analyze the commercial potential. Collaboration with compounding pharmacists, veterinarians and physicians will be undertaken to develop and safety-test future commercial products.

Estimate of sales revenues for five-year period into the future
Provided funding can be obtained, a commercial product could be on the market within a five-year period. Such a product could have global market potential, including use in underdeveloped nations to combat the blight of infectious disease.

Economic Impacts

New businesses created or expanded

[Increase in employment levels] – Student involvement

Four undergraduate students at Montana Tech, two undergraduate and one graduate student at MSU and two technicians (one from Montana Tech and one from MSU) have benefitted from the training and knowledge provided by working on this project. Based on preliminary data collected during the grant, three Montana Tech students have received additional funding from the campus Undergraduate Research Program to support further investigations of nanoparticles and bacteriophages. One student will attend the ASM meeting next summer to present her results. A MSU undergraduate student supported by the Initiative for Maximizing Student Diversity program will present the research findings at a conference for minority researchers. In ongoing and future studies, MSU and Montana Tech collaborators employing undergraduate students, graduate students and technicians will follow up with the results of this project. The potential impact in five years includes employment for these individuals involved in the marketing, manufacture, sales and distribution of the nanoparticle phage therapeutic products to veterinary and medical markets at the local, regional, national and international levels!

Patents applied for or granted
The work from this project has been used to apply for a patent.

Other
The results will be published as a letter to "Nature" on the novel findings of this research. The work will also be presented at the annual ASM meeting in San Francisco June 16-19, 2012. Meeting registration and transportation for the three PIs and two students were purchased with MBRCT project funds.

#11-50 Integration of Passive Seismic, Electrical and Temperature Measurements for Geothermal Resource Exploration
Leif Cox/Curtis Link – Montana Tech - Butte
$53,760
Final report approved: January 2014

Summary
The original objectives were not achieved due to problems with seismic data collection and changes in personnel. Two one-year, no-cost extensions enabled achievement of redefined objectives related to numerical modeling of geothermal resources. Two approaches were used: (1) A finite element approach (COMSOL); (2) A finite difference approach (Tessseral2D). The MS thesis describes the modeling approach and findings.

Commercialization Plan
As the objectives of this project changed, achievement of the goal of geophysical inversion of the multiple data types for final anomaly identification was not possible. The greatest potential for commercialization of this work as it has evolved will be to identify a company with broad geophysical experience that is willing to do reconnaissance work for geothermal resource prospecting. The Gprobe developed in the previous MBRCT project would be used to identify surface temperature anomalies that could indicate a productive geothermal source. It is the opinion of the PI that there is increasing interest in prospecting for geothermal resources, including such companies as Dewhurst Group in Montana City, and Gradient Geophysics, the industry partner in the previous MBRCT project. The approach outlined in this final report could

provide the pertinent information to a company to take advantage of exploring already identified zones for new sources of geothermal energy.

Economic Impacts

No information from the industrial partner, Gradient Geophysics, for any new developments or economic impacts related to this project is available. However, the results of the revised project could be implemented in a revised approach for geothermal prospecting and evaluation.