Ohio | Department of Development

Final Proposal Evaluation

2011

Third Frontier Advanced Materials Program

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This Report written by:

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Proposal Review Team

❖ TARATEC CORPORATION

- Dr. Edward Ungar, President
- Mr. Chuck Meadows, Project Leader
- Dr. Fred Clark
- Dr. Paula Dunnigan
- Mr. Bill Munk
- Mr. Reed Slevin

❖ SEVEN (7) EXTERNAL REVIEWERS

- Dr. Mohamed G Abdallah
  Dr. Abdallah has more than 27 years experience in all aspects of advanced composite materials including carbon and precursor fiber manufacturing and processing technologies; composites materials; and end-use product design, manufacturing, and marketing. He has managed, and directed consortium teams of researchers from industry, academia, and government agencies in producing ultra high-modulus, high-strength carbon fibers, technologies for low-cost carbon fiber production, stretch broken carbon fibers, carbon nanotube-related fibers, and carbon fiber for offshore oil exploration and production, automotive transmission devices, and industrial utilization in infrastructure for renewal and new bridge structures. After 24 years working for Hexcel Corporation/Hercules Company in all aspects of carbon fiber production, pre-preg manufacturing, composites structures manufacturing, design, and evaluations, he started MGA-Advanced Composites & Engineering Company (MGA-AC&E) to provide engineering services and consulting to the composites and carbon fiber industries. ORNL has awarded a multi-year consulting contract to MGA-AC&E in research area of carbon fiber precursor materials and conversion processing technologies.
- Dr. Robert Bell
  Dr. Bell has a Ph.D. in analytical chemistry and electronics engineering from LSU and an MBA from Texas A&M. His experience spans four industries including energy, information technology, retail, and chemical manufacturing. In 2007, he retired as CEO and President of Blue Magic Inc./Cargo Chemical Corporation, a $20M manufacturer and distributor of chemical products. In this position, he was responsible for the operation of three operating facilities, two in Georgia and one in Texas. Dr. Bell has been involved in the purchase of 5 businesses and is currently doing consulting work in the area of compliance with regulatory and third-party certification agencies.
- Mr. Mark W. Brown
  Mr. Brown brings extensive technical experience in the adhesives and solvent cements industry. In 2009, he retired from IPS Corporation as Vice President and Technical Director after a 25-year career with the company. At IPS, a global adhesives and chemical manufacturing company, he had experience working with private equity management and established the company's manufacturing operations in China. Mr. Brown has a bachelor's degree in chemical engineering from USC and completed the Management Development Program-Marshall School of Business at USC and the Advanced Management Program at Harvard Business School. He currently is the owner and president of a consulting firm that specializes in forensic failure analysis, industrial site inspection, third-party certification, and code body expertise.

Proposal Review Team *(continued)*

- Dr. Charles N. Bush
  Dr. Bush is currently President of PolymerPlus LLC, an R&D company focused on polymer multilayer films. In 2008, he retired from Oatey Co., a $400M Cleveland manufacturer of plastic pipe cements and plumbing products, as Vice President and Chief Technical Officer. Previously, he served as Director of R&D for the Geon Vinyl Division of BFGoodrich, a $1B producer of vinyl chloride monomer, PVC resin, and vinyl compounds. Dr. Bush has been active on ASTM committees, in the Vinyl Institute, and on various committees of the Plastic Pipe and Fittings Association. He serves as Director of Development in the National Science Foundation Center for Layered Polymeric Systems at Case. Dr. Bush combines a doctorate in Physical Organic Chemistry from the University of Illinois with business training from the Executive Program of the University of Virginia, Darden School of Business.
- Mr. Norman D. Malcosky
  Mr. Malcosky has over 40 years of experience in the energy industry performing and managing research activities in fossil fuel exploration, alternative fuel vehicles, biofuels, and fuel cells. He has specialized in Liquefied Natural Gas, Compressed Natural Gas, and propane-fueled vehicles. Using his strong background in mechanical engineering, he has patented various types of industrial equipment for the natural gas industry. Mr. Malcosky retired from Battelle Memorial Institute in 2002, where he served as a Senior Research Scientist in Battelle's Transportation Group and Equipment Design and Mechnical Systems Group.
- Dr. Joseph M. Morabito
  Dr. Morabito is a Director at Alcatel-Lucent. He was named a Bell Laboratories Fellow in 2004 for outstanding lifetime contributions to thin film surface and interface analysis and the development of new thin film systems that provide high density interconnections, thin film resistors, capacitors and cross-overs of high reliability and performance for the silicon integrated circuits (SICs) and hybrid integrated circuits (HICs) used in advanced telecommunications systems. Dr. Morabito is an expert in photovoltaic technologies and was a valuable advisor to the EPRI Solar Program for over 20 years. He has broad expertise in other distributed energy technologies and has published extensively on systems analyses linking various types of distributed energy generation with the smart grid. Dr. Morabito serves on the Board of Directors of the R&D Council of New Jersey.
- Mr. C. David Warren
  Mr. Warren is currently the Program Manager for Transportation Materials at Oak Ridge National Laboratory and Field Technical Manager for Materials in the Lightweighting Materials Program of DOE Vehicle Technologies. He has been at Oak Ridge National Laboratory working with composite materials for 18 years. Previously he was the program manager for Peacekeeper ICBM propulsion, Small ICBM basing and Rail Garrison support as a Captain in the United States Air Force prior to joining ORNL in 1991. He conducted all undergraduate and graduate work in materials science and engineering at Vanderbilt University. He has 54 technical publications mostly in composite materials development and application and vehicle technologies. Mr. Warren is recognized throughout the world for his leadership in the area of developing technology to produce low-cost carbon fiber.

Overview of Proposal Evaluation Process

- Two-stage evaluation process
- The evaluation process is objective and robust. Its consistency has been evaluated through rescoring. Results were found to be independent of the composition of the individual review panels and consistent year-to-year.
- The objective of the **First Stage Evaluation** is to rank the proposals on the basis of which best meet the RFP requirements and then to select the highest-ranking proposals for more in-depth evaluation.
  - The cut-point is based on significant score differences and best use of evalution resources. Taratec recommends a cut-point and ODOD selects the cut-point.
- The objective of the **Second Stage Evaluation** is to rank the highest-scoring proposals from the First Stage on the basis of the quality of investment for the State of Ohio.
  - Ohio job and revenue creation/retention that is likely to occur within 3–5 years
  - Company viability and business functions that are planned in Ohio
  - Potential of the project to contribute to a cluster of related companies in an industry that Ohio is trying to build

Proposal Evaluation Process

❖ FIRST STAGE EVALUATION

- Conflict of Interest evaluation for each reviewer
- Each proposal is read by 3 reviewers (internal and external)
- Proposal is scored by each reviewer using a scoring instrument based on the RFP criteria
- All scores from each reviewer are entered into a database
- Reviewers provide written comments on areas of concern or those requiring clarification
- A list of proposals ranked on the basis of their average scores is produced
- Taratec meets with ODOD to establish the competitive range (cut-point) for each competition
- Proposals scoring above the cut-point advance to the Second Stage Evaluation

❖ SECOND STAGE EVALUATION

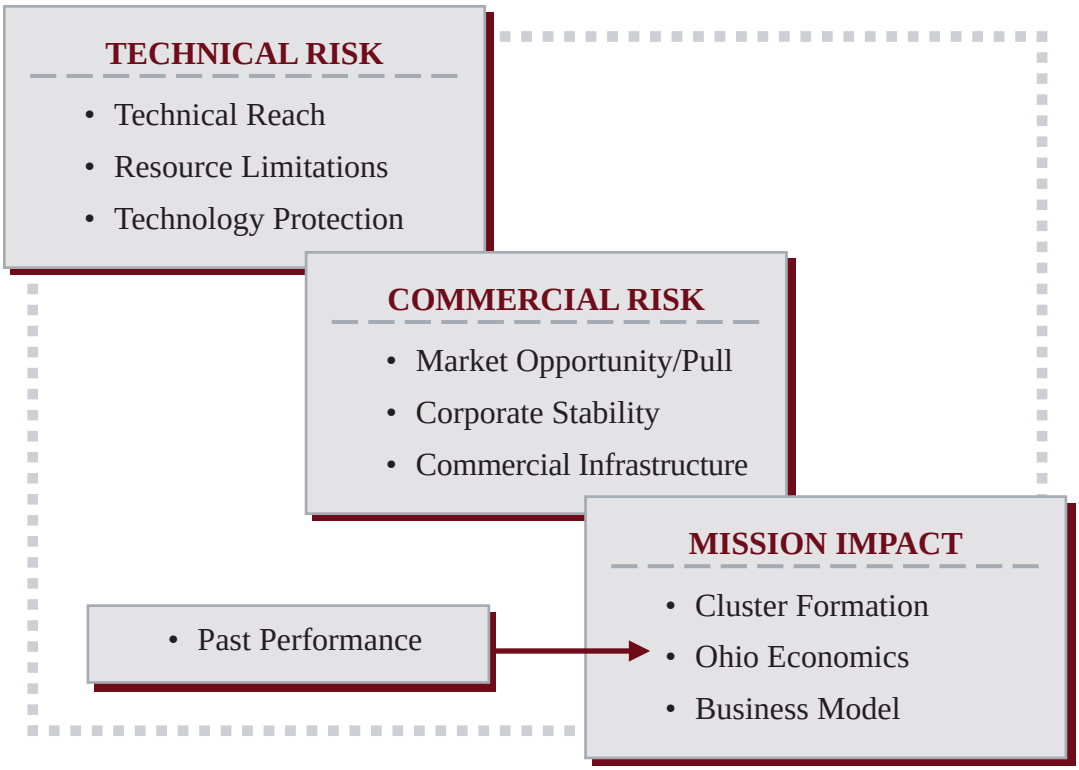
- Reviewer comments are integrated into the construction of a customized set of written questions for each applicant
- Applicants have one week to submit written responses
- Face-to-face meeting (90 minutes) for reviewers and applicants to discuss issues
- Final trade secret identification by applicants
- Preparation of 2-page project write-up and a 2-page confidential summary
- Risk-benefit scoring by the entire review team
- Scores entered into the database
- Final recommendations developed
- Preparation of materials for consideration by the Third Frontier Commission

SUMMARY OF FIRST STAGE EVALUATIONS

	TFAMP
Proposals Received	46
Proposals Recommended for 2nd Stage	13
Highest Score Recommended	89.8
Lowest Score Recommended	70.6
Highest Score Not Recommended	65.1
TFRDF Available	$7M
Cumulative TFRDF Requested	$7M

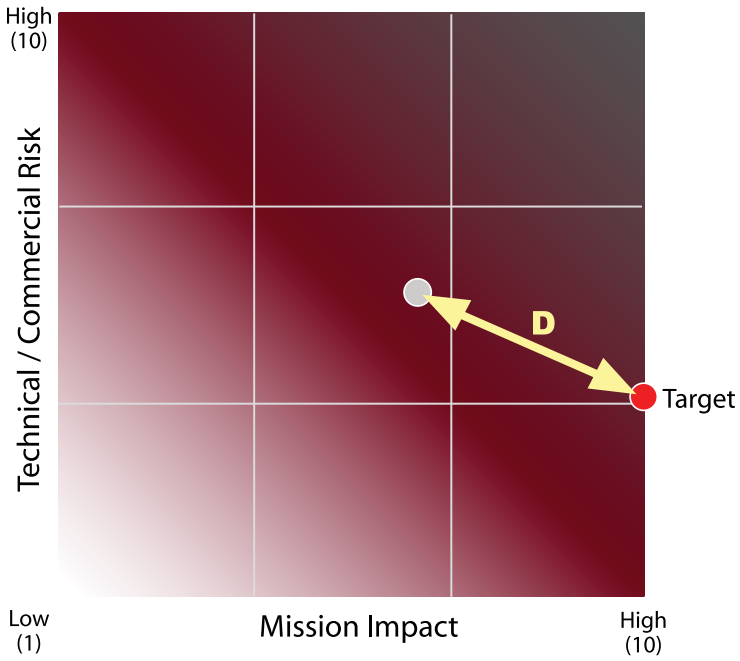
Scoring Methodology *(continued)*

SECOND STAGE EVALUATION FACTORS



Scoring Methodology *(continued)*

- Two 2-dimensional scoring matrices
  - One for Technical Risk
  - One for Commercialization Risk
  - Both risks are plotted against Mission Impact
- Target for Technical Risk is (10, 3.5)
- Target for Commercial Risk is (10, lowest value)
- Project's final score is based upon sum of D1 and D2



2011 TARGETS		
Technical Risk	Commercial Risk	Mission Impact
3.50	2.67	10.00

Target Definition for Ohio's Third Frontier Cluster Programs

The targets for Technical Risk, Commercial Risk, and Mission Impact have been set based on the profile of projects that are most likely to meet the intent of the Third Frontier Cluster Programs to develop new technology businesses that will produce economic development in Ohio in the 3- to 5-year timeframe. These targets were set after consultation with ODOD and the Third Frontier Commission.

Mission Impact

Ohio is seeking to fund the projects that will result in the highest economic development impacts for the dollars invested. Therefore, the target for mission impact has been set at the maximum of 10.

Technical Risk

Since economic development results are desired in a relatively short timeframe, projects selected for funding should be relatively mature, i.e., in the late Incubating or Demonstrating Stage with a functional prototype.

Projects that contain relatively little technical challenge, represent product line extensions, or are close to market are likely to score low on technical risk, i.e. 1 or 2. These types of projects would be candidates for internal funding by the applicant company, could attract investment, or would be bankable. They would not have the level of risk intended for this program.

At the other end of the spectrum, there will be projects that are still in early stages of development and have a number of significant technical and cost issues remaining to be resolved. These projects are frequently classified as Imagining or early Incubating Stage. They are likely to have technical risk scores in the range of 7–10. These projects would be candidates for federal R&D funding in the form of SBIRs or NIH grants. Only after they reach greater technical maturity would they be attractive candidates for the Third Frontier Cluster Programs.

The ideal level of technical risk for these three cluster programs has been set at 3.5. It is believed that this level of technical risk presents the optimum probability of achieving the intended economic development outcomes within the targeted timeframe.

Commercial Risk

The cluster programs are intended to serve the needs of both start-up companies and companies that have on-going business.

Existing companies frequently have well-developed distribution channels and some degree of financial stability resulting in low commercial risk scores. However, they may require assistance in new product development to reach a level of product maturity that will allow them to compete for scarce internal resources. Proposals from these companies will typically have commercial risks that score in the range of 1.5–2.5.

It was decided that these companies should not be penalized for having "too low of a commercialization risk." Therefore, for each competition, the target for commercial risk is set as the floor or at the lowest value of all proposals in the competitive range. This ensures that no proposal is penalized for having the ability to bring its product into the marketplace.

2011 TFAMP

Third Frontier Advanced Materials Program

Summaries of Proposals in Competitive Range

Recommendations for Funding
2011 Third Frontier Advanced Materials Program (TFAMP)

RECOMMENDED FOR FULL FUNDING

	OTF NO.	APPLICANT	SECOND STAGE SCORE	OTF $ REQUESTED	OTF $ CUMULATIVE
1.	TFAMP 11-732	Renegade Materials Corporation	89.8	$1,000,000	$1,000,000
2.	TFAMP 11-703	Iosil Energy Corporation	86.1	$ 925,500	$1,925,500
3.	TFAMP 11-773	Third Millennium Metals, LLC	84.8	$1,000,000	$2,925,500
4.	TFAMP 11-714	ChemImage Corporation	82.9	$ 999,877	$3,925,377
5.	TFAMP 11-722	NuVention Solutions, Inc.	82.3	$ 999,354	$4,923,731
6.	TFAMP 11-724	Momentive Performance Materials, Inc.	81.3	$1,000,000	$5,923,731
7.	TFAMP 11-737	MetaMateria Technologies LLC	70.6	$ 999,998	$6,923,729
TOTAL FUNDS REQUESTED					**$6,923,729**

2011 Third Frontier Funding Cycle Advanced Materials Program Final Round Scores

SCORE			City	County	OTFRD $ Requested	OTFRD $ Cumulative	WRIGHT $ Requested	WRIGHT $ Cumulative
Targets - Mission Impact: 10 Commercial Risk: 2.67 Technical Risk: 3.5								
89.8	**TFAMP 11-732**	Renegade Materials Corporation	Miamisburg	Montgomery	$1,000,000	**$1,000,000**		
	Hybrid Composite Materials for Commercial Aerospace Structures		Past Performance factor: 1					
	Technical Risk: **3.73**	Commercial Risk: **3.53**	Mission Impact: **8.92**					
	R: 4.00 L: 3.33 P: 4.00	P: 3.00 S: 4.00 I: 3.67	E: 9.00 M: 9.00 C: 8.67					
86.1	**TFAMP 11-703**	Iosil Energy Corporation	Groveport	Franklin	$925,500	**$1,925,500**		**$0**
	Commercialization of a New Manufacturing Process for the Production of Low-Cost, High-Purity Polysilicon for Solar Cells		Past Performance factor: 1					
	Technical Risk: **4.13**	Commercial Risk: **3.6**	Mission Impact: **8.5**					
	R: 5.33 L: 3.67 P: 2.67	P: 3.00 S: 4.00 I: 4.00	E: 10.0 M: 8.00 C: 6.00					
84.8	**TFAMP 11-773**	Third Millennium Metals, LLC	Waverly	Pike	$1,000,000	**$2,925,500**		**$0**
	Parallel Commercialization of Copper Covetics		Past Performance factor: 1					
	Technical Risk: **3.93**	Commercial Risk: **4.2**	Mission Impact: **8.5**					
	R: 4.00 L: 3.67 P: 4.33	P: 3.33 S: 5.67 I: 3.00	E: 9.33 M: 7.33 C: 8.00					
82.9	**TFAMP 11-714**	ChemImage Corporation	Pittsburgh	Outside OH	$999,877	**$3,925,377**		**$0**
	Manufacturing of Liquid Crystal Cells to Produce Multi-Conjugate Filters for Use in Hyperspectral Imaging Sensors		Past Performance factor: 1					
	Technical Risk: **4.13**	Commercial Risk: **3.13**	Mission Impact: **8**					
	R: 4.67 L: 4.00 P: 3.33	P: 4.00 S: 2.00 I: 3.67	E: 8.00 M: 8.33 C: 7.67					
82.3	**TFAMP 11-722**	NuVention Solutions Inc.	Valley View	Cuyahoga	$998,354	**$4,923,731**		**$0**
	Accelerating the Commercialization of a Novel Bio Resource Resiin (BR2) for Agricultural, Construction, and Industrial Applications		Past Performance factor: 1					
	Technical Risk: **4.33**	Commercial Risk: **4.07**	Mission Impact: **8.17**					
	R: 5.00 L: 4.00 P: 3.67	P: 3.00 S: 5.00 I: 4.33	E: 7.67 M: 9.33 C: 8.00					
81.3	**TFAMP 11-724**	Momentive Performance Materials Inc.	Strongville	Cuyahoga	$1,000,000	**$5,923,731**		**$0**
	Advanced Thermal Pyrolitic Graphite (TPG) Thermal Management Composite		Past Performance factor: 1					
	Technical Risk: **4.8**	Commercial Risk: **2.67**	Mission Impact: **7.92**					
	R: 6.67 L: 3.33 P: 4.00	P: 3.00 S: 2.33 I: 2.67	E: 7.33 M: 9.33 C: 7.67					
70.6	**TFAMP 11-737**	MetaMateria Technologies LLC	Columbus	Franklin	$999,998	**$6,923,729**		**$0**
	Water Purification using Nano-Enabled Solutions		Past Performance factor: 1					
	Technical Risk: **4.67**	Commercial Risk: **5**	Mission Impact: **6.92**					
	R: 4.67 L: 5.00 P: 4.00	P: 3.00 S: 6.33 I: 6.33	E: 7.33 M: 6.67 C: 6.33					

2011 Third Frontier Funding Cycle Advanced Materials Program Final Round Scores

SCORE		City	County	OTFRD $ Requested	OTFRD $ Cumulative	WRIGHT $ Requested	WRIGHT $ Cumulative
Targets - Mission Impact: 10 Commercial Risk: 2.67 Technical Risk: 3.5							
65.1	**TFAMP 11-760** Angstron Materials Graphene-Based Nano-materials for the Next Generation Thermal Management and EMI Shielding Solutions	Dayton	Montgomery	$993,452	**$7,917,181**		**$0**
	Past Performance factor: **1** Technical Risk: **5.6** (R: 5.33 L: 6.67 P: 4.00) Commercial Risk: **6.60** (P: 7.00 S: 6.67 I: 5.67) Mission Impact: **7.08** (E: 7.00 M: 7.33 C: 7.00)						
61.6	**TFAMP 11-740** WebCore Technologies LLC Structural Composite Panels for Trucks and Trailers	Miamisburg	Montgomery	$1,000,000	**$8,917,181**		**$0**
	Past Performance factor: **0.8** Technical Risk: **6.33** (R: 6.33 L: 6.00 P: 7.00) Commercial Risk: **5.27** (P: 4.33 S: 6.67 I: 4.33) Mission Impact: **6.2** (E: 5.06 M: 7.67 C: 7.00)						
60.0	**TFAMP 11-710** Ferro Corporation High Performance Glass Filled Barrier Coatings for Solar Modules	Independence	Cuyahoga	$1,000,000	**$9,917,181**		**$0**
	Past Performance factor: **1** Technical Risk: **7.6** (R: 8.67 L: 7.33 P: 6.00) Commercial Risk: **6.07** (P: 5.67 S: 7.33 I: 4.33) Mission Impact: **6.92** (E: 6.00 M: 9.33 C: 6.33)						
59.3	**TFAMP 11-735** PolyGreen Technologies Development of a Novel Process for the Commercialization of Biopolyols and Polyurethane Foams	Mansfield	Richland	$1,000,000	**$10,917,181**		**$0**
	Past Performance factor: **1** Technical Risk: **5.93** (R: 6.00 L: 6.33 P: 5.00) Commercial Risk: **6** (P: 4.00 S: 8.00 I: 6.00) Mission Impact: **6** (E: 6.33 M: 5.00 C: 6.33)						
56.8	**TFAMP 11-717** NGJ LLC Carbon Fibers: New Low Cost, Small Diameter Materials	Akron	Summit	$1,000,000	**$11,917,181**		**$0**
	Past Performance factor: **1** Technical Risk: **6** (R: 6.33 L: 7.00 P: 3.33) Commercial Risk: **6.87** (P: 6.00 S: 8.33 I: 5.67) Mission Impact: **6.00** (E: 5.67 M: 5.67 C: 7.00)						
45.8	**TFAMP 11-755** Chemtex International, Inc. Renewably Sourced Ethylene Glycol from Cellulosic Biomass	Sharon Center	Medina	$987,908	**$12,905,089**		**$0**
	Past Performance factor: **1** Technical Risk: **6.80** (R: 6.67 L: 7.67 P: 5.33) Commercial Risk: **7.47** (P: 6.67 S: 8.00 I: 8.00) Mission Impact: **4.84** (E: 5.67 M: 3.67 C: 4.33)						

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2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

Renegade Materials Corporation

Hybrid Composite Materials for Commercial Aerospace Structures

TFAMP 11-732 Final Score: 89.8 Rank: 1

Previous Ohio Investment

Renegade Materials Corporation has never been a Lead Applicant in an Ohio Third Frontier Program, but is currently participating as a collaborator in four (4) OTF projects.

Project Description

Renegade Materials Corporation is a small manufacturing company that produces resins, films, tapes, adhesives, fabrics, and precision pre-pregs for the aerospace (military and commercial), missile, and space industries. Currently, commercial airline manufacturers are pushing their component parts suppliers to produce higher strength, higher temperature-resistant (800ºF), and lower weight structural components. Renegade and Maverick Corporation have developed a line of resins, adhesives, films, and pre-pregs that can meet the OEM's increased temperature requirements. In this 2-year project, Renegade will integrate Maverick's high temperature polyimide with Renegade's polymers, ceramic resins, films, and pre-pregs into nano-adaptive hybrid fabrics (NAHF-X™) under license from the University of Dayton Research Institute (UDRI). Renegade will provide scaled-up quantities of formulations to collaborators, Goodrich Corporation and Spirit AeroSystems, for them to make nacelle components for evaluation and FAA certification. The goal is for Renegade to be considered a qualified material supplier for the upcoming large orders from aircraft manufacturers Boeing and Airbus. This project could eventually lead to a new production facility making finished composite parts for the higher temperature component commercial aircraft needs.

Key Issues

- Positive results on prototype test samples from third-party validations.
- Significant financial investment and interest from project collaborators and major next-stage developers, Goodrich and Spirit AeroSystems.
- There is a potential for establishing a new manufacturing facility in Ohio to make high temperature composite finished shapes using the products in this proposal.

Technical Risk

Overall Score = 3.73

Technical Reach

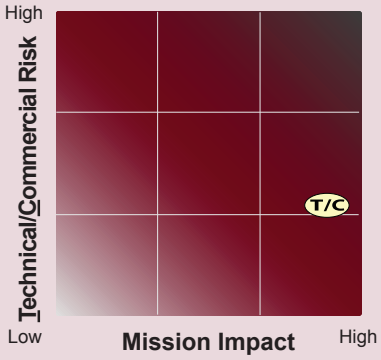
Internal and external evaluations of the resins, films, adhesives, pre-pregs, and polymer-ceramic coatings have been validated. The scope of this project is to scale-up production quantities of toughened epoxy pre-pregs for Goodrich and high-temperature polyimide pre-pregs and adhesives for Spirit for larger sample production by these next-stage developers for FAA qualification and certification. The goal is to have these materials qualified in time to take part of the upcoming large purchase orders for composite structures to be released by major aircraft OEMs.

Resource Limitations

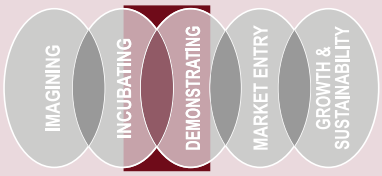
Renegade and Maverick, along with UDRI and project collaborators, have the necessary technical expertise to be successful in this project. Renegade and Maverick also have successful experience in developing new products for new market applications. Renegade forecasts it will need $4M for production equipment expansion to meet the forecasted sales in 2015 and beyond. Renegade expects to receive a $2M DOD SBIR award for plant expansion. Renegade has applied for and received local and Senate support for a $2M DOD Title III congressional grant to be used to increase Renegade's production capacity and ensure a reliable supply of composite materials for military programs. Maverick will ask for additional federal funding to support this project.

Technology Protection

Maverick owns the IP for the patented polyimide resins, has patents pending for the adhesive formulations and compounding, and will treat the polymer-ceramic hybrid resin as trade secret. Maverick has conducted exhaustive patent searches, and does not believe



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 1,000,000
WCF Request:	$ 0
TOTAL Request:	$ 1,000,000
Cost Share:	$ 1,000,000

Collaborators

- Maverick Corporation
- University of Dayton Research Institute (UDRI)
- Goodrich Corporation
- Spirit AeroSystems (Wichita, KS)

the polymer-ceramic IP is in violation of any current patents. Renegade's pre-preg machine design, manufacturing process, and resin formulations are proprietary and considered trade secrets. Renegade has been making pre-pregs, films, and adhesives for the last four years and has not been threatened with patent or trade secret infringements. Renegade has long-term agreements with UDRI for several patents concerning the manufacturing of the NAHF-X reinforcement materials.

Commercialization Risk

Overall Score = 3.53

Market Opportunity/Pull

Global commercial airline manufacturers such as Airbus, Boeing, GE, Pratt & Whitney, etc., are pulling the market to higher temperature-resistant, lightweight composite structural components. Global suppliers such as Aircelle, Goodrich, Spirit, BAE Composites, and others, are responding by demanding that their material suppliers, such as Renegade, provide materials that can withstand short duration temperature conditions up to 800°F. Goodrich and Spirit are actively involved in this project by producing the finished composite parts for evaluation and FAA certification. In 2018 the projected market potential for high temperature materials for composite structures in commercial aircraft applications will exceed $160M annually, and additional requirements for lower temperature composite materials for commercial aircraft will add another $100M annually.

Corporate Stability

Renegade is a small, privately owned, sister company to Maverick, founded in 2008 to manufacture high-temperature resins, pre-pregs, films, and adhesives for high temperature polymer composites, mainly for the aerospace industry. Renegade resides in a 25,000 square-foot manufacturing facility with 16 permanent, full-time employees. It is supported with revenues from product sales, R&D contracts, and grants.

Commercial Infrastructure

Renegade has invested over $7M to equip its 25,000 square-foot manufacturing facility in Springboro, Ohio with a 60-inch wide precision pre-preg machine and a small R&D lab. Sales and marketing efforts are conducted by the principal owners of Renegade, who have well-established contacts with next-stage developers and end-users.

Mission Impact

Overall Score = 8.92

Cluster Formation

Renegade purchases products from Maverick and raw materials from polymer, chemical, and carbon product suppliers in Ohio. Renegade also sells raw materials to Maverick Molding Company Inc. (Stow, Ohio) for its composite shape manufacturing facility. Renegade sells its products to other high performance composite shape manufacturers in Ohio as well as others outside of Ohio. Renegade wants to investigate the possibility of establishing a new, finished composite parts production facility in Ohio for sales to next- stage developers in Ohio as well as others outside of Ohio.

Ohio Economics

As a direct result of this project, Renegade and Maverick predict revenues of $6.8M in Year 3 (2014) and $33.5M in Year 5 (2016). They forecast 21 jobs will be created by the end of Year 3 (2014) and 98 cumulative new jobs by the end of Year 5 (2016).

Business Model

The current business model is for Renegade and Maverick to manufacture and sell the resins, adhesives, films, and pre-pregs in this proposal to next stage composite shape manufacturers such as Aircelle, Goodrich, and Spirit. At some point in the near future, Renegade and Maverick would like to establish a new production facility in Ohio to manufacture finished composite shapes as subcontractors to Aircelle, Goodrich, Spirit, and others, or even directly to end-user aircraft OEMs such as Airbus, Boeing, and others.

Prior Ohio Investments

- None

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2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

Iosil Energy Corporation

Commercialization of a New Manufacturing Process for the Production of Low-cost, High-purity Polysilicon for Solar Cells

TFAMP 11-703 Final Score: 86.1 Rank: 2

Previous Ohio Investment

Iosil Energy Corporation has not received prior funding from OTF.

Project Description

Iosil, a start-up company incorporated in 2007, was located in the National Institute for Nanotechnology in Edmonton, Alberta, because the founder was a local resident. It has since closed its operations in Edmonton and moved its R&D activities to Groveport, OH along with those members of its technical staff who decided to relocate. The company's headquarters are situated in Albuquerque, NM.

Iosil secured patent rights from the National Renewable Energy Laboratory (NREL) for an iodine-based process that potentially could significantly reduce the costs of refining metallurgical grade silicon and waste "kerf" silicon into a higher purity silicon that is suitable for silicon solar cells. This process is much more efficient and cost-effective than the chlorine-based process currently in use. The company has demonstrated the batch-wise feasibility of the iodine process at the laboratory level. Iosil has leased a facility in Groveport, Ohio to set-up a pilot-scale plant to produce solar grade silicon using the iodine process. The goal of this 1-year project is to accelerate the design, construction, and testing of the critical reactor. The skills of the Iosil staff will be augmented with those from EWI during this project to model the deposition process and to optimize the design of the iodine-based reactor. The pilot plant will be built using a Siemens chlorine-based deposition reactor whose operation is well understood, but the operation of the reactor will be optimized using the results of the 3D modeling for the iodine process, which will occur during this project. The pilot plant will produce solar grade silicon (7N or 99.99999% pure silicon) at a capacity of 50MT/year for 1–3 years. During this time the product will be sampled to customers and investors for purposes of end-use evaluation.

Construction of the first phase of a full-size plant (1,000 MT/year) will begin in 2012 at or near the current Groveport site. Physical modifications to the reactor that are based on the results of this project will be made to the reactor in the 1,000 MT facility and also in the second phase expansion by an additional 2,000MT which will require larger reactors.

Competition

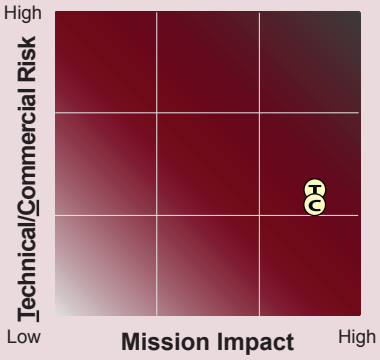
Hemlock Semiconductor Corporation, the world's largest producer of polycrystalline silicon, is building a $1.2B plant in Clarksville, TN that will be completed in 2012. There are more than 1,600 construction workers at the site. Hemlock is negotiating with TN officials on a package of incentives for an additional investment of $3B at the site that would raise the permanent employment to 1,400. Hemlock also has operations in MI and is investing more than $1B there to increase polysilicon capacity to 36,000 MT/year. Dow Corning is Hemlock's parent company.

Wacker-Chemie AG is investing $1.5 B to construct a 15,000 MT/year plant on a 550-acre site in Greenfield, in Bradley County, TN. This plant is expected to create 650 new jobs. The plant is expected to be operational in 2013. The availability of chlorine was a key factor in the selection of the TN site. In 2010, Wacker reported that because of long-term contracts, its entire polysilicon output through 2015 has been sold.

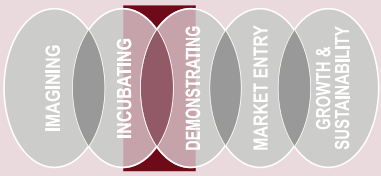
Other manufacturing sites include MEMC in Pasadena, TX and Merano, Italy with capacity being expanded to 12,500 MT/year by the end of 2011 and REC in Montana.

Key Issues

- Iosil is well financed and has a strong management team experienced in silicon production and product requirements.
- Solar grade polysilicon market pricing is approximately $50–70,000 per metric ton. Investment in the iodine process is expected to be approximately $20M per 1,000 MT/year of capacity. (The chlorine process requires an investment of $100M per 1,000 MT/year of capacity.) The iodine process uses 90% less energy than the chlorine process and operates at sub-atmospheric pressures rather than the several atmospheres of pressure required for the chlorine process.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	925,500
WCF Request:	$	0
TOTAL Request:	$	925,500
Cost Share:	$	943,639

Collaborators

- Edison Welding Institute (EWI)

- Iosil has made a commitment to construct a 3,000 MT/year facility in Ohio in two phases and has submitted a letter confirming this commitment. Since this commitment did not appear in the proposal, it should be integrated into the contract if an award is made.
- In 2010, iodine was produced by three companies operating in Oklahoma, with a fourth company initializing iodine production in Montana in March 2010. U.S. locations where kerf (the process feedstock) is generated include Portland, OR and Lexington, KY.

Technical Risk

Overall Score = 4.13

Technical Reach

The 3D computer simulation that will be developed using operational data from the pilot plant is critical to the success of this scale-up because it will allow optimal process parameters to be identified more economically than by empirical testing. The two major process risks are the control of the silicon deposition in the CVD reactor and the recapture and recycle of the iodine. Both the product quality and the cost of production will be determined by the operation of the CVD reactor. The modeling will also be used to design larger reactors with form factors that have been specifically optimized for the iodine process. These will be used in the full-size plant. This project will allow Iosil to incorporate external expertise from EWI and OSU at a critical point in the development and scale-up of the technology.

Resource Limitations

Iosil had previously raised $13.5M from investors, and it closed on $4.4M in new equity financing in May 2011 from many of these same investors. This funding is expected to be sufficient to construct and operate the pilot plant in Groveport, OH. Fundraising for the first phase of the full-size plant is planned for mid-2012 and will likely require an additional $20–30M. Current investors and new investors who wish to participate in this first tranche should allow Iosil to access the needed funding if the product from the pilot plant meets the cost and performance targets. Fundraising for the second phase of the full-scale facility is expected to require an additional $30–40M and is planned for late 2013 or early 2014.

Technology Protection

It appears that Iosil has a strong IP position as a result of the process patents it has licensed on an exclusive worldwide basis from NREL. The company has a robust IP strategy for expanding its patent coverage and works with a major legal firm in San Francisco, CA. There are current filings in process in the U.S., Canada, Europe, China, Japan, Malaysia, Singapore, and Russia. Patents of key industry players are being monitored to manage potential conflicts and preserve the freedom-to-operate.

Commercialization Risk

Overall Score = 3.60

Market Opportunity/Pull

The market for solar grade polysilicon was estimated at $8B worldwide in 2008. It is one of the fastest growing markets in the world with a history of 30% CAGR over the last several decades. However, the PV industry is facing strong cost pressures as subsidies are being reduced. The outlook for a process that will produce high purity solar grade polysilicon at a cost 70% below market is strong, and several of Iosil's investors are strategically positioned in the silicon PV industry. This appears to be the only process capable of cost-effectively converting kerf saw waste back into solar grade polysilicon.

Corporate Stability

Iosil has moved its R&D from Edmonton, Alberta to Groveport, OH and currently has 17 employees in Ohio including 4 who relocated from Canada. It has signed a 5-year lease on its Ohio pilot plant site. The company has sufficient funding in-hand to complete its pilot plant and to generate silicon for evaluation in solar cells. Success in this effort should ensure that the company would be able to raise additional investment ($60M in 2 tranches) from both current sources and new investors to fund its next stage of development, which is the construction of a full-size facility (3,000 MT/year).

Commercial Infrastructure

The number of global silicon solar cell producers is relatively small, so establishing a sales/marketing infrastructure for this market does not appear to be challenging. At present, Iosil is staffed as an R&D company that is about to transition into low-volume production. The company plans to sample potential customers with product from the pilot plant, and if the material produces good PV cells, these companies are expected to purchase the more economical high-grade polysilicon from the 1,000MT facility that should start to produce product in commercial quantities in late 2013 or early 2014.

Mission Impact

Overall Score = 8.5

Cluster Formation

Iosil has relocated to Ohio, moved key staff members from Canada, has signed a long-term lease, and has hired local employees. The company has committed to construct its pilot plant and first full-size plant (3,000 MT) in Ohio and is contracting with Ohio engineering, architectural, and construction firms. Testing and R&D work will be done by Ohio State and EWI. Because of the high value of the polysilcon product, lack of proximity to iodine and kerf production is not seen as a problem in siting this first facility. Proximity to technical expertise appears to be more critical.

Ohio Economics

Iosil projects that it will create annual revenue of $55M and $132M in 2014 and 2016, respectively as the first phase and later the second phase of the full-size plant come on-line. Manufacturing headcount is estimated at 127 and 475 in those same years. The revenue and employment projections appear credible based upon the selling price of solar grade silicon ($50-70,000/MT), worldwide demand, and typical headcount at a chemical manufacturing facility.

Business Model

Iosil experienced significant difficulties with its relocation from Canada and desires to build and maintain its technical team in Ohio as it moves toward full-scale production. It plans to start production of solar grade polysilicon in the first phase of its full-size facility (1,000 MT) by late 2013 or early 2014. Production in the second phase of the facility (2,000 MT) will begin in 2015. While additional plants may be required for growth in the future, the location of these plants will likely be determined by investment decisions or the location and availability of feedstocks.

Prior Ohio Investments

- None

Ohio | Department of Development

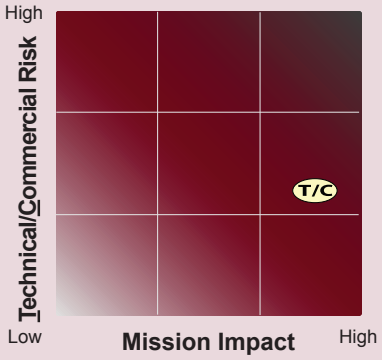
2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

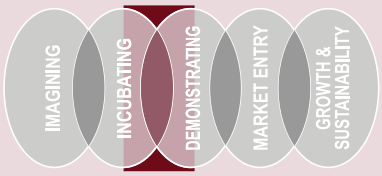
Third Millennium Metals, LLC

Parallel Commercialization of Copper Covetics

TFAMP 11-773 Final Score: 84.8 Rank: 3



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 1,000,000
WCF Request:	$ 0
TOTAL Request:	$ 1,000,000
Cost Share:	$ 1,363,740

Collaborators

- Ajax Tocco Magnethermic
- Youngstown State University
- IW High Performance Conductors, Inc. (Inman, SC)

Previous Ohio Investment

Third Millennium Metals LLC (TMM) has not received prior funding from OTF.

Project Description

After 12 years of development, TMM has created a new copper material that it calls copper covetic. This material has shown a 50% increase in tensile strength, a 50% increase in thermal conductivity, and a 70% increase in electrical conductivity and fuse current over pure copper. It is a copper alloy that contains a covalently bonded nano-carbon. The covalent compound does not separate when the alloy is remelted and the copper covetic material retains its properties during laser ablation and magnetron sputtering. This behavior has been validated in testing by national laboratories, the Navy, academics at the University of Illinois and the University of Maryland, and various industrial organizations.

In this project, TMM intends to scale-up the manufacturing process for copper covetic from its current 30-pound furnace at ATM to a newly installed 100-pound furnace in Dayton. The operating parameters of the manufacturing process will be correlated with the physical properties needed by the two industrial collaborators for their end-use applications. ATM intends to use the copper covetic material for coils and bus work in induction melting or heating systems as well as for cooling tubes and heat sinks. IWHPC will use the material for multi-strand high-performance conductors for military and aerospace applications. In this project, the raw materials will be characterized, the melting and mixing furnace requirements will be defined, and the cool down and bar rolling requirements will be investigated. Suitable testing methods will be developed to ensure product consistency and quality. The information gained regarding the covetic manufacturing process will be used to design a 1000-pound furnace so that TMM can supply covetic material in quantity to its licensees.

Key Issues

- Each end-user has a different set of properties that will be needed for its intended end-use applications. It is unclear how much processing latitude exists in the copper covetics manufacturing process and if it will be sufficient to meet these very different product requirements.
- TMM does not yet appear to have a good grasp of the value of its material in different end-use applications. Given the price of its raw materials, TMM should be able to match the price of various grades of pure copper. However, there may be an opportunity for value pricing in certain applications, and this has not been well articulated.
- Construction of the 1,000-pound furnace and full commercialization of the covetic material is expected to require $5M. TMM is going to need strategic investors to implement its growth plans, and the path to future investment is not clear at this point.

Technical Risk

Overall Score = 3.93

Technical Reach

Copper covetic has attained TRL 6 and MRL 4 in its work with the Navy. The performance of the material has been evaluated by numerous independent laboratories, and significant improvements in tensile strength, thermal conductivity, electrical conductivity, and corrosion resistance have been validated. Both ATM and IWHPC have evaluated the performance data for the material and judged it to be a significant improvement over the currently available copper alloys. Technical challenges remain in tailoring the properties of the product during the manufacturing process and ensuring its consistency.

Resource Limitations

The two collaborators in this project have strong positions in their existing markets and

bring access to key end-users and internal technical expertise. They have the ability to introduce a new material like copper covetic and to secure the necessary industry and government approvals for its use. The TMM team has sufficient experience to optimize the manufacturing process. However, TMM is constrained by its limited financial resources, and this may slow its ability to produce the final products and to tailor them for the number of end-uses it envisions.

Technology Protection

A very thorough prior art analysis was performed prior to initiating patent filing, and no significant impediments were identified. TMM began the patent application process in early 2009 with a composition of matter patent for copper covetics. Six additional applications have been filed for other metals. After an expedited review, TMM has been notified of final office action on its original filing and has been advised to expect the USPTO response by the end of 2011. During this project, TMM anticipates that it will file for additional coverage for specific end-use applications, but some inventions such as the inoculation process will be kept as trade secrets.

Commercialization Risk

Overall Score = 4.20

Market Opportunity/Pull

The size of the furnace market is $2B/year and the copper and aluminum portion of the aerospace conductor wire market is $60M/year. TMM is working with an industry leader in each of these areas in ATM and IWHPC. In addition, end-users such as GE Aviation, Goodrich Engine Control and Electrical Power Systems, and Boeing have expressed interest in the IWHPC products. A conductor size reduction of 10% due to the improved conductivity of covetic copper could reduce the weight of Boeing's new 787 platform by as much as 500 pounds saving $500,000/year per plane.

Corporate Stability

TMM is a start-up company that is funded by early investors, strategic partners, and research agreements. TMM has raised $900K in cash and over $2.75M in in-kind support contributions. TMM began to generate revenue in 2010 from product sales and grants including an R&D project for the International Copper Association and an STTR award from NavAir on aluminum covetics. Above this, ATM is currently supporting the company through a strategic alliance agreement costing over $1.5M, a portion of which serves as in-kind support and cost share for this program, in return for certain product rights. ATM is a wholly owned division of Park, Ohio Industries of Cleveland, OH and has the second largest market share of companies selling and repairing induction heating and melting equipment. ATM has annual sales of approximately $300M and three of its 18 facilities are located in Ohio employing more than 450 Ohio workers. IWHPC is a wholly owned division of International Wire Group of Camden, NY and is the largest high temperature/high performance conductor manufacturer in the world.

Commercial Infrastructure

TMM headquarters are located in Waverly, OH and project work will be done using both the laboratory and the 30-pound furnace located within the ATM facility in Warren, OH and the 100-pound furnace being installed at TMM's Dayton facility. Materials characterization laboratories are located at YSU and at IWHPC in Inman, SC. The sales and marketing infrastructure for end-use products containing copper covetics is already in place and will be provided by IWHPC and ATM.

Mission Impact

Overall Score = 8.50

Cluster Formation

Material characterization work for this project will involve YSU and specific equipment previously funded by the TFP. TMM has purchased time on an 850-ton extrusion press located within AFRF for initial extrusion of rods, tubes and bars of copper covetics. ATM will process the extruded tubes into coils at its Warren, OH or North Canton, OH facility. IWHPC will draw the extruded rods into wire at its Inman, SC or Trenton, GA facility. Numerous other Ohio manufacturers have expressed interest in the properties of the copper covetic material. TMM is contacting Ohio metals manufacturers to identify those who might be interested in obtaining manufacturing licenses.

Ohio Economics

TMM projects that it will create 19 jobs by Year 3 and 43 jobs by Year 5 after the start of this project. Revenue projections for the sale of covetic induction furnaces and covetic materials have been estimated at $11.4M in Year 3 and $38.8M in Year 5 for both TMM and ATM. These revenue figures do not include the improvement to ATM's current product line which would result from the use of covetic materials and would give the company an advantage over its competitors by creating a large retrofit opportunity. If ATM is able to achieve a 25% increase in efficiency in its induction systems through the use of more efficient coils, the company believes that could result in an annual increase in sales of $100–150M requiring the addition of 100–150 Ohio engineering and production workers.

Business Model

TMM plans to produce and sell covetic materials using the 100-pound furnace from this project. This will bring it to pilot production with the capability of producing 350,000 pounds of copper melt annually. TMM hopes to add an 850-ton extrusion press as soon as equity funds become available. TMM plans to serve as a toll converter for licensees who have licensed the rights to use covetics for specific end-uses, and will move to the 1,000-pound furnace that will be designed in this project. TMM also plans to sell custom-designed furnaces manufactured by ATM to inoculate the melt and infuse carbon exclusively to its subsidiaries during Years 6-10. The subsidiary companies will be required to purchase a manufacturing license and preference will be given to those who are willing to locate/relocate in Ohio. They will only be allowed to sell covetic material to those companies that have purchased end-use application licenses.

Prior Ohio Investments

- None

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

ChemImage Corporation

Manufacturing of Liquid Crystal Cells to Produce Multi-conjugate Filters for Use in Hyperspectral Imaging Sensors

TFAMP 11-714 Final Score: 82.9 Rank: 4

Previous Ohio Investment

ChemImage Corporation has not received prior funding from OTF.

Project Description

ChemImage produces a line of instrumentation for performing molecular chemical imaging (hyperspectral imaging). The key component in this instrumentation is ChemImage's multi-conjugate filter (MCF), a liquid crystal-based tunable optical filter. The goal of the proposed project is to refine the manufacturing process for both the liquid crystal (LC) cells used in the MCF as well as the MCF itself and to consolidate the MCF manufacturing into one facility in Ohio. Specifically, ChemImage will transition the current LC prototype production to a pre-production version. Cell production will be at the Liquid Crystal Institute (LCI) at Kent State University (KSU) and cell stack production will be at temporary facilities in Stow, OH. Full construction of the MCF will be done under clean room conditions at its current Pittsburgh facilities. By the end of the 18-month project, ChemImage will have consolidated its MCF manufacturing to a single Ohio facility, will have validated the product performance and ramped up to a production level of greater than 200 units per year.

Key Issues

- Successfully achieving the Ohio impacts projected relies on ChemImage's success in expanding sales of its current product line and introducing new products in the next 2 to 3 years. ChemImage's teaming agreements with established government contractors provide a path to reach those markets. The introduction into the medical markets presents a greater challenge.
- The opportunity in each of markets targeted, material analysis (forensic), threat detection and health care, is significant, and therefore, the competition is strong and active. ChemImage appears to have a unique approach using the LC-based MCF that provides key advantages for several segments of these targeted markets.

Technical Risk

Overall Score = 4.13

Technical Reach

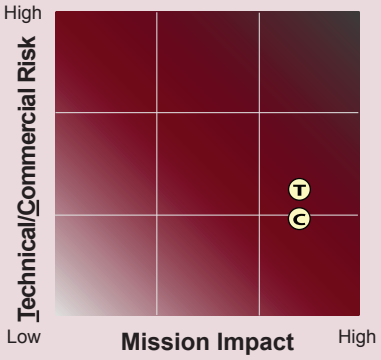
ChemImage uses a 6-step, Stage Gate process for its product developments and the LC-based MCF proposed has completed the first 3 steps leading to the initial phase of the TFAMP project—prototype refinement and demonstration. Each of ChemImage's current commercial products employs the MCF, but the current LC providers are not able to meet ChemImage's latest market requirements forcing the company to make the business decision to take production of this key component in-house.

Resource Limitations

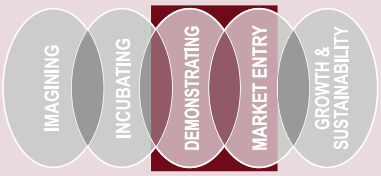
The project funding will support the efforts at LCI (LC "front-end" manufacturing) and the construction of the temporary cell "back-end" manufacturing facility. ChemImage will support the construction of the consolidated manufacturing facility and the continuing commercialization activities. The combination of LC expertise at LCI and ChemImage's ability to integrate the new MCF into its existing product line constitute a strong technical and commercialization team.

Technology Protection

ChemImage has over 50 patents that protect its threat detection systems and methods and 16 patents protecting filter technology. Three patents specifically cover the LC-based MCF and five provisional patents have been filed. A preliminary freedom-to-operate search has not uncovered any conflicts that will require resolution.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	999,877
WCF Request:	$	0
TOTAL Request:	$	999,877
Cost Share:	$	1,135,811

Collaborators

- Kent State University

Commercialization Risk

Overall Score = 3.13

Market Opportunity/Pull

Hyperspectral imaging (HSI) instrumentation serves several large markets including material research, defense, forensics, food safety and health care. The opportunity for HSIs for standoff detection of explosive threats alone results in a market potential of over $200M for MCFs. Direct competition using LC-based filters exists, but none meets the requirements specified by ChemImage's customers. Competition from other commercial and developing imaging modalities also exists, but ChemImage's HSI products offer advantages for applications in several of markets mentioned. Both DOD and the Department of Homeland Security have supported the technology development, and ChemImage has partnership agreements in place with several major federal agency contractors.

Corporate Stability

ChemImage has been in business since 1994, employs about 75, and has had increasing revenues for the last 3 years. It is cash flow positive, and revenues will approach $20M in 2011. It has a line of commercial HSI instrumentation and an established customer base. It also has an independent subsidiary that provides materials characterization services.

Commercial Infrastructure

ChemImage has a sales and marketing team that directly sells its products into the forensic, pharmaceutical and threat detection markets. It also has teaming agreements in place with General Dynamics, Raytheon and Smiths Detection that provide access to government markets. It has established distribution channels in China, Europe and South America.

Mission Impact

Overall Score = 8.00

Cluster Formation

ChemImage is moving its MCF production to Ohio to take advantage of the LC cell expertise, facilities and analytical equipment at the LCI, the LC companies clustered around KSU and the general manufacturing expertise in NE Ohio. It will source components from Ohio suppliers when possible.

Ohio Economics

The Ohio impacts in the near-term will come from the MCFs produced at the consolidated manufacturing facility. MCF revenue projections are based on the projected sales of ChemImage's instruments that incorporate the MCF. In Year 3 after the project start, ChemImage estimates from $7M to $14M in MCF sales, and in Year 5 this will grow to between $15M and $30M. Job projections in for Year 3 and Year 5 are 9 and 20, respectively. These jobs are in addition to the management team that has already set-up operations in Stow, OH.

Business Model

ChemImage will follow its current model that provides direct HSI instrumentation sales, sales through distributors and licensing to system integrators such as General Dynamics. ChemImage Corporation will continue to be based in Pittsburgh, PA, conducting its HSI R&D, sales and licensing there. It also provides contracting services through its Gateway Analytical subsidiary (Gibsonia, PA). MCF manufacturing will be entirely moved to its new Ohio facility (ChemImage Imaging Technology).

Prior Ohio Investments

- None

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

NuVention Solutions, Inc.

Accelerating the Commercialization of a Novel Bio Resource Resin (BR^2) for Agricultural, Construction, and Industrial Applications

TFAMP 11-722 Final Score: 82.3 Rank: 5

Previous Ohio Investment

NuVention Solutions, Inc. (NVS) has not received prior funding from OTF.

Project Description

NVS and its collaborators propose accelerating the commercialization of a bio-based resin (Bio-Resource Resin or BR^2) for a variety of applications including asphalt replacement and seed coatings. The raw material for BR^2 is swine manure, a renewable, biodegradable, nutrient-bearing waste. In the TFAMP project, funding is requested to supplement the operation of a demonstration facility to produce the bio-oil from the waste feedstock that is further refined into the BR^2 and to develop additional applications with Ohio-based companies. Specifically, the applicability of BR^2 for roofing products, crack filler and fertilizer coatings will be pursued. Project tasks include optimization of the bio-oil reactor, establishing the BR^2 formulations for the specific applications and end-user qualification testing.

NVS has already produced a BR^2 –based pavement binder for asphalt road construction and has received a commitment from the Ohio Department of Transportation to evaluate this product on a 20-mile strip of highway to be laid in October 2011. To produce the material, NVS purchased its first commercial bio-oil reactor and is installing it in Jeromesville, OH. Only about 10% of the reactor output is needed for the highway project, leaving 90% available for the products to be developed and tested in the TFAMP project.

Key Issues

- The testing to date of BR^2 as an asphalt filler, for fertilizer dust control and for agricultural coating has validated its performance, but several technical challenges remain related to specific application formulations, odor remediation, waste water management and optimized BR^2/asphalt blending levels. Each of these issues is being addressed in the proposed project, but failure to resolve any of these will reduce market potential to some extent.
- The collaborating end-users have indicated a strong and serious interest in applying the BR^2 product to specific applications. Some of these applications are likely to require extended validation testing before commercial adoption is achieved.
- The project collaborators represent a strong team that includes Ohio technical, material and industry resources that will all benefit from successful product commercialization.

Technical Risk

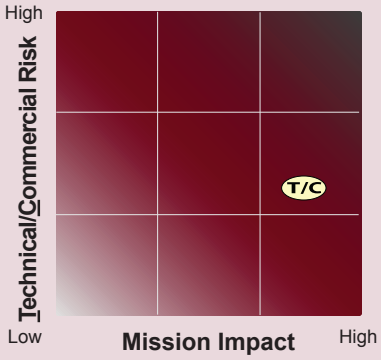
Overall Score = 4.33

Technical Reach

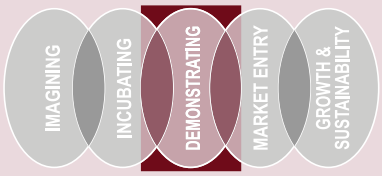
The swine manure to bio-oil reactor (SMB) and the BR^2 conversion process both have been demonstrated by the SMB producer located in Missouri. In a road pavement test there, the BR^2 product has outperformed the control pavement for over 1 year. The first Ohio unit (a 3rd generation design) is being installed this summer and will produce product for an Ohio pavement test and for the product demonstrations proposed in this project. Proof-of-concept formulations for roofing mastic, agricultural dust control, and anti-abrasion coatings have been developed, and initial testing has been completed.

Resource Limitations

The NuVention team includes Innoventor (the SMB developer), Momentum Technologies (the BR^2 developer), agricultural experts from OSU, OARDC and OBIC and committed end-users. Nearly $5M in financial commitments has been obtained to date. A plan for the additional cash flow and capital needed for sustaining NuVention through product commercialization has been developed. The end-users involved in the project have committed to product purchases upon successful demonstrations.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 998,354
WCF Request:	$ 0
TOTAL Request:	$ 998,354
Cost Share:	$ 1,357,703

Collaborators

- The Ohio State University (OSU)
- Owens Corning
- The Garland Company
- Ohio BioProducts Innovation Center
- Momentum Technologies, Inc.
- Kokosing Materials, Inc.
- Turf Care Supply Company
- Ohio Agricultural Research and Development Center (OARDC)
- Royal Chemical Company
- JumpStart
- Ohio Soybean Council
- Innoventor, Inc. (St. Louis, MO)

Technology Protection

Patents controlled by Innoventor cover the SMB technology, and Momentum has patents on the BR^2 technology. NVS has obtained exclusive rights to the BR^2 end-use applications from Momentum Technologies. It also has an exclusive market and production agreement for SMB technology and exclusive options from OSU and North Carolina A&T for future IP related to BR^2 formulations and production. The BR^2 process is not limited to the SMB reactor technology if other bio-oil reactors become available.

Commercialization Risk

Overall Score = 4.07

Market Opportunity/Pull

There is a growing shortage of petroleum-based asphalt and the cost is increasing as oil prices increase. The market for agricultural coatings is about 5M tons/year. Asphalt applications (pavement binders, roofing material and crack fillers) represent a market of about 27M tons/year. Current agricultural coatings are about $1000/ton and liquid asphalt sells for about $500/ton. Collaborators Turf Care, Kokosing, Owens Corning and Garland all indicate serious interest in the purchasing the BR^2 product.

Corporate Stability

NVS is a new company spun-off from Momentum Technologies. Its majority owner is the General Manager of Momentum. It is located in the Sherwin Williams Technology Incubator in Valley View, OH. It indicates it has raised and will continue to raise sufficient capital to support operations until it is self-sufficient from product sales. Investors have indicated over $2M is available contingent upon the installation of the first production unit (ongoing) and the OTFAMP award. Revenues will begin in 2011 and NuVention projects profitability by 2013.

Commercial Infrastructure

The first commercial BR^2 processing unit is expected to be in operation in mid-summer 2011. This unit will produce sufficient product for end-user evaluation/validation. Feedstock for this unit has been acquired, and OBIC is working with Ohio farmers to build a network of feedstock providers. An Ohio feedstock collection network is being established. NVS will market and sell the BR^2 from production units strategically located in Ohio. The project collaborators are the potential first customers for the product, and their supply requirements will support the output from multiple BR^2 units.

Mission Impact

Overall Score = 8.17

Cluster Formation

The project team includes many Ohio organizations, companies and individuals involved in the Ohio agricultural and polymer clusters. Its collaborators include Ohio-based end–users such as Owens Corning, Garland and Turf Care. NVS is a spin-off of Momentum Technologies, an Ohio-based specialty polymer distributor and services company that was founded in 1996 and has over $50M in annual sales. NVS is locating its business in Ohio. Ohio is a leading pork-producing state and thus has a significant supply of BR^2 feedstock.

Ohio Economics

NVS's Ohio impact projections are based on the installation of 7 Ohio processing units by Year 3 (from the project start) and 30 by Year 5. Revenue projections for NVS are $7M in Year 3 and $27M in Year 5. NVS job creation for these years are projected to be 24 and 29, respectively. Over 50 additional jobs outside of NVS will be created by Year 5 from this project. These jobs will be directly related to product refinement, distribution and end-use applications in Ohio.

Business Model

NVS will own and operate the production units, and market the product to the targeted end-users. It will also negotiate the feedstock supply with Ohio farmers. Discussions with Kokosing and other companies with trucking and asphalt terminaling resources needed for feedstock collection are underway. Output product will be provided to Royal Chemical for further processing for fertilizer applications, to the collaborating companies interested in asphalt filler applications, as well as to other end-use customers.

Prior Ohio Investments

- None

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

Momentive Performance Materials, Inc.

Advanced Thermal Pyrolitic Graphite (TPG) Thermal Management Composite

TFAMP 11-724 Final Score: 81.3 Rank: 6

Previous Ohio Investment

In 2010 Momentive Performance Materials Quartz, Inc. (MPM) was awarded OTF grant 10-081 for production of boron nitride powders in LED-housing applications. To date, MPM is performing satisfactorily on this grant. In support of this grant, the parent organization, Momentive, has invested over $10M in upgrades to the Ohio facilities in Strongsville and Hebron.

Project Description

MPM intends to develop a composite material for advanced thermal management systems for a variety of electronics industries, including defense, aerospace, and telecommunications. In these industries, power requirements are increasing and size is decreasing, putting a premium on removal of heat that limits performance and decreases lifetime. Current solutions to heat management problems involve materials with low thermal conductivities or materials with high thermal conductivities that have coefficients of thermal expansion (CTE's) that are mismatched to other system components. MPM's solution is to bond thermal pyrolytic graphite (TPG) to materials that have CTE's matched to the electronic components mounted on them. The TPG forms the center of a layered structure with the outer layers typically made of alloys of copper or aluminum. The CTE's of these alloys can be adjusted to provide the best match to the electronic components mounted on them. These alloys are not good thermal conductors, but the TPG is an excellent thermal conductor, so the combination provides both high thermal conductivity and good CTE matching.

CWRU will advise on producing high-throughput TPG synthesis. EWI will advise on bonding techniques between the TPG and the encapsulation alloys. The other collaborators are all end-users who will be providing specs and performing testing on the end products.

Key Issues

- There are two key technical issues. First, the cost of making TPG needs to be lowered. It is currently made with a Chemical Vapor Deposition (CVD) technique followed by a heat treatment. To lower the manufacturing cost, MPM is working with Case Western Reserve on three different approaches.
- The second key technical issue is assuring a strong bond between the outer layers of CTE-matched alloys and the high thermal conductivity TPG at the center of the composite. To achieve this bonding, MPM will work with EWI on two approaches, both of which are areas in which EWI has expertise.

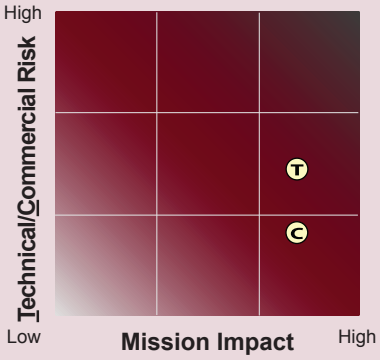
Technical Risk

Overall Score = 4.80

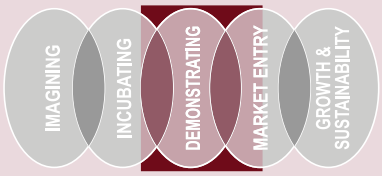
Technical Reach

The technology to be developed is a platform technology, with potential uses in a wide variety of products. In this proposal, MPM is focused on five specific thermal management products. Each of these products will be developed in consultation with five different customers, all of which are end-user collaborators in the program. Each of these five collaborators will provide product specifications and product testing of samples delivered to them by MPM and will contribute this testing as cost share to the program. MPM intends to introduce all these products within the two-year time frame of the program. The products are intended both for the military and civilian markets. In addition, MPM has identified five additional market opportunities and products and these will be introduced within five years. MPM also expects that the bonding techniques for dissimilar materials developed in conjunction with EWI will have uses outside of MPM's target markets and thus will present licensing opportunities.

To lower the manufacturing cost, MPM is working with Case Western Reserve on



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 1,000,000
WCF Request:	$ 0
TOTAL Request:	$ 1,000,000
Cost Share:	$ 1,082,797

Collaborators

- Case Western Reserve University
- Raytheon Integrated Defense Systems (Sudbury, MA)
- CAP Wireless (Newbury Park, CA)
- Coherent Semiconductor Business Unit (Santa Clara, CA)
- Solid UV Inc. (Clifton Park, NY)
- Torrey Hills Technologies (San Diego, CA)

three different approaches. One involves improvements to the current production methods. The other two involve approaches that have shown success when used to synthesize other materials. Success with any one of these three approaches will lower costs by 50–70%. Even with this lower cost, the materials will be suitable only for the high-end markets. While these markets are substantial, the new materials will still be too expensive to be used in the commodity market.

Resource Limitations

MPM is a subsidiary of Momentive, a company headquartered in Columbus with $7.4B in annual revenues and 10,000 global employees. MPM competes internally for development funds, and OTF funding would leverage these funds. Momentive has given a guarantee of providing cost share funds if the project is approved. The research and commercial teams at MPM appear to be strong and capable of being successful both technically and commercially. Both EWI and CWRU have the resources and experience necessary to make this project a success. Substantial investments in equipment at MPM will be required by 2016 to achieve the revenue and job goals. This investment will be made by the parent company, Momentive.

Technology Protection

MPM has five issued patents, with an additional three patents pending and one recently filed patent application that are relevant to the project. The recently filed application applies specifically to the technology in this proposal, and one of the issued patents protects the specific form of high thermal conductivity TPG required for this technology. There is additional trade secret IP involved in the bonding technology. MPM has established the freedom-to-operate.

Commercialization Risk

Overall Score = 2.67

Market Opportunity/Pull

Thermal management is a well-known problem for high-performance electronics and is a rapidly growing multi-billion dollar market worldwide. The high performance segment of the market targeted by this proposal is $200M as supported by market research from Infogroup ORC and Prismark and is expected to grow substantially over the next few years. There is no competing material on the market that provides the combination of properties that are found in the materials that will be manufactured in this program. Market pull is demonstrated by the involvement, as end-users, of the five collaborators who are willing to provide specification requirements and testing for MPM's products.

Corporate Stability

MPM is part of a larger family of companies, and revenues are reported for this family of companies rather than for the individual components. For the family, adjusted revenues were $377M in 2008, dropping to $284M in 2009, and rebounding to $524M in 2010. MPM guarantees that it is capable of providing all cost-share in the unusual case that its collaborators could not and commits adequate resources to ensure the development and commercialization of this project.

Commercial Infrastructure

The Quartz and Ceramics Division of MPM is headquartered in Strongsville, OH. It has four manufacturing sites in Willoughby, Newark (Hebron), Richmond Heights, and Strongsville, all in Ohio, along with two technical centers. This division has 565 employees in Ohio and 788 global employees. The division uses multiple Ohio suppliers.

Mission Impact

Overall Score = 7.92

Cluster Formation

The proposal leverages the talents and expertise of both EWI and CWRU and builds on the use of carbon-based technologies in Ohio. It is estimated that 90% of MPM's suppliers are Ohio-based.

Ohio Economics

The proposal puts forth a credible plan to produce $4M in revenue and 14 jobs after three years and $10M in revenue and 35 jobs after five years. The average salary of the jobs created is estimated to be $70,000.

Business Model

MPM plans to use its existing facilities in Ohio for manufacturing and to use its existing sales and marketing personnel to market the products. It will continue to develop additional products at its technical centers based on product specifications provided by end-users.

Prior Ohio Investments

- "Optimized Boron Nitride and Production Efficiency for Lower Cost Polymer Composites in LED Luminaires", 2010 OTFAMP, $918,000

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

MetaMateria Technologies LLC

Water Purification Using Nano-enabled Solutions

TFAMP 11-737 Final Score: 70.6 Rank: 7

Previous Ohio Investment

The current corporate entity, MetaMateria Technology (MMT), has not received prior OTF funding. The prior organization, MetaMateria Partners, was originally located in Columbus, OH but was purchased in 2004 by NanoDynamics, Inc., a company located in Buffalo, NY. NanoDynamcis declared bankruptcy in 2009, and the former owner of MetaMateria Partners purchased the assets of the company (including the IP) and moved it back to Columbus. MetaMateria Partners has received the following three OTF grants:

- 2004 TFFCP $968K "Cost Effective Materials and Components for SOFC" for adaptation of gel casting technology to make SOFC tubes and gas distribution manifolds.
- 2005 TFFCP $385K "Nanostructured Cathode for High Performance Fuel Cell" for development of a nano-structured cathode-supported SOFC using its nanoparticulate coatings and room-temperature densification technologies.
- 2007 ORCGP 07-024 $350K "Commercialization of a Novel Forming Method for Making Porous Ceramic Parts" for producing short to medium production runs of complex ceramic parts using water-based colloidal processing techniques.

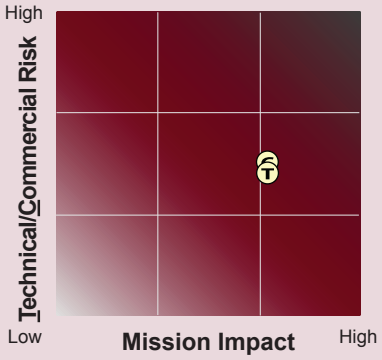
From these three awards, the ODOD DB indicates that MetaMateria Partners created 42 jobs and obtained $8.7M in leverage. Elements of the core technologies developed under the prior OTF programs form the basis of the technology and products in this proposal.

Project Description

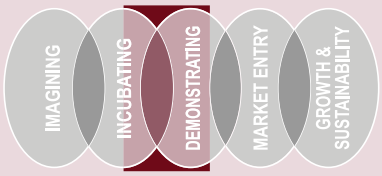
MMT has developed a wastewater treatment media for the chemical and bioremediation of contaminated water. Sold under the name "Cell-Pore™", the media consists of non-fired ceramic granules or monoliths with a high percentage, internal, interconnected porosity that house nanomaterials, organics, or beneficial bacteria. The specially prepared media capture pollutants such as nitrates, phosphates, residual organics, trace metals, and hydrophobic organics (oils and hydrocarbons) from water with high flow rates and can be regenerated. The media can also kill pathogens such as fecal coliforms, etc. During the course of this 2-year project MMT will provide samples to the commercial collaborators for 3 market applications. Streamside Environmental will field evaluate MetaMateria media for use in phosphate removal in sediments and silt removal systems at Grand Lake St. Mary's. PRD Tech will field evaluate MetaMateria media for removing ammonia and treatment of odors and volatile organic compounds (VOCs) in its biofilm treatment / biotrickling filter system (DEBIE) for treatment of municipal and industrial wastewater. Consolidated Treatment Systems will field evaluate MetaMateria media for nitrogen, phosphorous, and pathogen removal in its on-site waste treatment systems (OWTS) as a replacement for septic systems. Wright State University will analyze and characterize samples from these field evaluations to help understand how the microstructure and chemistry affect product performance and life.

Key Issues

- MMT appears to have unique materials fabrication expertise, much of which is protected as a trade secret. This may enable MMT to protect its technology and market position from reverse engineering and intrusion by larger corporations.
- This manufacturing process is not capital intensive. Funding for a larger production facility is expected to require $1–2M and remains to be secured. Positive results from field trials should enable the company to move forward with its expansion plans.
- MMT has selected collaborators that have the capability of incorporating MMT's media into their treatment systems. The robustness of these systems and current level of sales is not entirely clear.
- If the technology proves successful, MMT could potentially become an acquisition candidate. However, the location of the technical staff in Ohio and the existence of a claw-back provision in the State's contract would reduce the risk of the company relocating outside of Ohio.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	999,998
WCF Request:	$	0
TOTAL Request:	$	999,998
Cost Share:	$	1,000,295

Collaborators

- Streamside Environmental LLC
- PRD Tech, Inc.
- Consolidated Treatment Systems
- Wright State University

Technical Risk

Overall Score = 4.67

Technical Reach

The unique technology developed by the MMT staff consists of a geopolymer-based porous ceramic media and the processes for modifying the ceramic with nanomaterials and organics to enhance its performance. MMT has performed internal evaluations of media performance and submitted samples for external third-party evaluations. Based on these positive results, MMT wants to produce larger quantities of specific media for each of its three collaborators so they can evaluate product performance under end-user conditions. By the end of the project, MMT plans to have three media products ready for the market including an antibacterial filter, a nitrogen biofilter, and phosphorous absorption bed.

Resource Limitations

The current MMT staff developed the base technology while at MetaMateria Partners/ NanopDynamics, and continued product development after the bankruptcy acquisition. MMT appears to have excellent technical capabilities for producing its various media products. MMT's collaborators are well-established next-stage developers and end-users that provide a solid path to limited market niches. If the field evaluations are positive, the results are expected to create new funding opportunities for the company. MMT management also plans to apply for federal funding to gain additional visibility.

Technology Protection

MMT filed a provisional patent for its nitrate removal media in 2010 and that is now being converted to a patent application that will be filed in July 2011. The applicant believes the potential patent is unique and will result in a significant improvement in nitrate removal from wastewater, stormwater and agricultural runoff. Another provisional patent for the phosphate media will be filed in the summer of 2011. The patents will cover both composition of matter and the physical form of the media. MMT is not aware of any issue that would preclude it from conducting business in environmental products. Much of the intellectual property includes the manufacturing process and the product application know-how and is considered trade secret.

Commercialization Risk

Overall Score = 5.00

Market Opportunity/Pull

The potential market for water purification and remediation is huge, varied, and global. For just one sub-market, the USEPA has set a technology-based upper limit of 0.1 ppm (mg/L) for phosphate and estimates that it will cost approximately $44.5B to remove phosphorus from municipally treated wastewater using conventional technology. One of the collaborators estimates that there are more than 40M on-site waste treatment systems (OWTS) in the U.S., and that his niche is 300,000 systems in 6–8 key states with annual media requirements of $40M. New USEPA regulations pertaining to stormwater run-off, large animal farms, and municipal wastewater are expected to further increase the demand for remediation systems and media. MMT is already in discussions with major firms regarding licensing overseas production for specific applications and obtaining media in ton quantities for field trials.

Corporate Stability

MMT is a privately owned small business formed in 2009 after purchasing the assets of MetaMateria Partners from a New York Bankruptcy Court. It is located at a leased 6,000 SF facility in the TechColumbus Incubator in Columbus, OH that houses its offices and pilot manufacturing. Current staff consists of 5 professionals (3 with PhD) and 3 technical support staff with associate degrees.

Commercial Infrastructure

MMT will develop a plan for a commercial manufacturing facility by the end of Year 2. This new manufacturing facility will be a subsidiary organization and will be built once the sales reach a level that will support a stand-alone operation. MMT intends to sell media to end-users and to manufacturers of small treatment systems. Since market applications for this media will extend beyond Ohio and the U.S., MMT will actively seek strategically positioned commercialization partners. MMT plans to add a commercialization manager within the first year to manage an interface with current and future commercialization partners.

Mission Impact

Overall Score = 6.92

Cluster Formation

MMT is working with 3 Ohio companies that will incorporate the MMT media into their small treatment systems and will evaluate its performance in field trials relative to existing products. Performance measurements will be made by Wright State University. Local labor and supplies will be utilized in the field demonstrations that will be conducted in Ohio.

Ohio Economics

MMT predicts annual sales of media of $1.6M in Year 3 and $7.7M in Year 5 and cumulative new job creation of 18 by Year 3 and 53 by Year 5. Additional job and revenue creation is likely to occur at the three Ohio collaborators that are planning to use the MetaMateria media in their remediation systems. While specific projections for these collaborator impacts were not provided, companies in this industry have reported growth from $5M to $100M within 10 years.

Business Model

MMT plans to enter the market primarily through commercialization partners already serving the target markets. MMT will set-up a subsidiary production company, "MetaH2O," that will be located in central Ohio to manufacture and market the proposed media. The company presently has access to 10,000 SF with an option for an additional 10,000 SF for expansion. The media will be sold to both end-users and to manufacturers of treatment systems who will incorporate it into their products. Revenues will come from product sales through MetaH2O, licensing fees, or joint ventures.

Prior Ohio Investments

- None

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

Angstron Materials

Graphene-based Nano-materials for the Next Generation Thermal Management and EMI Shielding Solutions

TFAMP 11-760 Final Score: 65.1 Rank: 8

Previous Ohio Investment

In October 2007, Angstron Materials, the manufacturing spin-off "sister company" of Nanotek Instruments, received $10,000 from the Entrepreneur Signature Program (ESP) to pay for an independent market study on nano graphene platelets (NGPs). In 2009, Nanotek Instruments received an Ohio Research Grant (ORCGP) of $349,500 to purchase the equipment necessary to produce lithium-ion (Li-ion) anode materials by 2012. The project was also intended to support the construction of a pilot-scale anode and battery manufacturing facility in Dayton. Nanotek leveraged the ORCGP funds to obtain additional $1.5M in federal grants supporting anode material and battery development and has set up a complete pilot-scale production line for making prototype Li-ion batteries in the form of button cells, pouch cells and prismatic cells. In June 2011, Nanotek was awarded $999,996 for TFAEP 11-303 "Nano Graphene-enabled Supercapacitors for Electric Vehicles, Renewable Energy, and Modern Grid Technology Applications" for Angstron to build a pilot-scale production line for supercapacitor-grade NGPs. Nanotek reports that it created 8 jobs and retained 5, and Angstron indicates that it made <$200K in annual product sales.

Project Description

In this 2-year project, Angstron will continue development of the NGP manufacturing process, and the functionalization and dispersion of NGPs for use in EMI shielding and thermal management applications. Collaborator Nanotek provides the IP for making the NGPs. Collaborator Buckeye Composites will use the functionalized NGPs to make buckypaper for EMI shielding applications. Collaborator Case Western Reserve University will evaluate the thermal conductivity properties of the lab-produced samples. Functionalized NGPs will be produced for next-stage developers to make and evaluate products in the field for the EMI shielding and thermal management markets.

Key Issues

- Nanotek/Angstron have received many years of federal and state funding, yet have not been able to fully transition from an R&D house to a production and sales operation.
- While Angstron and Buckeye Composites have excellent technical capabilities in the production of NGPs and related products, they are limited in their knowledge of the EMI shielding and thermal management market requirements, competition, and realistic opportunities. Angstron will rely upon strategic partners and other next-stage developers to commercialize NGPs in the EMI shielding and thermal management markets.
- Nanotek/Angstron has received OTF funding for another project that appears to have a higher priority and a higher market potential for NGP products.

Technical Risk

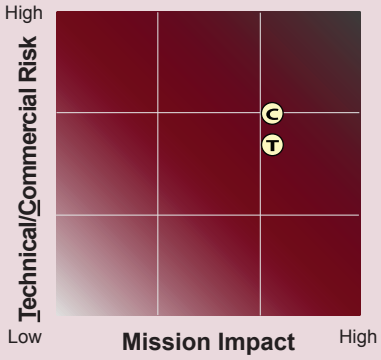
Overall Score = 5.60

Technical Reach

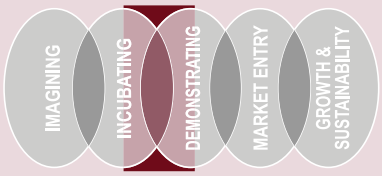
The NGP production scale-up by Angstron is covered by funds from other projects. Angstron plans to use funds from this project to continue development on functionalization and dispersion agents for EMI shielding and thermal management applications, and developing sales and marketing channels for EMI shielding and thermal management products.

Resource Limitations

Nanotek is an established R&D company and a recognized leader in graphene technology, and sister manufacturing company, Angstron, is the leading producer of NGP materials. In addition to past OTF funding ($1.36M+), Angstron has $4.4M in on-going development and commercialization grants. For cost share on this proposal, Angstron expects to receive at least $1M in federal grants within 1.5 years of project beginning, and a NSF STTR Phase II grant. In addition, Angstron is waiting to hear if it won a DOE Vehicle Technology grant of



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	993,452
WCF Request:	$	0
TOTAL Request:	$	993,452
Cost Share:	$	996,661

Collaborators

- Buckeye Composites
- Nanotek Instruments
- Case Western Reserve University

$4M. Angstron has signed a letter of intent with an out-of-state company (Graphene Energy Inc., Austin, TX) to merge and build a supercapacitor manufacturing facility, most likely in Ohio. Commercializer, Buckeye Composites, will need $2.5M from investors and/or other funding to scale up to production levels in 9 to 12 months after the need for production quantities is realized.

Technology Protection

Two key members from Nanotek, Dr Zhamu and Dr Jang, are among the first to discover and develop NGPs and NGP nanocomposites in the world. All the IP involved in this project is fully owned by Nanotek, and licensed to Angstron. Nanotek has filed 50+ patents on NGPs, and has 10 issued patents related to graphenes for this project. According to Angstron, there is no single existing patent portfolio which controls composition of matter for carbon nanomembrane or paper fabricated exclusively from nanoscale materials. While there are issued patents to create paper-like material utilizing carbon nanotubes/nanofibers, none of these patents detail a continuously produced, free-standing mat consisting of 100% nanomaterial without macro-scale fibers or binders. Buckeye Composites will pursue an application approach to patents instead of focusing on buckypaper processing.

Commercialization Risk

Overall Score = 6.60

Market Opportunity/Pull

While there appears to be a significant market for EMI shielding products and thermal management products, few end-users or next stage developers are significantly involved in this project. Angstron intends to rely upon collaborators, strategic partners and nex- stage developers for commercializing the NGP products to these markets. The EMI shielding market appears to be an approximately $700 million market potential. The applicant will rely upon collaborator Buckeye Composites to make and sell NGC products for EMI applications. Buckeye Composites' market knowledge is limited to the information from end-user customers that approach Buckeye Composites. Buckeye will utilize its existing contacts at Raytheon Missile Systems, Boeing, USAF, and General Cable to evaluate EMI shielding products. Angstron eventually intends to approach the commercial EMI shielding market through next-stage developers such as Tyco, Hitachi, and National Cable. The thermal management products market is approximately $10 billion per year, with a submarket of thermal interface materials at approximately $2 billion per year. For thermal management markets, Angstron is aware of potential opportunities, and will contact a few potential next-stage developers during the course of the project.

Corporate Stability

Nanotek is a privately owned company that has been in business for over 13 years as an R&D organization successfully procuring federal grants to remain income positive. In the last few years it has attracted early investor support and has spun-off Angstron Materials to produce NGP materials. Angstron provides a royalty revenue stream back to Nanotek, but although Angstron is the leading producer of NGP materials, its sales to date are generally for evaluation and demonstration purposes.

Commercial Infrastructure

Angstron will develop the manufacturing and marketing infrastructures during the project. By the end of 2013, Angstron will scale up its 22,000 square foot manufacturing capacity for initial production quantities, and will significantly increase production capacity again by 2016 for all NGP market applications. Nanotek/Angstron will develop a network of industry partners and distribution channels with the intent to sell NGP materials to manufacturers that will provide the commercial infrastructure for the end-product sales. Sales to the EMI shielding market will be through collaborator Buckeye Composites. Buckeye will use NGPs in the production of "buckypaper" and sell to existing customers. Buckeye Composites, located in the National Composite Center, has enough current capacity to handle immediate needs. Once a larger scale opportunity emerges, Buckeye Composites can setup a higher capacity, wide web manufacturing facility in 9 to 12 months with an additional investment of $2.5M. For the heat spreader and thermal interface materials markets, Angstron plans to work with thermal management solution providers or thermal management hardware manufacturers to either co-develop the products or secure investments from these strategic partners.

Mission Impact

Overall Score = 7.08

Cluster Formation

The production of nanographene platelets involves a variety of starting materials, chemicals, and industrial gases, which are all available from Ohio-based companies. There are also many next-stage developers, such as collaborator Buckeye Composites and others, that blend the NGPs with chemicals and polymers (also available from Ohio-based companies) for EMI shielding and thermal management companies in Ohio and around the world.

Ohio Economics

Angstron projects sales revenues of approximately $3 million into the EMI shielding and thermal management market in 2014. Angstron also predicts sales of approximately $22.5 million for these two markets in 2016. Angstrom projects approximately 15 new jobs by 2014, and approximately 90 cumulative new jobs by 2016. Angstrom projects even larger sales revenues and job creation in these two years by collaborators, strategic partners and next-stage developers.

Business Model

Angstron will develop, manufacture and functionalize nanographene platelets (NGPs) in its Dayton area facility for use in all application markets, and sell or deliver the NGPs to EMI shielding and thermal management next-stage developers or strategic partners for incorporation into products for the ultimate end-users.

Prior Ohio Investments

- "Commercialization of Nano Graphene Composite Electrodes for Lithium Ion Batteries", 2009 ORCGP, $349,500 (Nanotek)
- "Nano Graphene-enabled Supercapacitors for Electric Vehicle, Renewable Energy, and Modern Grid Technology Applications", 2011 TFAEP, $999,996 (Nanotek)

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

WebCore Technologies LLC

Structural Composite Panels for Trucks and Trailers

TFAMP 11-740 Final Score: 61.6 Rank: 9

Previous Ohio Investment

WebCore has received 3 TFP awards as the applicant ($1.9M) and an additional 2 awards where it was a key collaborator ($1.8M of those funds going directly to WebCore). All five awards were focused on developing and commercializing its TYCOR technology for various end-uses. Beginning with a Technology Action Fund award in 2001, WebCore developed a production process for making its proprietary composite materials and qualifying these products for commercial uses. In 2005, WebCore was awarded a $175,000 Ohio Research Commercialization Grant to commercialize TYCOR. In 2007, WebCore received $1.3M from a total $8M Research and Commercialization Program grant to a consortium led by the Center for Multifunctional Polymer Nanomaterials and Devices (CMPND) at Ohio State University (OSU) to commercialize composite materials for wind energy and other applications. CMPND, an OTF-funded center of excellence in advanced materials, assembled this consortium that includes OSU, WebCore, Owens Corning, General Electric, University of Dayton, and the National Composite Center. In 2009, WebCore further received a $1M Ohio Third Frontier Advanced Energy Program (TFAEP) grant award to commercialize TYCOR in wind turbine blades. Webcore was also a subcontractor to Ershigs in a 2010 TFAEP award to develop composite wind turbine towers using TYCOR material.

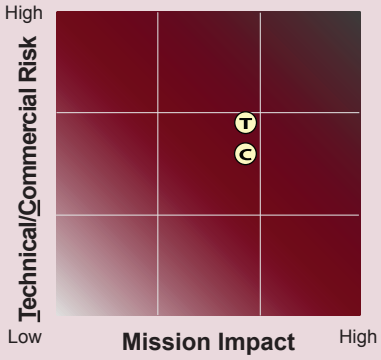
As a result of these projects, WebCore secured an initial sales order from a turbine manufacturer and one for freight car floors. The economic development impacts attributed to WebCore in the ODOD DB are 14 new jobs created, 3 jobs retained and product sales of $187K, but WebCore indicates that it has sold a total of $6M of product.

Project Description

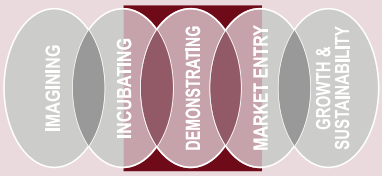
WebCore currently uses its polymer-based TYCOR-W composite cores to make wind turbine blades, and also makes prototype TYCOR-T cores for truck floors. In this 2-year project WebCore plans to develop TYCOR-T based products for two sub-segments of the truck industry: medium-duty truck floors, and high load-bearing floors for Class 8 trailers. Cores made for Crane Composites (Channahon, IL) for composite medium-duty truck floors already have demonstrated significantly improved fuel economy, but the manufacturing costs of the cores must be reduced 50% for market acceptance. WebCore will develop alternate core designs and work with Crane Composites to reduce manufacturing costs in order to make competitively priced cores for composite floor panels for medium-duty trucks. WebCore will also develop alternate core designs and work with next-stage developer and collaborator, Fiber-Tech, to make 8 foot by 53 foot, single-piece composite floor panels that weigh 1,000 pounds less than existing floors and can withstand 20,000 pounds load for Class 8 heavy-duty truck trailers. Collaborator and next-stage developer, Great Dane, will evaluate smaller panel samples from Fiber-Tech, and eventually use the full-size floor panels from Fiber-Tech in its production process to manufacture and sell Class 8 heavy-duty truck trailers. EMTEC will provide management and administrative support to WebCore. By the end of the project, WebCore plans to introduce lower cost panel floors to the medium-duty truck market, and in 2014 Great Dane plans to introduce trailers with composite floors for heavy-duty use.

Key Issues

- Webcore has two excellent paths to market with Crane Composites for the medium-duty truck market, and collaborators Fiber-Tech and Great Dane for the Class 8 heavy-duty trailer market.
- Past WebCore development efforts funded by the TFP have been directed toward a freight railcar floor, a cargo ship floor, aircraft floors, and bridge decks. The technical innovation that will be incorporated into the Class 8 truck floor is not clear, and there is no discussion of the role that technology from these earlier projects will play in this project.
- WebCore's sales of its prime product, wind turbine blades, have significantly declined placing WebCore in a weak financial condition. If the sales of wind turbine blades do not rebound, it is not clear that WebCore will be able to meet its cost-share obligations or improve its financial condition.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 1,000,000
WCF Request:	$ 0
TOTAL Request:	$ 1,000,000
Cost Share:	$ 1,000,000

Collaborators

- Fiber-Tech Industries
- Great Dane Trailers (Savannah, GA)
- Edison Materials Technology Center (EMTECH)

Technical Risk

Overall Score = 6.33

Technical Reach

WebCore has two parallel development programs using its basic product technology, but each program is in a different stage of development, and each has different technical and commercial goals that have not been met. The current program with Crane Composites (medium-duty truck floors) has demonstrated technical success with field trial protoypes that reduced fuel consumption, but WebCore and Crane must reduce manufacturing costs by 50% to meet commercial price targets. The development stage of the Class 8 truck trailers floor product is Imagining, and WebCore plans to develop a proof-of-concept product. A customer has committed to fund the development of an advanced lightweight trailer that will weigh less than 10,000 pounds—about 30% lighter than a standard trailer. WebCore, Great Dane, and Fiber-Tech have developed respective designs for this trailer, and plan to fabricate the panels using expensive carbon fiber and fabricate the trailer in 2011. The team does not believe there will be commercial interest in this high-priced design, and plans to build upon this POC product to develop a lightweight trailer design that meets Class 8 trailer requirements and is economically competitive.

Resource Limitations

WebCore's sales of its prime product, wind turbine blades made with TYCOR-W, have declined significantly since 2009 coinciding with the downturn in the economy. WebCore expects these sales to rebound in the latter half of 2011, but until this occurs, WebCore has limited resources upon which to draw. WebCore will rely on anticipated subcontracts of $0.8–$1.0M with Daimler Trucks and Volvo Trucks as part of the DOE Super Truck program along with projected sales increases of wind turbine products to meet its cost-share for this proposal. These sources of income are not guaranteed, and without them it is not clear that WebCore can meet its cost-share obligations.

Technology Protection

WebCore has five patents (issued from October 1995 to July 2008) on its products and processes and relies upon these to prevent others from duplicating its core design manufacturing process. However, there are many other core products and core technologies that can be applied in this composite space. Both WebCore and Fiber-Tech retain trade secret IP in their manufacturing processes. It is not clear if WebCore and Crane Composites have a similar trade secret arrangement concerning Crane Composites' manufacturing process. WebCore claims that its product concept for a trailer floor is novel, but the IP protection for this concept is not described.

Commercialization Risk

Overall Score = 5.27

Market Opportunity/Pull

The U.S. market for trailer floors is estimated to be $400–500M/year. Great Dane manufactures about one-third of all the truck trailers made in the U.S., and its inclusion as a collaborator and next-stage developer on this project lends credence to market pull. Due to the high cost of diesel fuel, Great Dane claims it receives constant calls from the trucking industry to reduce the weight of the trailers, and one customer is even willing to sponsor the development of a reduced-weight trailer. DOE is actively pursuing a weight reduction strategy for Class 8 trucks in its $200M Super Truck program.

Corporate Stability

WebCore has been in existence for 20 years but has experienced a significant decrease in product sales during the past 2–3 years that was attributed to the economic downturn and the slow development of demand for wind turbines. WebCore has contracted to 32 employees and has annual sales in the range of $1–3M. WebCore appears to be relying on debt financing and has received loans from the IOF, its local ESP, and private investors.

Commercial Infrastructure

WebCore plans to manufacture its basic polymer cores in Ohio and ship the resulting products to Fiber-Tech and Crane Composites (Chicago, IL) for manufacturing of the finished panel products. Fiber-Tech will ship the large finished panels for Class 8 trailers to Great Dane which will build the complete trailer at its facilities in IN, PA, TN, and AR. Crane Composites will produce and sell the medium-duty truck floor panels to its end-user customers. As a feedstock supplier, WebCore has an exclusive supply agreement with Great Dane for Class 8 trucks until 2014, so scaling-up its sales and marketing capability will be delayed until the appropriate time.

Mission Impact

Overall Score = 6.20

Cluster Formation

WebCore and Fiber-Tech are parts of the large cluster of polymer-based companies in Ohio. EMTEC is a respected participant in this cluster. Most of the fiberglass woven fabric that will be used in the panels will be produced by ValueTex, a Fiber-Tech subsidiary, in its plant in Washington Courthouse, Ohio.

Ohio Economics

Based on the assumption that WebCore and the panel manufacturers can deliver composite panels at $5/SF, the estimated job creation at WebCore and Fiber-Tech will be 14 jobs based on $4.4M in sales ($0.9M from Great Dane, and $3.5M from the medium-duty truck floor market) by 2014, and 42 cumulative jobs based on $15.4M in sales ($9.45M from Great Dane, and $5.95M from the medium-duty truck floor market) by 2016.

Business Model

WebCore has had an on-going business collaboration with Fiber-Tech. WebCore produces the polymer cores and winds them with fiberglass to strengthen them. These are then assembled into the truck flooring products by Fiber-Tech. Floor panels for large trucks will be sold to Great Dane exclusively until 2014 when other manufacturers will be approached. WebCore also produces the polymer cores for Crane Composites. Crane Composites uses these cores to make and sell composite flooring products for medium-duty trucks.

Prior Ohio Investments

- 2001 TFAF, $750,000
- 2005 ORCGP, $175,000
- 2007 RCP, $1.3M out of $8M (subcontractor to CMPND)
- 2009 TFAEP, $1,000,000
- 2010 TFAEP, $462K out of $1.1M(subcontractor to Ershigs)

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

Ferro Corporation

High-performance Glass-filled Barrier Coatings for Solar Modules

TFAMP 11-710 Final Score: 60.0 Rank: 10

Previous Ohio Investment

Ferro received at 2010 TFPVP award to develop and commercialize a vitreous glass frit edge seal for solar modules that would provide increased module life and greater useful power generation area. The seal is intended to reliably hermetically seal second- and third-generation thin film solar cells for a 20-year plus service life. The final product will consist of a rapid curing edge seal containing glass frit that can be cured at low temperature. Performance and environmental testing were to be done at OSU and EWI. Since the product is still being developed, the project has created two jobs at Ferro and retained two. Another job was created at OSU.

Project Description

In this 30-month project, Ferro intends to develop a polymeric encapsulant pottant containing glass flake that will improve the service lifetime of thin film PV modules. Ferro hopes to develop a novel encapsulant formulation that can be processed at lower temperature in order to eliminate the vacuum lamination process which will increase throughput and reduce overall module cost. Ferro's core competency lies in the design and manufacture of custom glasses.

The initial task in the work plan will be to characterize and select candidate glass and polymer resins and to develop initial formulations to evaluate their performance, processability, and cost. A set of six candidate resin systems will be evaluated as will three candidate glass flakes. The refractive index of the flake will have to be adjusted to be compatible with the resin selected. Ferro will then produce glass flake in two thicknesses to evaluate the effect of thickness on the degree of hermeticity and will study the effect of size after milling. The surface of the glass will be functionalized to improve compatibility between the glass and polymer matrix. Formulations will be evaluated for both wet and dry deposition and compared to the current industry standard, ethyl vinyl acetate. The formulations selected will be evaluated for material properties such as weatherability (oxygen/moisture permeation data) and physical property data. The formulations will be evaluated in International Electrotechnical Commission (IEC) module tests. If the formulations meet these standards as well as necessary cost and processing requirements, they will be scaled-up for manufacture.

Key Issues

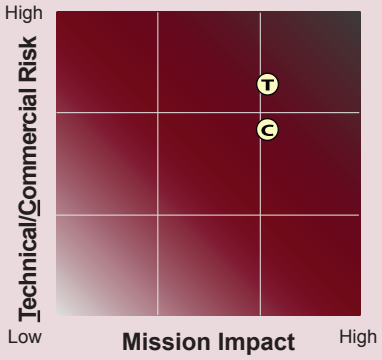
- The unique technology in this proposal appears to be the addition of specialized glass flake to the PV encapsulant. Basic performance data of current PV encapsulants with and without glass flake has not been generated making it difficult to assess the potential value of the glass flake as an encapsulant additive.
- Ferro stated that it had not done any moisture and permeability measurements on the initial films it produced because it lacked equipment. It is not clear why its partners in the 2010 award who are running performance and environmental tests on the edge seal were unable to assist or to participate in this work.
- Ferro stated that it "currently does not have the infrastructure and technically diverse skill set for high quality polymer development." The proposal does not explain why this project will involve developing new encapsulant resins when the performance of the current encapsulant resins has not been measured. It appears that Ferro intends to rely on a new set of academic partners for this expertise.

Technical Risk

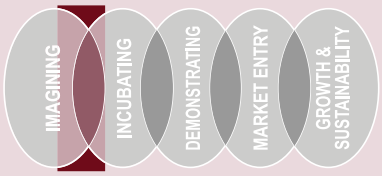
Overall Score = 7.60

Technical Reach

Ferro claims proof-of-concept based upon early results from mixing glass flake with a resin system and demonstrating that the presence of the flake retarded moisture penetration. However, this project still appears to be at an early stage of development with the screening for the resin system and glass flake yet to be done and none of the standard performance testing completed



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 1,000,000
WCF Request:	$ 0
TOTAL Request:	$ 1,000,000
Cost Share:	$ 1,171,000

Collaborators

- Case Western Reserve University
- University of Akron
- University of Toledo
- Nanofilm Ltd.

with laboratory samples. Cost targets for materials and processing were not provided, so it is not clear if this project will result in viable economics. Xunlight 26, an end-user who will evaluate the encapsulant, received previous TFP funding for encapsulant development, but its collaborator encountered difficulties in development of the encapsulant product, and Xunlight 26 had to resort to a commercial encapsulant.

Resource Limitations

Ferro plans to rely exclusively on its academic partners for expertise in polymer development and testing of the formulations. It is unclear which organization(s) will be responsible for understanding the cost and performance characteristics of current encapsulants and guiding the development of the new candidates. The proposal did not present evidence of team members'experience working with and characterizing current encapsulants. Calyxo, Xunlight 26, Plextronics, and Solexant, the end-users that were to test the new formulations in thin film modules, did not provide evidence of their thin film manufacturing capabilities, so it is unclear if they are currently producing commercial product. Ferro claims that the level of technical risk in this project is too high to allow it to secure internal funding, and cost share appears to consist of time from existing staff.

Technology Protection

Ferro filed a provisional patent application on hermetically sealed electronic devices in July 2010 and plans to prepare a non-provisional version in July 2011. An invention conception record covering edge seals and moisture barrier coatings was signed in February 2011 by the inventors. Ferro believes it will have freedom to operate after it conducted a patent search and that the resin system and glass flake to be developed in this project will lie outside the scope of existing patents.

Commercialization Risk

Overall Score = 6.07

Market Opportunity/Pull

Ferro's projections of the size of the thin film encapsulant market are proprietary, but they were estimated to be in the range of $150–250M at market entry in 2013 with the potential to double by 2016. Numerous companies associated with thin film PV modules have expressed interest in the encapsulant concept that Ferro has described, but their interest is contingent upon Ferro's ability to create a product that meets the stated cost and performance requirements. The current production of thin film modules by these companies and their consumption of encapsulant was not described, so it is unclear how directly involved they are.

Corporate Stability

Founded in Cleveland, Ohio in 1919, Ferro is an established Ohio-based company employing nearly 600 Ohio workers. It employs 5,300 globally and reported sales of over $2.1B in 2010. It is the world's leading supplier of metallic powders and flakes (including gold, copper, silver, and platinum) for electronic applications.

Commercial Infrastructure

Ferro's Electronic, Color and Glass Materials (ECGM) business unit is currently one of the world's largest suppliers of metallic contact materials in the solar cell marketplace and will maintain relationships with end-user solar customers. Ferro sells a variety of products to the crystalline PV industry, and it is a supplier to 8 of the top 10 crystalline silicon PV producers. Ferro wants to add an encapsulant for thin film PV modules to its portfolio, but this will necessitate forming new relationships with the thin film PV producers.

Mission Impact

Overall Score = 6.92

Cluster Formation

Ferro believes this project will strengthen Ohio's advanced materials and thin film PV clusters and supply chain. It plans to do beta testing of the new encapsulant with Calyxo USA and Xunlight 26, both PV companies located in northwest Ohio. Development of the encapsulant formulation and initial testing will involve Case, University of Akron, University of Toledo, and Nanofilm Ltd located in Valley View, OH.

Ohio Economics

This project is projected to create 6.5 jobs three years after the start of the project and 19.75 jobs five years after the start of the project. Sales of the Ferro encapsulant are expected to begin in 2013 and will generate revenues of $1.3M 2014 and $28.7M in 2016. It is not clear that this 30-month development project and subsequent IEC certification of PV modules containing the product can be completed within this timeframe.

Business Model

Ferro intends to produce the glass flake at its Cleveland plant. The compounding of the glass flake into the polymer will be done at Ferro's polymer processing plant in Stryker, OH. Both plants have adequate excess capacity for this product. In Year 5 of the projections, this product will account for 0.9% of the capacity of the Cleveland plant and 3.4% of the capacity of the Stryker plant. However, new flaking equipment will be required at the Cleveland plant for this product. The product will be sold through Ferro's ECGM business unit.

Prior Ohio Investments

- "Advanced Durability Sealing Systems for Solar Cells," 2010 TFPVP, $1,000,000

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

PolyGreen Technologies

Development of a Novel Process for the Commercialization of Biopolyols and Polyurethane Foams

TFAMP 11-735 Final Score: 59.3 Rank: 11

Previous Ohio Investment

PolyGreen Technologies has not received prior funding from OTF.

Project Description

Crude glycerin is a by-product in the production of biodiesel. Purification of this material has not been cost-effective, so it is treated as a waste material. Dr. Yebo Li of OARDC has developed a process for converting crude glycerin into polyol, a key component in the manufacture of polyurethane (PU) foam. PolyGreen and its team of collaborators plan to scale-up this process at a facility in Mansfield, OH.

In the work plan for this project, Dr. Li and his staff will do laboratory work to increase the consistency of the polyol produced, reduce its hydroxyl number, optimize the product formula for two PolyGreen products, and scale the production recipe from laboratory-scale to a 50-gallon reactor ($601K). This work is expected to take 18 months. The 50-gallon reactor has already been installed in the plant and validated. Procedures to assess the quality of the raw materials and finished product will be developed, test equipment will be purchased, and two new 500-gallon reactors will be designed and installed during the first 6 months of this project ($750K). The source of the raw material for this product is not entirely clear as the proposal indicates that PolyGreen intends to use Tenaska Biofuels, a collaborator, as its exclusive supplier and also that it intends to obtain crude glycerin from Ohio biodiesel producers.

The work plan includes tasks for PolyGreen and its consultants to negotiate feedstock supply contracts ($105K), identify additional end-users ($75K), identify target markets ($185K), prepare samples ($215K), oversee the testing of polyol samples ($324K), negotiate contracts ($150K) and purchase additional reactors ($300K).

Key Issues

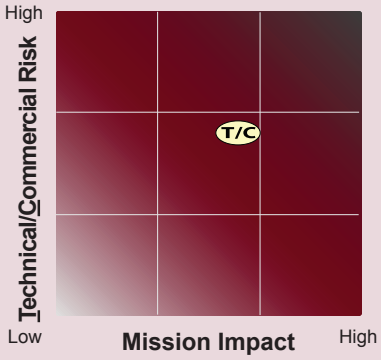
- While the proposed technology appears to have merit, there are issues related to the work plan that create concerns that the project can achieve the technical and business objectives proposed. Specifically, the work plan contains a number of inconsistencies in its timeline, particularly in the sequencing and duration of the scheduled tasks. Basic laboratory studies will not be completed before scale-up to the 500-gallon reactors and full-scale plant operations are scheduled to occur.
- The roles of the collaborators on this team, particularly Tenaska Biofuels, HFI, and Green Technologies, are not consistent with the tasks provided in the work plan nor are they reflected in the staffing for those tasks. Project resources appear to be directed almost entirely to PolyGreen and its consultants. The funding shown in the proposal budget forms for HFI and Green Technologies does not appear to be allocated to product evaluations by these end-users.
- Conflicting information about the potential supply of crude glycerin and the lack of information regarding the potential consumption of polyol by team's collaborators create concerns on the appropriateness of the level-of-effort assigned to PolyGreen and its consultants relative to working with additional suppliers and end-users.
- The proposal indicates that a chemical engineer will be hired by PolyGreen as needed, but tasks related to process scale-up, refining the design of the large reactor, and developing recipes for the production reactor do not include time or funding for someone with this expertise.

Technical Risk

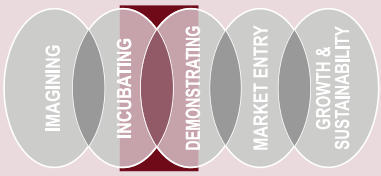
Overall Score = 5.93

Technical Reach

Dr. Li's group has produced samples of crude glycerin-based polyol which have been converted into rigid PU foam or blended with petroleum-based polyol to produce flexible PU foam. Since crude glycerin can come from many sources with different contaminants, characterization of the feedstock for this process is particularly important. Basic informa-



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 1,000,000
WCF Request:	$ 0
TOTAL Request:	$ 1,000,000
Cost Share:	$ 1,728,844

Collaborators

- Ohio Agricultural Research and Development Center (OARDC)
- PolymerOhio
- HFI, Inc.
- Green Insulation Technologies
- Gerard Thomas Company (Southfield, MI)
- Ohio Soybean Council
- Buckeye Fabricating Company
- Tenaska Biofuels (Omaha, NE)

tion, such as clarifying the feedstock source, volumes available, and demonstrating its suitability for this process, remains to be done and would be useful in assessing the viability of this project. Inconsistencies in the project's task schedule, timeline, and resource allocations significantly raise the risk associated with the scale-up of this process.

Resource Limitations

The PolyGreen management team has not presented evidence of successful prior experience operating a chemical processing plant or commercializing a commodity chemical product. Some expertise is being acquired through the use of external consultants, and the OARDC researchers will bring technical skills. While collaborators have strong positions in various sections of the value chain, their participation in this project has not been well integrated into the overall work plan and the resources to fund their participation remain unclear.

Technology Protection

OSU has a pending patent for a method of producing polyols using crude glycerin. PolyGreen and OSU are developing an agreement to allow PolyGreen to obtain rights to this technology, but the agreement has not yet been signed. The legal counsel for PolyGreen has issued an opinion that there are no existing IP impediments that would inhibit PolyGreen's ability to produce its polyol.

Commercialization Risk

Overall Score = 6.00

Market Opportunity/Pull

PU foam is used in many interior automotive applications and these end-uses are highly cost-driven. In 2008, over 6B pounds of PU foam were produced for a wide variety of end-use applications. This bio-based polyol from waste glycerin has the potential to replace a fraction of the petroleum-based and soy-based polyols currently used in the production of PU foam because of its lower cost. Ford has visited OARDC to discuss the process and will test sample material as it becomes available. Honda has furnished specifications and is also interested in evaluating the material.

Corporate Stability

PolyGreen was formed on March 28, 2011. PolyGreen has received an initial investment of $1.3M, currently has no debt and expects to receive an additional $3.2M by the end of July. Part of this investment involves payment for an exclusive license in Asia for the polyol technology. PolyGreen purchased some of its equipment from Arlington Energy, a startup biodiesel producer, and has the same management as Arlington Energy, its largest investor. Arlington Energy ceased operations in August 2010 and has not produced biodiesel since Fall 2008. The applicant did not provide information on the size or success of Arlington Energy's earlier business.

Commercial Infrastructure

PolyGreen plans to manufacture polyol in Ohio and intends to hire much of its operations staff with resources from this project. The company currently relies on external resources for technical support and will be hiring staff for marketing. Plans to secure crude glycerin feedstock are unclear, but a significant portion is likely to originate outside Ohio. While two Ohio members of the team are capable of converting the polyol to PU foam and have made investments in PolyGreen, their volume requirements are unknown. PolyGreen intends to rely on contract service providers to develop its customer base for the remainder of its production capacity.

Mission Impact

Overall Score = 6.00

Cluster Formation

PolyGreen is funded primarily by Ohio investors and intends to commercialize technology developed at OARDC. PolyGreen plans to use crude glycerin from Ohio biodiesel plants but also indicates that Tenaska Biofuels located in Omaha NE is its exclusive source. An exclusive arrangement with Tenaska makes it likely that PolyGreen will use significant quantities of crude glycerin from outside Ohio and possibly outside the U.S. Ohio collaborators, HFI and Green Insulation Technologies, plan to use the polyol from PolyGreen as a substitute for a portion of the raw material that they currently purchase.

Ohio Economics

Production of polyol from the pilot facility and generation of revenue are projected to begin in Year 1 of this project, and the team claims that all the equipment for a complete production line and testing facility will be in place this year. Revenues from this plant are estimated at $54M in Year 3 and over $100 M by Year 5 as additional production lines are added. Job creation at the plant in Mansfield is projected to be 28 in Year 3 and 44 in Year 5. These projections appear overly optimistic given the fact that the basic laboratory-scale characterization and recipe development for the process will not be completed for 18 months. Unanticipated difficulties with either the feedstock stream or the product stream will have to be investigated by Dr. Li's team, since PolyGreen has limited expertise in this area, and this could have a significant adverse effect on the timing of these projections.

Business Model

PolyGreen claims that its headquarters and initial production facilities will be situated in Mansfield, OH in order to ensure close proximity to Dr. Li, the inventor of the technology who is located at OARDC. Replication of the initial production line is being planned at this site. PolyGreen already is licensing use of this technology in Asia in return for an initial investment, so it is likely that at least one plant will be located there. Asian royalty arrangements are unknown. At this time, it appears that a significant portion of the plant's feedstock will be generated outside of Ohio and possibly outside the U.S., but PolyGreen claims the process economics are sufficiently attractive to permit the crude glycerin to be shipped to Mansfield. Given the low capital costs of this facility and the process equipment, a large centralized conversion facility does not appear to be a realistic scenario. A licensing and/or a distributed processing model with facilities located close to feedstock and/or PU producers appears more likely.

Prior Ohio Investments

- None

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

NGJ LLC

Carbon Fibers: New Low-cost, Small-diameter Materials

TFAMP 11-717 Final Score: 56.8 Rank: 12

Previous Ohio Investment

NGJ LLC has not received prior funding from OTF.

Project Description

NGJ, a spinoff start-up from the University of Akron Research Foundation (UARF), intends to commercialize production of carbon fibers with diameters between those of carbon nanotubes and standard carbon fibers at a significantly lower price. The fibers will be made by a patented process known as "Nanofibers by Gas Jet" (NGJ) invented at the University of Akron (UA). The fibers will be mixed with other carbon nanotubes and standard carbon fibers to make lower cost composites with improved strength, lower weight, and improved thermal and electrical conductivities. NGJ will form a joint venture with NanoSperse to produce the fibers at NanoSperse's facilities at the National Composite Center. GrafTech will produce and optimize the low-cost feedstock for NGJ. PolyOne will continue evaluations of electrically conductive NGJ fibers in thermoplastic compounds for automotive applications. Goodyear Tire & Rubber Company Innovation Center will continue evaluations of NGJ fibers for use in tire formulations that discharge static electricity during use. Stonhard, a manufacturer of high performance polymer floor systems, will continue evaluations of NGJ fibers for conductive coatings on its flooring products. The project goal is to build a 5-pound/hr pilot plant at NCC to produce sufficient quantities of fibers for thorough testing by the end-users and other potential customers.

Key Issues

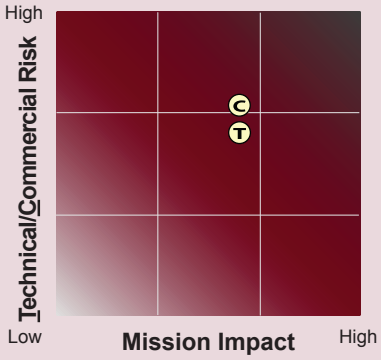
- NGJ has provided proof-of-concept with its gas jet process at a lab-scale but has not yet shown that it can be scaled-up to the 5 lb/hr rate needed for a pilot plant or that the process can be scaled-up to larger production quantities.
- NGJ is relying on GrafTech to produce a low-cost feedstock, and GrafTech predicts it will not be able to supply the feedstock until near the end of the 2-year program. This increases the risk of extending the program's time line and delaying the forecasted impacts. The impact that this new feedstock will have on the properties of the carbon fiber is not known.
- GrafTech will not know the actual feedstock cost until near the end of the 2-year program, which increases the risk associated with production of a low-cost carbon fiber. The availability of such a feedstock is critical to competitiveness of the carbon fibers.
- Potential end-users will require large quantities for evaluations before committing to significant purchase orders. Commercial evaluations could require at least 6–12 months, and military and commercial aircraft applications typically take much longer. The projected sales forecasts appear optimistically early.

Technical Risk

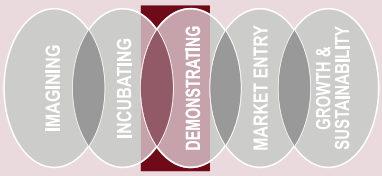
Overall Score = 6.00

Technical Reach

10-g lots of NGJ fibers were produced in the UA lab for evaluation by collaborators. NGJ will upgrade the UA unit to a 450-g/hr (1 pound/hr) lab production unit at UA and evaluate the fibers. NGJ will then design and fabricate a 5-pound/hr production unit and send fibers to NanoSperse for evaluation. Once successful, NGJ will design, fabricate, and install a NGJ pilot line at the NCC facility. NGJ claims this is a low risk effort since another licensee was able to scale up to production quantities of polyolefin fibers in 6 months. NGJ will purchase feedstocks from Mistsubishi and Cytec until GraftTech can produce the targeted lower-cost feedstock. GrafTech predicts it will not be able to provide a feedstock until near the end of the 2-year project, and that it will not know



Stage of Development



County Location

Funds Requested

TFRDF Request:	$ 1,000,000
WCF Request:	$ 0
TOTAL Request:	$ 1,000,000
Cost Share:	$ 1,000,000

Collaborators

- University of Akron
- NanoSperse, LLC
- Stonhard (Maple Shade, NJ)
- PolyOne Corp.
- Goodyear Tire & Rubber Company Innovation Center
- GrafTech International Holdings, Inc.

the feedstock's cost and price until then. It is unclear if the change in feedstocks during the course of the project will affect the performance of the carbon fiber and if the end-use testing data will be transferrable.

Resource Limitations

The team appears to have sufficient capabilities to overcome technical obstacles associated with this project. As a start-up in 2009, the only revenue NGJ has received has come from small grants and investor funding. NGJ is not able to cover the entire cost-share requirements if any of the collaborators is unable to meet its obligations. NanoSperse is also a start-up company and will supply its cost share through grants or access to loans and/or capital markets. NGJ forecasts it will need an Angel/Series A investment of $2–3M in Year 2. Another $3–5M investment from a strategic partner or loan in Year 4 will be needed for a second commercial-scale facility. NGJ is working with Jump Start's Entrepreneur-in-Residence to improve its business plan and implement a program to raise capital.

Technology Protection

NGJ has licensed three patents and a patent application from the UA. The gas jet process IP has been licensed to other companies for different, non-competitive products, and these companies have been able to scale-up to large quantity production of various resin systems. The UA has advised there is freedom-to-operate.

Commercialization Risk

Overall Score = 6.87

Market Opportunity/Pull

There is a demonstrable need for carbon fibers that are larger than expensive nanotubes, but smaller than most other carbon microfibers. The involvement of large end-user/next-stage developers and cost-sharing collaborators Stonhard, PolyOne Corp. and Goodyear indicates there is market interest in the NGJ fibers.

Corporate Stability

NGJ is a start-up (2009) spin-off from the University of Akron Research Foundation (UARF). NGJ has not generated any income from product sales. In the short term, NGJ plans to obtain some income from initial sales of small quantities of carbon fibers produced by the pilot plant.

Commercial Infrastructure

NGJ has no manufacturing, sales, or marketing capability. Instead, it will rely on a joint venture with NanoSperse and its production facility at NCC for all of these functions.

Mission Impact

Overall Score = 6.00

Cluster Formation

The UA is a recognized leader in nanofiber technology, and raw material supplier GrafTech provides carbon fiber feedstock to a variety of industries. NGJ and NanoSperse plan to produce NGJ fibers and disperse them into products for sale to next-stage developers and end-users, three of which are Ohio-based collaborators.

Ohio Economics

NGJ projects revenues of $900K and 14 new jobs in Year 3 and revenue of $8M and 25 total jobs by Year 5. These optimistic projections depend on early qualification of the carbon fiber products by the end-users and the ability of GrafTech to supply low-cost raw materials in a timely manner.

Business Model

NGJ will form a joint venture with NanoSperse to establish a 5-pound/hr pilot plant. Product from this plant will be used by end-users to qualify their product. NanoSperse will provide sales and marketing capabilities as well as contacts with additional potential end-users. After initial qualification and small orders are established, it will be necessary to go to capital markets to provide funding for scale–up to production of commercial quantities of fibers. NGJ/NanoSperse will focus on developing potential investment relationships with several strategic partners along the carbon fiber supply chain. Investments from major potential customers like PolyOne or Goodyear or RPM will be pursued, as will potential investments from overseas contacts in Germany and India. NGJ plans for an exit in Year 8 to a strategic investor.

Prior Ohio Investments

- None

Ohio | Department of Development

2011 TFAMP Evaluation Summary

Third Frontier Advanced Materials Program

Chemtex International, Inc.

Renewably-sourced Ethylene Glycol from Cellulosic Biomass

TFAMP 11-755 | Final Score: 45.8 | Rank: 13

Previous Ohio Investment

Chemtex International, Inc. has not received prior funding from OTF.

Project Description

In 2009, Chemtex and OSU began working to improve the process for converting the sugars from biomass into ethylene glycol. Biomass is saccharified into a mixture of C5 and C6 sugars through a steam explosion process and subsequent hydrolysis. In this project, the team will attempt to increase the product yield of ethylene glycol to 40%, minimize the formation of by-products, and reduce the amount of catalyst required. Current yields of ethylene glycol in a C5 system are 10–11%. Information from this project will be used to design a continuous process for converting biomass into ethanol and ethylene glycol. If Chemtex is able to achieve these process targets, it expects to produce ethylene glycol from bio-based sources at the same price as petroleum-based ethylene glycol.

Key Issues

- There are two other manufacturing processes currently in use for converting biomass into ethylene glycol. Chemtex believes that the process in this project has the potential to become cost competitive with petroleum-based product at $0.50/pound versus the $0.65–$0.79/pound currently charged for bio-based ethylene glycol from the other two processes.
- M&G has reduced its support for the Sharon Center facility and moved work to its center in Italy. Further reductions in M&G's funding for the Sharon Center facility could compromise the ability of the applicant to execute the work plan.
- Chemtex has multiple options for the location of its plants and the processing technology that will be incorporated in those plants. Chemtex recently won an Asian project to build an ethanol dehydration facility, a process that would compete with the process being developed in this project to produce ethylene glycol.

Technical Risk

Overall Score = 6.80

Technical Reach

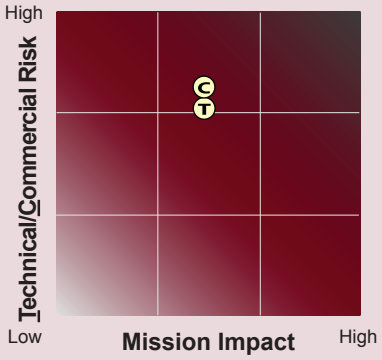
While this process has been demonstrated at the laboratory level, it remains to be optimized and to demonstrate the projected economics. Project work will focus on the catalytic conversion of sugar, lignin conversion, and product separation technologies. These tasks are expected to be manageable. The expertise of the staff at Sharon Center will be augmented with support from Italy. M&G Group has made a considerable investment in bio-based technologies and appears to have a center of excellence with a staff of 60 as well as a pilot plant in Italy.

Resource Limitations

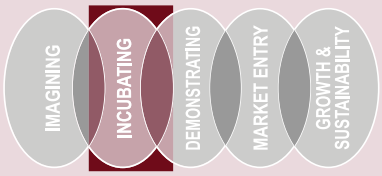
Although M&G has committed $25M to a new R&D center fully dedicated to renewable energy and $125M for second-generation ethanol development, these investments have been made in Italy. M&G has cut support for the Sharon Center facility by $3-4M annually resulting in a contraction of headcount by approximately 50%. This research has been moved to Italy. The applicant hopes that an investment by Ohio will sway future investments by M&G and will allow new separation equipment to be located in Sharon Center and encourage facility expansion to service potential customers. The cost share for this project is coming almost exclusively from the budget of the Sharon Center research facility, and there is no commitment of continued support at current levels from M&G.

Technology Protection

Chemtex has currently made one patent application that covers hydrogenolysis. Further IP will be based on improving the yield and purification of the catalytically cracked ethylene glycol. Chemtex and OSU have an agreement covering trade secrets and patent rights. Chemtex has an on-going relationship with an IP firm that oversees its patenting strategy.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	987,908
WCF Request:	$	0
TOTAL Request:	$	987,908
Cost Share:	$	1,288,000

Collaborators

- The Ohio State University (OSU)

Commercialization Risk

Overall Score = 7.47

Market Opportunity/Pull

The size of the North American market for ethylene glycol for the PET industry is large and has been estimated at 350M gallons per year with a price that fluctuates between $3.71 and $5.56 per gallon. Coca-Cola has initiated its own development program to produce PET bottles from renewably sourced ethylene glycol. In 2010, Coke sold bottles containing 3.6M gallons of bio-based ethylene glycol, and it hopes to double that in 2011. Heinz, Nestle, and Pepsi have shown interest in the use of bio-plastics for food packaging, but none of these end-users is actively engaged in this project.

Corporate Stability

The M&G Group is the parent company to both M&G Polymers and Chemtex International, Inc. It employs nearly 3,000 individuals and has annual revenues of nearly $3B. M&G Polymers is a world leader in PET plastic manufacturing with facilities in the U.S., Italy, Mexico, and Brazil. M&G has operated an R&D center in Sharon Center, OH since 2002, when it acquired Chemtex from Mitsubishi Corporation. The center was originally dedicated to PET research but has been partially converted to bio-based research. Chemtex, a global engineering subsidiary, has its U.S. headquarters in Wilmington, NC.

Commercial Infrastructure

Chemtex is a technology developer that provides engineering, procurement, and construction services to build plants or licenses technology to customers who will provide their own engineering, procurement, and construction. The company believes there will be many opportunities for technology licenses for this process, both foreign and domestic. While the company has an infrastructure to support its current business, it did not commit to the development of a specific project related to this technology in Ohio. At best, there is a possibility of such a project being initiated at some point in the future. The cost for such a project is likely to be in the range of $100M.

Mission Impact

Overall Score = 4.84

Cluster Formation

The optimization of the chemical process will involve expertise from OSU. Chemtex has secured a commitment from M&G Polymers to use ethylene glycol from this process in its PET plant in WV, but color problems with the samples have been reported and remain to be resolved. If the manufacturing process can be developed to the point where it is economically competitive, a facility could be developed in Ohio, but the proposal presents this as a possibility with no substantive commitments from M&G or other potential investors.

Ohio Economics

There are currently 23 employees working at the R&D center in Sharon Center, OH. The work plan would involve 16 jobs during the 2 years of this project, 11 retained jobs and 5 new jobs. The project is not expected to generate any direct revenues. However, additional jobs and revenues may result if a plant is built in Ohio. Retrofitting one of 7 shuttered Ohio ethanol plants could result in the creation of 90 new jobs.

Business Model

The long-term plan would involve either a retrofit or a new build for a process to convert plant biomass to ethanol. After the R&D for this project is completed and when ethanol subsidies are reduced or come to an end, the plant would be converted to maximize ethylene glycol production. Ethylene glycol can be used at M&G's PET facility in Point Pleasant, WV. A large-scale ethanol/ethylene glycol plant is expected to be operating in the U.S. in 2013, but Chemtex has already begun work on such a plant in NC and has applied for a DOE loan guarantee for that plant that includes a commitment to cultivate 40,000 acres of biomass crops there. Field trials for biomass production were initiated in OH, KY, TN, and NC in 2009 and expanded to WV and FL in 2010, so additional projects could be developed in any of these areas.

Prior Ohio Investments

- None