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Lead Applicant: University of Akron Research Foundation

Lead Applicant Address: 170 University Circle, Suite 312, Akron, Ohio 44325-2103

Contact Person: George R. Newkome, PhD

Contact Phone Number: 330-972-6458

Contact Email: newkome@uakron.edu

Estimated Project Total Cash Costs: \$30,000,000

Estimated State Funds to be Requested: \$10,000,000

Anticipated Project Title: Polymeric and Engineered Materials Technology
Commercialization Center

I. Introduction

The University of Akron Research Foundation (UARF) Polymeric and Engineered Materials Technology Commercialization Center (PEM TCC), established in cooperation with The University of Akron (UA), will enhance support for early stage companies that are nearing market entry or ready to scale-up production (Ohio Third Frontier's Demonstrating, Market Entry, and Growth and Sustainability stages) by providing market insight, expert support services, mentorship, and much needed funding to companies as they approach market entry and experience growth.

Polymeric and engineered materials are a long-standing field of strength for Northeast Ohio, which is home to UA's world-renowned polymer program, Kent State University's Liquid Crystal Institute, engineering and macromolecular research labs at Case Western Reserve University, and almost 3,000 polymers and advanced materials companies including research facilities for Goodyear Tire and Rubber Company, Bridgestone Americas Inc., Omnova Solutions, The Timken Company, PolyOne Corporation, as well as others.

PEM TCC will increase success for deal flow from these universities and corporations, as well as companies willing to locate in the region, through three initiatives: PEM TCC Services, the Technology Demonstration Fund, and the Scale-Up Investment Fund. PEM TCC Services will be offered to the full continuum of conception to scale-up companies, complementing existing entrepreneurial expertise with subject matter experts, industry connections, and a focus on customer contact from the earliest stages of development. The Technology Demonstration Fund will offer \$25,000 to \$200,000 non-equity investments for customer-driven product testing and demonstration needed to prove the commercial viability of potential products or services. The Scale-Up Investment Fund will operate as a true investment fund, making equity investments in companies approaching market entry or seeking rapid growth. The goal is to provide world-class investment opportunities to the Scale-Up Investment Fund, which in turn will support a sustainable center by bringing on investors and maximizing returns.

II. Stature and Resources

Akron is the world's leader in polymeric and engineered materials research, development, manufacturing, and technology commercialization. In recent years, Akron has transformed itself from the "rubber" capital of the world to a true "polymer" center. UA is home to the largest, oldest, and most active polymer program in the world with a rich 70-year research history, more than 30 faculty members and more than 300 graduate students and postdoctoral researchers. UA also houses a world-class engineered materials program, including a nationally recognized corrosion engineering center and a collaborative surface engineering lab with The Timken Company. UA's polymeric and engineered materials research faculty include two members of the National Academy of Engineering, three fellows of the National Academy of Inventors, two fellows of the Association for the Advancement of Science, five fellows of the American Physical Society, two fellows of the Society of Plastic Engineering, and six editors in the most prestigious international polymer journals. UA, an Ohio Center of Excellence for Polymers and Advanced Functional Materials, ranks #1 in the U.S. for publications in the polymer science and engineering fields and #2 in the world for its graduate polymer science program. UA faculty hold more than 200 active patents related to polymeric and engineered materials.

Beyond UA's campus, collaborative institutions have complementary expertise in polymeric and engineered materials. Kent State University's Liquid Crystal Institute (LCI) is the birthplace of liquid crystal displays (LCDs) and the world's first research center focused on the science of liquid crystals. Research at LCI, which has been one of the major contributors to the dramatic rise of LCDs, is directed toward a broad range of multidisciplinary topics. LCI has 21 professors and 46 graduate students in its chemical physics interdisciplinary program. The program has generated 14 issued and pending patents and is the birthplace of successful spinout, Kent Displays, a world leader in developing LCDs that retain images without power and offer beneficial characteristics such as sunlight readability and wide viewing angles. Case Western Reserve University (CWRU) offers nationally recognized science and engineering research, particularly in its Department of Macromolecular Science and Engineering, the first for education and research in this field. In federal expenditures for science and engineering research and development, CWRU ranks 23rd in the nation in number of undergraduates, who earn engineering and science doctoral degrees and 24th among universities. Recent innovations emerging from CWRU include a more natural artificial eye, a better pothole patch, and self-healing polymers.

Northeast Ohio, Akron specifically, has a robust industry infrastructure for polymers. In a study by the CIT Group of New York, Ohio ranked #1 in plastics and polymers manufacturing and #1 in rubber and miscellaneous plastic products manufacturing. Major polymer facilities in Northeast Ohio include the Goodyear Tire and Rubber Company world headquarters and the Bridgestone/Firestone North American Technical Center, both located in the City of Akron. Goodyear and Bridgestone/Firestone have announced a combined investment of approximately \$1 billion in these facilities. Specific polymeric and engineered materials industry partner institutions with whom UA has previously collaborated include: Goodyear Tire and Rubber Co., Bridgestone Americas Inc., Omnova Solutions, The Timken Co., GrafTech International Ltd., PolyOne Corp., Akron Polymer Systems, The Lubrizol Corp., The Sherwin-Williams Co., FirstEnergy Corp., and RPM International Inc. to mention but a few.

Northeast Ohio is home to unique world-class facilities for polymer research, testing and training, including:

- The 146,000 sq. ft. **Goodyear Polymer Center** incorporates 8 large polymer synthesis groups with specialized labs for all categories of synthesis.

- The **National Polymer Innovation Center** with its Wright Center of Innovation in Polymer Engineering supports state-of-the-art research with instrumentation and large high-bay areas in a 42,750-square-foot multi-laboratory facility open to all universities and subscriber companies.
- The **Akron Functional Materials Center** is a unique innovation platform focused on elevating the technology readiness level and accelerating the translational potential of new polymeric materials into high-value applications across a number of commercial markets.
- The **Applied Polymer Research Center** has provided contract services to industrial and government clients for over 50 years. With a full-time staff, the Center performs 300 – 400 projects a year.
- The **Akron Polymer Training Center** provides workforce training and non-credit course offerings supported by its computer and processing laboratories housed in an 18,000 sq. ft. facility.
- The **Sidney L. Olson Research Center** supports compounding, blending, extrusion, film blowing, blow molding, biaxial stretching, filament winding, and fiber spinning in its 70,000 sq. ft. facility, which includes advanced laboratories for coatings and specialized processing equipment.
- The **Center for Mass Spectrometry and Imaging of Materials** supports research and development at UA and its academic and industrial partners by providing multidimensional mass spectrometry methodologies for the characterization of synthetic polymers, biopolymers, and polymer-biomolecule interfaces and conjugates.
- The **Center for Surface Engineering and Lubrication Research**, which grew out of UA's first-in-class research collaboration with Timken, has equipment to perform ASTM standardized testing on lubricants, base oils, and additives, as well as fabricating novel, high-performance surface coatings.
- The **National Center for Education and Research on Corrosion and Materials Performance** is a holistic program that incorporates the nation's first baccalaureate degree in corrosion engineering and world-class research in corrosion and materials performance.
- The **Center for Tire Research** was founded with funding from the National Science Foundation Industry/University Cooperative Research Centers Program. Currently, there are 17 tire and automotive companies financially supporting this center, which is expected to fund ten projects per year to the cost of approximately \$400,000.
- The **Advanced Liquid Crystalline Optical Materials** is located at the Liquid Crystal Institute at Kent State University, where ALCOM has consolidated the internationally recognized and complementary expertise of scientists from Kent State University, Case Western Reserve University, and UA, and integrates their activities with liquid crystal research worldwide.
- The **American Chemical Society Rubber Division** is focused on enhancing science, technology, and business across the evolving elastomeric community, while expanding the elastomeric profession and individual development through educational, technical, and interactive activities.
- The **Akron Global Polymer Academy** assists the UA and its partners in creating and disseminating knowledge about polymer science and polymer engineering by providing consulting and training services to the polymer industry worldwide.

Beyond the research infrastructure, Northeast Ohio is an emerging leader in entrepreneurial support. Specifically, UARF is a nationally recognized leader in supporting intellectual property development, technology commercialization, and entrepreneurial ventures. To augment this, UA recently won one of three 2013 National Science Foundation (NSF) I-Corps Sites programs in recognition of its expertise in supporting early stage technologies, businesses, and entrepreneurs in developing deeper market analysis prior to engaging in complete commercialization efforts. Among its many successes, UA and UARF have:

- Ranked #1 in patents per research dollar in a five-year study;

- Pioneered an innovative Senior Fellows as well as International Senior Fellows program, which brings former industry executives to the region to work with emerging technologies and connect with industry partners;
- Held a Northeast Ohio conference series on Open Innovation, led by Proctor & Gamble, to teach companies to implement open innovation principles;
- Founded (2005 with 35 members) and maintain the Akron Regional CHange Angels Investment Network (ARCHangels, currently 650 members), which has presented 106 early stage companies that have received to-date \$455 million in follow-on funding;
- Led an initiative to create a proof-of-concept center to support early stage market and technology validation; and
- Networked to other key entrepreneurial resources, including serving as a founding partner in the Innovation Fund and the Austen BioInnovation Institute in Akron, and as a member of the JumpStart Entrepreneurial Network.

As explained in this section, UA and UARF are world-class coupled infrastructure in polymeric and engineered materials. UA and UARF have attained this stature through recognized, external, independent rankings, and benchmarks of past performance. UARF also has a demonstrated track record of commercializing polymeric and engineered materials technologies that exceeds that of many other technology centers in the State of Ohio.

III. Scale and Opportunity

Ohio ranks first in the nation in the size of its polymers and advanced materials industry, with more than 2,800 companies and 140,000 employees working in the polymer sector, generating nearly \$50 billion in revenue each year. Nearly 50 percent of Ohio’s polymer production facilities are located in Northeast Ohio. Ohio has a robust supply chain for moving polymeric and engineered materials products to market, including top academic and technical institutions like UA, KSU, and Case, design and machinery shops, more than 250 mold builders, resin suppliers and compounders, *e.g.* PolyOne and BASF, and more than 1,600 plastics and polymer processors.

As evidence of the opportunity for entrepreneurial ventures in the polymeric and engineered materials space, 104 advanced materials startups have contacted the JumpStart Entrepreneurial Network since its inception. The advanced materials field is among the top three technology areas for network members, network funding recipients and total funding received with 78 companies joining the JEN Network, 26 receiving network funding and \$132 million in total funding to advanced materials startups (See Table 1 below). Only software and medical technologies have received more funding.

Table 1: Companies inquired to any member of the JumpStart Entrepreneurial Network.
(includes all companies who first inquired between 4/1/2000 and 8/1/2013)

Technology	Inquired	Accepted into Network	Funded by Network	Total Funding from All Sources
Medical Technology	266	193	56	\$1,469,595,978
Software Applications for Business and Healthcare	360	223	87	\$272,839,158
Advanced Materials	104	78	26	\$132,174,200
Sensing and Automation Technologies	69	54	15	\$88,214,575
Aeropropulsion Power Management	7	6	1	\$41,283,553
Fuel Cells and Energy Storage	33	22	5	\$28,879,295
Solar Photovoltaics	8	6	0	\$7,370,000
Situational Awareness and Surveillance Systems	21	18	3	\$5,208,182
Other Non-State Category	394	89	10	\$53,264,137

Similarly, advanced materials technologies and startups have been supported by Ohio Third Frontier. Deal flow related to polymeric and engineered materials through Third Frontier remains strong with the Technology Validation and Startup Fund receiving 49 applications related to polymeric and engineered materials, leading to 18 awards, in the grant program's four cycles to date.

Specific to UARF, 21 of the 54 startups created since 2001 are based on polymeric and engineered materials, including:

- Akron Polymer Systems, which currently employs 14 Ph.D. researchers, has raised more than \$1.5 million in federal research funding and has commercialized coatings for high performance displays;
- SNS Nano Fiber Technologies, a joint venture with German specialty chemical company Schill & Seilacher which employs 15 and produces specialized wound dressings;
- NGJ, a recent Technology Validation & Startup Fund grant recipient that produces nanofibers through a novel gas jet process;
- Akron Surface Technologies Inc., a venture stemming from UA's partnership with Timken that is opening facilities to provide specialized engineered surfaces services for aerospace, automotive, industrial, and medical applications; and
- Poly MedTech, a wound closure adhesive company stemming from Third Frontier funded research at UA and led by OrthoHelix founder David Kay.

IV. Business Driven/Market Focus

The Polymeric and Engineered Materials Technology Commercialization Center (PEM TCC) will have at least three mechanisms for obtaining continuous market insight:

- The Board of Advisors, which provides overarching strategic direction to PEM TCC, will be led by an individual with significant industry experience and comprised of a majority of board members from the private sector.
- The Technology Demonstration Panel, which will make decisions regarding which emerging technology and products receive PEM TCC Services and Technology Demonstration Funding, will include industry personnel, investors and entrepreneurs, as well as leading researchers to instill the desired state-of-the-art technology.
- The Scale-Up Investment Fund, which will negotiate large investments for market entry and company growth, will function like a VC with an experienced manager leading day-to-day operations and a group of investors, entrepreneurs, and representatives from large corporations providing leadership.

Beyond these groups, PEM TCC will engage the private sector in a wide range of center activities, including generating research and technology that can serve as deal flow, serving as mentors to technology teams in the imagining and incubating stages of development, issuing "challenges" that describe industry needs to be met by researchers at regional universities, and providing direct feedback on the market potential of technologies, products and/or companies.

V. Service and Technology Acceleration Orientation

The PEM TCC (See Table 2 below) will fill a gap in the Demonstrating to Market Entry stages for Northeast Ohio startups (shown in green). Over the past decade, Northeast Ohio has built a strong ecosystem for funding and supporting early stage ventures, including sourcing significant deal flow from universities,

corporations, and startups in the Imagining stage as well as providing financial support through the Technology Validation and Startup Fund, Innovation Fund, and JumpStart in the Incubating and Demonstrating stages.

In the late Imaging to early Incubating stages, UA has added two new programs to sharpen the market focus of emerging technologies. UA's NSF I-Corps Site is open to university faculty across the region and teaches through direct contact with potential customers to assess a product's viability, learn pain points, and specify a minimum viable product. The program serves as a feeder into the nation-wide federal I-Corps Teams program, which provides later-stage, more advanced training. Similarly, UA's Innovation Practice Center commits UA funding to form business teams around the most promising university technologies and to fund initial prototyping.

Adding to this capability, PEM TCC will provide new technology vetting expertise by convening a Technology Demonstration Panel of top scientific researchers, industry, and market experts, and venture capital managers, as stated above. This panel will provide strong market-driven insight, discussing the market potential of technologies brought to the panel and formulating lists of market needs that can be shared with regional research institutions. Experienced panel members will provide connection to technical and business support services already existing in the region. Furthermore, the PEM TCC will provide new prototyping and technical services through shared resources and the acquisition of new resources needed by the region. The PEM TCC Services program will support full-time personnel with significant experience in supporting technology and startup development to provide such support services as connection to facilities for prototyping, testing and technical support, intellectual property strategy, market analysis, customer discovery, and business planning. This expertise will complement the existing expertise of UARF.

Table 2: Relationship for how the PEM TCC will help fill significant commercialization gaps in Northeast Ohio.

Imagining	Incubating	Demonstrating	Market Entry	Growth & Sustainability
University research labs				
Corporate research labs				
	OTF TVSF Phase 1			
		OTF TVSF Phase 2		
UA I-Corps Site				
	NSF I-Corps Teams			
UA Innovation Practice Center				
		Innovation Fund		
		Federal Agency SBIR Phase I		
		Federal Agency SBIR Phase II		
		ARCHAngels		
		JumpStart Fund		
PEM TCC Services				
	PEM TCC Demonstration Fund			
		PEM TCC Scale-Up Investments		
			Other VCs	

- UA/UARF programs
- Ohio Third Frontier funded programs
- Federal programs
- Other private actors
- PEM TCC

Two mechanisms will be created to provide needed funding to emerging technologies and companies: the Technology Demonstration Fund and the Scale-Up Investment Fund. The Technology Demonstration Fund will offer \$25,000 to \$200,000, in a milestone-driven fashion, to support technologies in need of prototyping, third party validation or other support critical to demonstrating product feasibility. It is estimated that up to 30 technologies may receive this funding each year. Complementing the efforts of the Technology

Demonstration Fund, the Scale-Up Investment Fund will select products to receive significant pre-VC funding of \$200,000 to \$1,000,000 in equity investment funding to achieve market entry or grow a business. The number of companies receiving Scale-Up Investments will vary based on the number of qualified candidates and the size of investments.

VI. Validation and Sustainability

The PEM TCC will achieve sustainability for all three of its key components through interdependencies and shared resources amongst the programs. PEM TCC Scale-Up Investments, which will represent PEM TCC's latest stage involvement in promising companies, will operate similar to a VC fund making equity investments in the most promising companies emerging from the Center. The Scale-Up Investments arm will continually solicit external investors and will provide a return to these investors as well as to the fund itself. The PEM TCC Demonstration Fund and Services will maintain their budget through participation in the Scale-Up Investment Fund. Unused portions of the Demonstration Fund and Services budget will be invested each year as part of the Scale-Up Investment Fund. These investments will provide regular returns, which will be used to fund future year PEM TCC Demonstration and Services programs and re-investment in the Scale-Up Investment Fund. Again, external investment coupled with the return-on-investment will be pivotal to long-term sustainability.

To assist UARF in the equity investment and funding, we have partnered with and will be using the services of Acquire Investments, which is a regional, private investment firm that focuses on driving commerce in Northeast Ohio and providing exceptional results for their investors. Acquire Investments is well-established and respected within our community, has a knowledge insight and strong connections into local and national resources, as well as possesses a unique overview of the Northeast Ohio community *via* their value-driven network of people and resources. In the past year and one half, Acquire Investments has retained or created 175 jobs, increased their clients payroll by \$7.8M, and deployed \$10M plus in deployed capital.

VII. Economic Impacts

The PEM TCC will have significant and lasting impacts in Northeast Ohio. Specifically, the PEM TCC will become sustainable through investment and return on investment through the Scale-Up Investments. PEM TCC will provide services to more than 200 technologies throughout this six-year period. It is estimated that the subsequent companies that are created based on the services provided to these 200 technologies will be responsible for more than 1000 new high paying, technology-based jobs in Ohio. Additionally, on the conservative side but based on the performance of our ARCHAngels network noted above, these companies will raise more than \$50-100M in follow-on investment and will account for aggregate product and service sales of more than \$120M.