

# ANNUAL REPORT FY 2021—2022

**Center for Manufacturing Research**

**College of Engineering**

**Tennessee Tech University**



**College of Engineering**  
TENNESSEE TECH



**Center for Manufacturing Research**  
*Moving Technology Forward*

## **About the Cover**

Shown on the cover is Mechanical Engineering undergraduate student Vanessa Hughes, checking the compressed air lines for costly leaks using an ultrasound leak detector at a local manufacturing plant, as part of the mission of the Industrial Assessment Center (IAC). The IAC is funded by the U.S. Department of Energy to provide no-cost energy efficiency assessments to small and medium sized manufacturers. IAC students learn practical energy efficiency skills and knowledge in real world plant environments while assisting the manufacturers save money on their utility bills and reduce their carbon footprint. The CMR has administered the IAC program since its inception at Tennessee Tech University in 2006.

### **Center for Manufacturing Research**

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# **Tennessee Technological University Center for Manufacturing Research Annual Report – FY 2021 – 2022**

## **Mission Statement (Unchanged since 2001)**

*“To advance and support scientific and engineering knowledge in areas related to manufacturing through fundamental research and technology transfer activities, and to impact the instructional program in those areas.”*

***The Center for Manufacturing Research (CMR) at TTU was established in 1984 and named a THEC Established Center of Excellence in 1990.***

### **Director**

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### **CMR External Advisory Board**

Dr. Abhijeet Borole – Electro-Active Technologies, Knoxville, TN  
Thomas Lawson – Nissan North America, Decherd, TN  
Brad Long – Cummins Filtration, Cookeville, TN  
Jonathan Miller – Aerojet Ordnance Tennessee, Jonesborough, TN  
Dr. Richard Mu - TSU Interdisciplinary Graduate Engineering Research Institute, Tennessee State University, Nashville, TN  
David Nesbitt – Applied Thermal Coatings, Chattanooga, TN  
Robert Wiseman – Lochinvar LLC, Lebanon, TN

### **CMR Faculty and Staff**

Brian Bates, Senior R&D Engineer  
Michelle Davis, Outreach Coordinator  
Dr. Mingyang Gong, Postdoctoral Research Associate  
Dr. Nan (Terry) Guo, Assistant Research Professor  
E. Wayne Hawkins, Material Science Lab Manager  
Suzanne Henry, Center Manager  
Giovanni Mainardi Neto, R&D Engineer I  
Tammy Martin, Financial Associate (part-time, temporary)  
Phyllis Stallion, Administrative Associate V  
Darlene Wiegand, Financial Analyst (part-time, temporary)

## **CMR Faculty Associates\***

Dr. Mohammad Albakri, ME  
Dr. Ali Alouani, ECE  
Dr. Steven Anton, ME  
Dr. Pedro E. Arce, ChE  
Dr. Andrea Arce-Trigatti, Curriculum & Instruction  
Dr. Indranil Bhattacharya, ECE  
Dr. J. W. Bruce, ECE  
Dr. Stephen Canfield, ME  
Dr. Pinggen Chen, ME  
Dr. George Chitiyo, Curriculum & Instruction  
Dr. Glenn Cunningham, ME  
Dr. William Eberle, CS  
Dr. Ismail Fidan, MET  
Dr. Manaak Gupta, CS  
Dr. Syed Rafay Hasan, ECE  
Dr. Ada Haynes, Sociology & Political Science  
Dr. Stephen Idem, ME  
Dr. Duckbong Kim, MET  
Dr. Ethan Languri, ME  
Dr. Allen MacKenzie, ECE  
Dr. Mohamed Mahmoud, ECE  
Dr. Vahid Motevalli, College of Engineering, ME  
Dr. Joseph Ojo, ECE  
Dr. Andy Pardue, ME  
Dr. Avinash Paruchuri, MET  
Dr. Darek Potter, STEM  
Dr. Mohan Rao, ME  
Dr. Rory Roberts, ME  
Dr. Jonathan (Robby) Sanders, ChE  
Dr. Susmit Shannigrahi, CS  
Dr. Ambareen Siraj, CS  
Dr. Holly Stretz, ChE  
Dr. Doug Talbert, CS  
Dr. John Tester, GBE  
Dr. Dennis Ulybyshev, CS  
Dr. Ahmedreza Vasselbehagh, ME  
Dr. L. (Fred) Vondra, MET  
Dr. Chris Wilson, GBE, ME  
Dr. Dale Wilson, ME  
Dr. Jiahong (John) Zhu, ME

\* CMR Faculty Associates are TTU faculty members who have been working with the CMR through serving as principal investigators, co-principal investigators or other senior personnel on externally-funded projects, or submitting proposals to seek external funding.

# EXECUTIVE SUMMARY

FY21-22 has been an exciting year for the Center and some significant achievements have been made by the committed CMR Faculty Associates. To advance technologies and optimize efficiency, resiliency and sustainability across the full manufacturing life cycle, CMR Faculty Associates have focused their efforts in a range of research areas.

Dr. Duckbong Kim has received the National Science Foundation's (NSF) most prestigious Early Career Development (CAREER) award, \$526,186 in total to support his research and teaching activities in the area of additive manufacturing of refractory alloys for high-temperature applications. Dr. Kim and his graduate students will determine the root causes of imperfections in additively-manufactured refractory alloy structures and provide transformative knowledge and scalable methodology to industries. The educational and outreach activities will help develop the skills for K-12, undergraduate, and graduate students, particularly for underrepresented minorities.

The Industrial Assessment Center (IAC) led by Dr. Ethan Languri has received a 5-year award of \$2.3M (\$1,750,000 sponsor share + \$560,026 cost share) from the Department of Energy (DOE) to continue their efforts in the DOE IAC program. Tennessee Tech is the only university in Tennessee that has had this Industrial Assessment Center for the past 15 years. The CMR IAC will continue to provide solutions and assistance in energy saving and waste reduction to small- and medium-sized manufacturers across the State.

Dr. Rory Roberts has received a \$1.5M grant (\$1,337,282 sponsor share + \$168,619 cost share) from DOE to address challenges faced in all electric propulsion-based aviation. With a very ambitious goal, this project is looking at the larger 737 Boeing type aircraft for moving a large number of people for flights that are six to eight hours long, cross country and even U.S. to Europe. The idea is to utilize carbon neutral fuels such as bio-derivatives, bio natural gas and methane to be integrated with traditional propulsion systems on aircraft to enable economically viable net-zero greenhouse gas emissions for long-range electric commercial aviation.

In FY21-22, 23 research projects were activated for a total of \$2,085,716 from various funding agencies; this number would have been much higher but award negotiations caused some delay in new award activation. CMR faculty and faculty associates submitted 41 research proposals with a total over \$30M, which reached the highest level since the Center's inception in 1984. We believe the seeds have been planted, and just like hardworking farmers, we eagerly await the harvest.

CMR Faculty Associates have also been dedicated to teaching and training next-generation manufacturing workforce. In FY21-22, the CMR supported a total of 53 graduate students (23 M.S. and 30 Ph.D. students). Among the graduate students funded by CMR, 5 M.S. and 6 Ph.D. students were from underrepresented minorities. CMR Faculty Associates and R&D engineers have published 50 journal papers, 54 conference papers, and five book chapters during the past year. They have also filed one invention disclosure.

## Center Research, Education and Outreach Areas

**Digital Design and Manufacturing** including (1) additive manufacturing, (2) advanced robotics and controls, and (3) cybersecurity in manufacturing.

**Sustainable Materials and Manufacturing** including (1) materials processing and modeling and (2) energy conversion / storage materials and devices.

**Industry Support** provides Tennessee manufacturers with technical expertise in problem-solving challenges faced in materials, design, testing, and processes.

**Education and Outreach** efforts enhance the Tennessee workforce development and outreach in the CMR's research areas in addition to such other activities as energy efficiency, waste reduction, and productivity improvements.

## Selected Highlights from FY 2021 – 2022

Twenty-three different research projects were funded for a total of \$2,085,716 from various funding agencies (i.e., National Science Foundation, Department of Energy, Tennessee Valley Authority).

CMR's new matching funds for the past FY were \$1,643,235. This amount excludes \$460,921 of indirect costs associated with this year's funded projects.

Forty-one research proposals totaling \$30,896,217 were submitted by CMR faculty and faculty associates.

CMR supported 53 graduate students during the past FY. Twenty-three M.S. students and 30 Ph.D. students were funded from both State appropriations and external funding received by faculty. Specifically, external grants funded nine of the M.S. students and 11 of the Ph.D. students. Thus, 38% of CMR graduate students supported was from external funding. Among the graduate students funded by CMR, five M.S. and six Ph.D. students were from underrepresented minorities.

Seven M.S. students and five Ph.D. students supported by CMR received their degrees during FY 2021-2022.

CMR supported a total of 41 undergraduate students during this past fiscal year from both State Appropriations and externally funded projects.

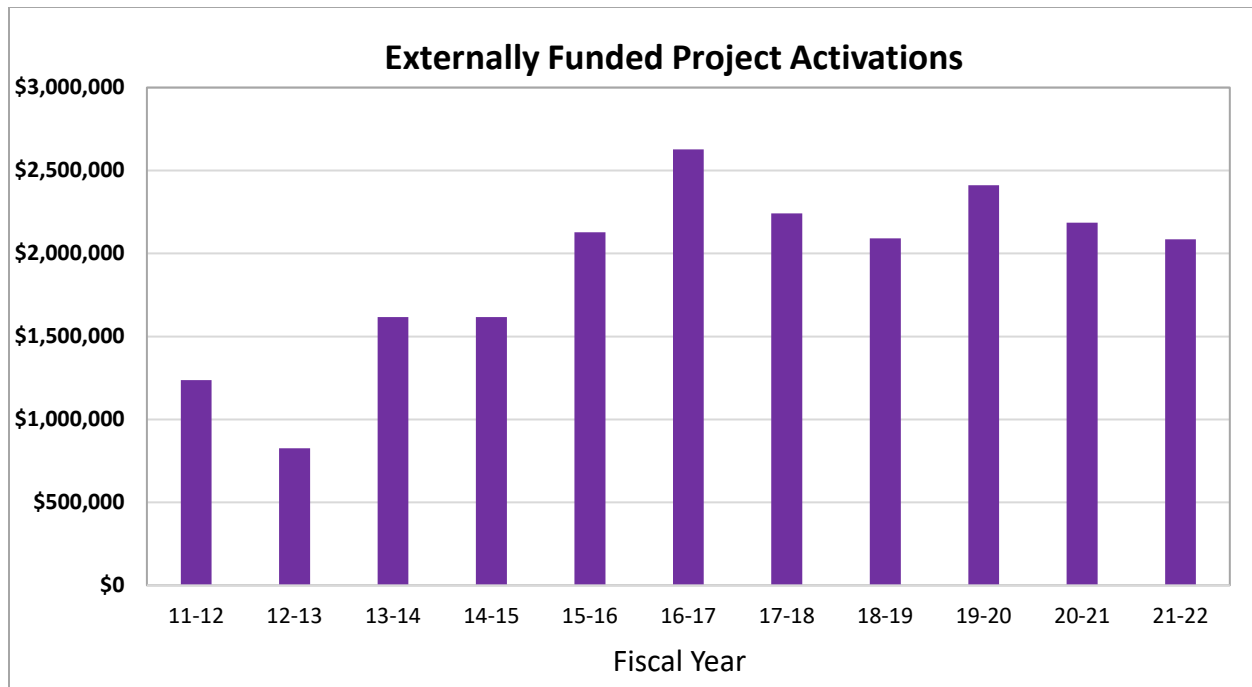
CMR Faculty Associates and R&D engineers have published 50 journal papers, 54 conference papers, and five book chapters during the past year. They have received one invention disclosure.

**Table 1. Summary of CMR Accomplishments**

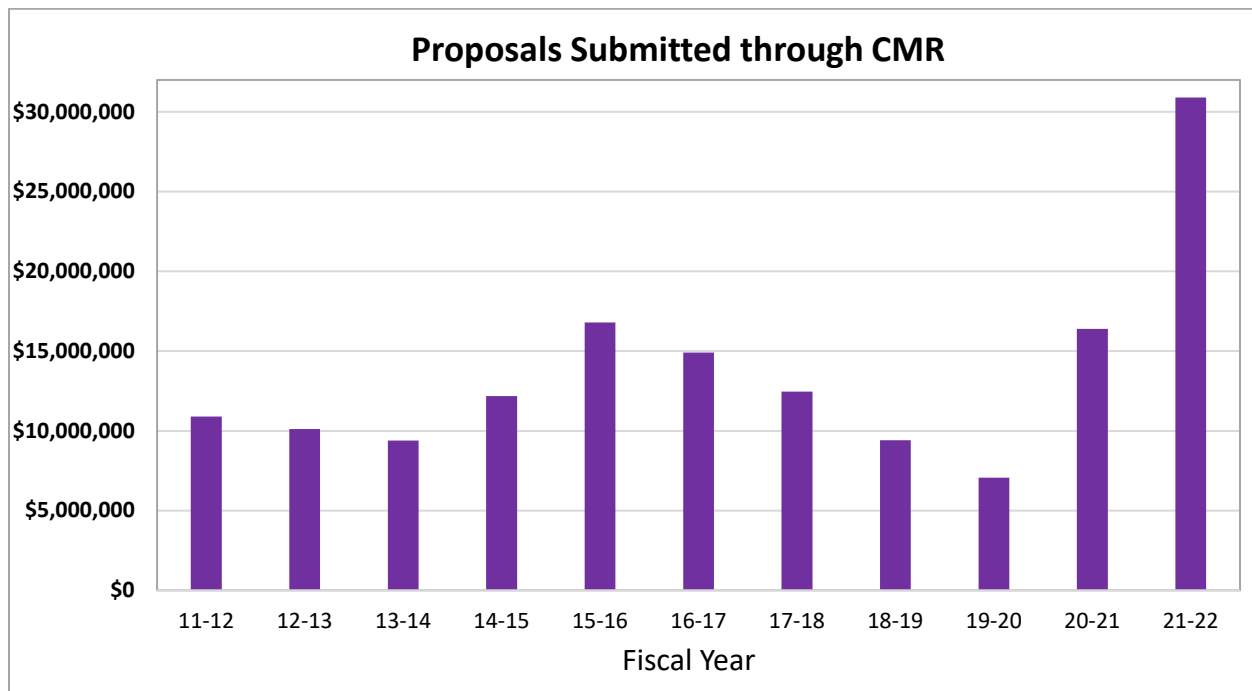
|                                                                                         | <b>FY 16-17</b> | <b>FY 17-18</b> | <b>FY 18-19</b> | <b>FY 19-20</b> | <b>FY 20-21</b> | <b>FY 21-22</b> |
|-----------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Total External Activations                                                              | \$2,628,183     | \$2,242,209     | \$2,090,724     | \$2,411,429     | \$2,185,133     | \$2,085,716     |
| Number of Graduate Students Supported by External Funding and State Appropriations      | 55              | 46              | 33              | 36              | 41              | 53              |
| Percentage of Graduate Students Supported by External Funding                           | 49%             | 67%             | 55%             | 53%             | 59%             | 38%             |
| Number of Undergraduate Students Supported by External Funding and State Appropriations | 69              | 53              | 46              | 35              | 50              | 41              |

Table 1 summarizes CMR accomplishments in the past six years. A brief description of some of these funded projects can be found in the “Research Highlights” on pages 7-9.

The Center’s annual external activations (FY11-12 to FY21-22) are presented in Figure 1. The proposals submitted by the CMR Faculty Associates (FY11-12 to FY21-22) are shown in Figure 2.



**Figure 1 – Externally Funded Activations Since FY11-12**



**Figure 2 – Proposals Submitted Through CMR Since FY11-12**

Table 2 shows various sources of external revenues for the past six years that were used to “release” or “free up” State appropriations for other strategic investment areas.

**Table 2. Salary and Supplies Released by External Funding**

| <b>Performance Metrics</b>                                                                             | <b>FY 16-17</b> | <b>FY 17-18</b> | <b>FY 18-19</b> | <b>FY 19-20</b> | <b>FY 20-21</b> | <b>FY 21-22</b> |
|--------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| CMR faculty and staff release time                                                                     | \$142,801       | \$101,464       | \$86,717        | \$129,844       | \$155,410       | \$80,066        |
| Graduate student stipend and fees from external sponsors                                               | \$481,254       | \$428,579       | \$287,144       | \$157,179       | \$294,022       | \$431,500       |
| Total of income resources (F&A return, testing income, GRA support, equipment usage, and release time) | \$796,950       | \$614,388       | \$412,454       | \$304,220       | \$472,841       | \$542,281       |

### **Research Highlights**

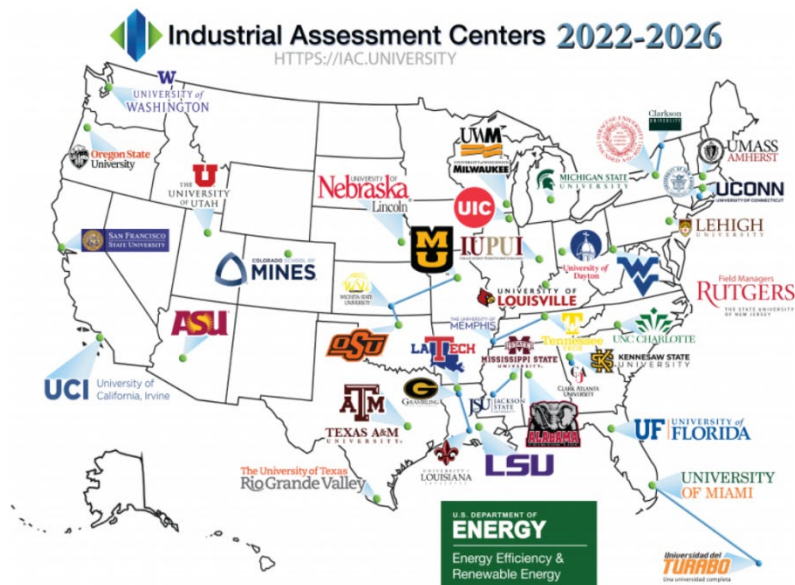


CMR Faculty Associate **Dr. Duckbong Kim** (Manufacturing and Engineering Technology) received the prestigious National Science Foundation CAREER Award for research into the additive manufacturing of high-temperature alloys capable of withstanding harsh environments such as rocket engines, high-temperature furnaces, and electronic components. Dr. Kim received a five year award of more than \$500,000 for the NSF's Faculty Early Career Development (CAREER) Award (Year 1 activation of \$81,169) to further investigate the high-temperature alloy titanium-zirconium-molybdenum (TZM), which holds tremendous potential for the energy and space industries because of its exceptional strength, stability, and high melting point. Ultimately he will develop a methodology to successfully fabricate TZM parts using wire+arc additive manufacturing – an arc welding process for 3D printing metal parts. The NSF CAREER grant will also fund workforce development initiatives to equip Tech's students with cutting-edge skills in emerging, technology-intensive additive manufacturing and data science. The award will facilitate

undergraduate and graduate internships at national laboratories and create an initiative to provide hands-on STEM experiences to students in K-12 schools.



**Dr. Rory Roberts**, CMR Faculty Associate, was awarded a total of \$1,337,282 for a two year project from the Department of Energy for the project titled “High Power Density Carbon Neutral Electrical Power Generation for Air Vehicles”. The Year 1 funding of \$822,342 was received and shared between CMR and CESR (Center for Energy Systems Research) for \$411,171 each. Electric propulsion for air vehicles requires a high-power density and high-efficiency electric storage and power generation system that can operate at 35,000 feet in altitude to meet economic and environmental viability. This project will combine a stack comprised of tubular Solid Oxide Fuel Cells (SOFCs) with a gas turbine combustor to address challenges faced in all electric propulsion-based aviation. The combined SOFC-combustor concept maximizes power density and efficiency while minimizing system complexity, weight, and cost. This elegant and revolutionary concept meets specific power and energy requirements to enable economically viable net-zero greenhouse gas emissions for long-range electric commercial aviation.



**Dr. Ethan Languri and Dr. Stephen Idem**, CMR Faculty Associates, received two awards from the Department of Energy totaling \$350,000 (\$1.5M total 5-year award = \$1,337,282 sponsor share + \$168,619 cost share) to continue the mission of the Tennessee Three-Star Industrial Assessment Center (IAC). Established in 2006, the IAC has two primary goals: 1) Assisting small to medium sized manufacturers in improving their energy efficiency, and 2) Training

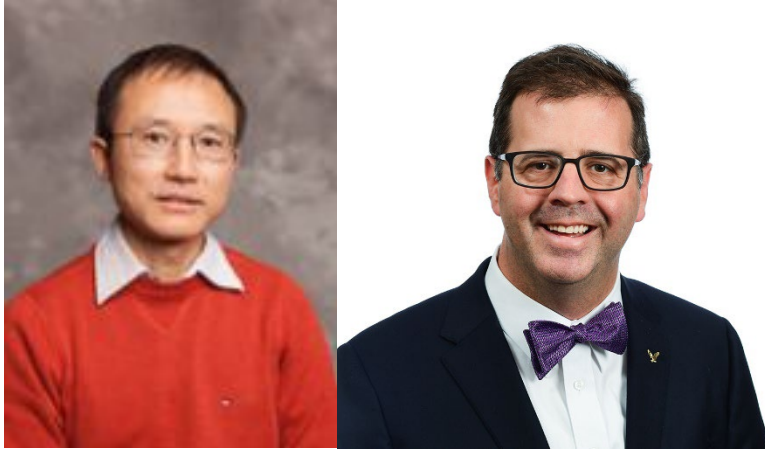
engineering students in best practices of industrial energy efficiency to prepare them for the workforce. Tennessee Tech is the only university in Tennessee that has had this Industrial Assessment Center for the past 15 years.

In FY 2021-22, the IAC conducted energy efficiency assessments for 22 clients in Tennessee, Kentucky, Alabama, and Mississippi. One such client was NASA's Marshall Space Flight Center in Huntsville, AL (pictured). The IAC team audited most of the buildings on campus and made recommendations for improvements that will increase the campus' energy efficiency and lower their carbon footprint. One such recommendation was to recover heat from the air compressor cooling water to preheat the hot water boiler return water. This project alone will save an estimated \$5,000 on the facility's natural gas costs.

Over the sixteen years that the IAC has been in existence at Tennessee Tech, recommendations that have been implemented have saved 10.91 trillion BTUs of energy and .67 million metric tons of CO<sup>2</sup> from the atmosphere.



**Dr. Ismail Fidan**, CMR Faculty Associate, was awarded \$49,196 from Somerset Community College, via NSF funds, for a project titled "Improving Technician Skills in Advanced Manufacturing with Low-Cost Virtual Reality Platform". The goal of this project is to improve student learning by increasing the accessibility of virtual reality training applications for students in advanced manufacturing technician programs. To test the effectiveness of the platform, the project will develop a number of virtual reality modules on blueprint reading, geometric dimensioning and tolerancing, basic work area safety, and quality control. The effectiveness of the modules in improving student learning will be assessed using pre- and post-tests for incumbent manufacturing technicians and student technicians. The project team will then train faculty to develop and implement their own customized modules and contribute to an online library of all the resulting virtual reality modules.



**Dr. Nan "Terry" Guo**, CMR Assistant Research Professor, and **Dr. Allen MacKenzie**, CMR Faculty Associate, were awarded \$64,073 from NSF for a project titled "Collaborative Research: Sensing by Leveraging Cellular Communication Networks: A Framework of Medium Distance Baseline Interferometry". The objective is to develop a passive integrated Sensing and Communication (ISAC) scheme with medium-distance-baseline interferometry in outdoor sensing, by exploiting the baselines formed by fixed or mobile base stations in cellular communication networks, and taking advantage of both communication signals and the existing infrastructure.



**Dr. Syed Hasan and Dr. Mohamed Mahmoud**, CMR Faculty Associates, received \$130,577 from NSF for the third year of a three-year project titled "REU Site: Secure and Privacy-Preserving Cyber Physical Systems: Software and Hardware Approaches". Ten undergraduate students from Tennessee Tech and other universities across the country participated in a ten-week collaborative research program at the Tennessee Tech campus. Student interns were matched with faculty researchers and graduate student mentors to conduct research into cybersecurity challenges in future cyber-physical systems including smart and safe cities, self-driving cars, industrial internet of things, and smart power grid.

## Center Activities

### External Advisory Board

Formed in 2020, the CMR External Advisory Board (EAB) held its annual meeting in March 2022. The EAB is a dynamic group with members from industry and academia, such as Nissan North America, Cummins Filtration, and Aerojet Ordnance Tennessee. In the board meeting, members were introduced to the CMR and its mission, vision, goals and focus areas. Current research projects and research education infrastructure were reviewed. The EAB will provide guidance, advice, and direction for the CMR's activities and assist the Center with its strategic initiatives.



### National Manufacturing Day

Each year, Manufacturing Day (MFG Day) is held on the first Friday in October in order to show students, parents, and the public what modern manufacturing is all about. **Dr. Ismail Fidan**, CMR Faculty Associate, hosted Tennessee Tech's annual MFG Day celebration with tours of campus manufacturing laboratories, a visit to the Mobile Additive Manufacturing Platform, and demonstrations of metal casting practices in the on-campus foundry. Over 160 educators and students attended.

### Additive Manufacturing Day at Tennessee Tech

In November 2021, the CMR hosted the inaugural Additive Manufacturing (AM) Day at Tennessee Tech. This virtual event attracted attendees from many countries to participate in presentations from AM researchers and industry leaders on topics such as: AM with Cement-based materials,

Multi-material AM, Wire-Arc AM, AM from the UK, and AM Potpourri. This event was organized by **Dr. Ismail Fidan** and is planned to be an annual event.



## Fall Fun Fest

In September 2021, the Mobile AMP (Additive Manufacturing Platform) trailer was on site at Cookeville's annual fall festival to demonstrate the latest advances in additive manufacturing technology to the public. This project and its deliverables were presented to 843 participants including educators, students, and children.

## Materials Science Laboratory



The Materials Science Laboratory (MSL) conducts morphology and topographical characterization for a wide range of materials, including (but not limited to) polymers, ceramics, metals and their alloys, fibers, aggregates and composites. A centerpiece of the MSL is the ultra-high-resolution Field Emission Scanning Electron Microscope Hitachi FE\_SEM SU7000. Tennessee Tech was the first university in North America to receive this equipment.

### Testimonials from CMR Faculty Associates:

“In general, I would say that students are delighted to use an instrument of this type to explore surface effects on transport and reaction mechanisms of different applications. It has been an amazing tool to attract students to areas of research related to materials characterization in applications related to the environmental water cleaning from biopharmaceutical compounds, contamination of bio samples such as bird feathers by oil spills, and hydrogels in wound healing and other applications of health care engineering” – Dr. Pedro Arce.

“[A student] is participating in a Cookeville high school student work based learning internship in Dr. Rice’s chemical engineering lab ... Such internships are occurring throughout Cookeville to provide experiences to senior high school students in their prospective future fields of interest. Dr. Rice has [the student] working on research related to zinc/air batteries, specifically the control of electrodeposited surface morphologies. The SU7000 SEM provides physical quantification of the quality of the electrodeposit and the effectiveness of the removal process.” – Dr. Cynthia Rice.

## CMR Staff Recognition and New Hire



Phyllis Stallion, Administrative Associate 5, retired in February 2022 after 38 years of service with Tennessee Tech (37 years with the CMR). Phyllis worked closely with graduate students and faculty associates. She served as a liaison and advocate for CMR-supported graduate students and played a key role in the daily administrative operations for the CMR research activities. Her dedication and caring spirit are greatly missed.



In November 2021, Giovanni Mainardi Neto joined the CMR as an R&D Engineer I. Giovanni graduated with his B.S. in Mechanical Engineering in 2017 and his M.S. in Mechanical Engineering in 2019 at Tennessee Tech University. He has experience with material strength characterization, microstructural analysis, coating development, arc melting & gas atomization, high-temperature oxidation testing, and additive manufacturing.

As a student, he worked in the powder metallurgy industry at Hoeganaes Corporation in Gallatin, TN, where he developed documentation to cover equipment specification and software troubleshooting. He also worked at Shiroki NA in Smithville, TN, assisting with project kickoffs, supporting pre-production trial runs, and generating project status reports. His graduate research focused on developing electroplated metal-matrix composite coatings for high temperature applications. During his graduate studies, he also worked as a teaching assistant for Dynamic Modeling & Controls Lab, supervising and teaching weekly sections of 18-20 junior-level undergraduate students.

Currently, as an R&D Engineer, Giovanni is supporting research efforts in areas related to advanced manufacturing and sustainable materials, and developing gas-atomized metal powder for additive manufacturing. Giovanni also supervises the Mechanical Properties Testing laboratory, working closely with faculty and students to develop testing methods for determining strength and fatigue characteristics of novel and traditional materials. He has recently attended a four-day advanced course in test method development for tensile, compression, and fatigue testing at the INSTRON Training Center in Norwood, MA.

## Faculty and Student Accomplishments and Awards

CMR Faculty Associate **Dr. Manaak Gupta** (Computer Science) was awarded the 2021 – 2022 Kinslow Engineering Research Award which is given for the best paper written by a TTU engineering faculty member and published in a refereed professional journal.

CMR Faculty Associate **Dr. Mohamed Mahmoud** (Electrical and Computer Engineering) was awarded the 2021 – 2022 T.S. McCord Engineering Faculty Award which is given to an outstanding engineering faculty member who demonstrates a deep compassion for his/her students and is dedicated to their teaching and advising of students and have the students' welfare as top priority in all that he/she does.

CMR-supported student **Anfal Haris** won the Chemical Engineering Ph.D. division of the Tennessee Tech Research and Creative Inquiry Day for her paper "Role of Nanocellulose Hydrogels in Regenerative Medicine: Preliminary Observations".

CMR-supported student **Steven Lam** won the Chemical Engineering Master's division of the Tennessee Tech Research and Creative Inquiry Day for his paper "Direct Formic Acid Fuel Cells: Mass Transport Optimization of the Anode Catalyst Layer".

CMR-supported student **Mohammad Alshaikh Ali** won the Manufacturing and Engineering Technology Master's division of the Tennessee Tech Research and Creative Inquiry Day for his paper "Optimizing Lattice Infill Structures to Reduce Mass & Power Consumption for Popular 3D Printing Technologies".

CMR-supported student **Mithila Rajeshirke** tied for the winner of the Manufacturing and Engineering Technology Ph.D. division of the Tennessee Tech Research and Creative Inquiry Day for her paper "Fatigue Analysis of Carbon Fibre Reinforced Composite Components Manufactured by Fused Filament Fabrication".

CMR-supported student **Andrew Gothard** won the Mechanical Engineering Master's division of the Tennessee Tech Research and Creative Inquiry Day for his paper "A Method to Generate 3D Patient-Specific Total Knee Arthroplasty Tibia Models".

## Select 2021 - 2022 CMR Supported Alumni



**Rumman Ul Ahsan**, Ph.D., Mechanical Engineering, 2022  
Materials Engineer  
Solvus Global  
Worcester, Massachusetts



**Ankit Gupta**, Ph.D., Mechanical Engineering, 2022  
Research & Development Intern  
Ford Motor Company  
Michigan



**Divya Susmitha Jaladi**, Ph.D., Mechanical Engineering, 2021  
Mechanical Engineer  
Lam Research  
Portland, Oregon



**Hajar Taheri**, Ph.D., Chemical Engineering, 2021  
TD Mod & Integr. Yield Engineer  
Intel Corporation  
Hillsboro, Oregon



**Kuo Yang**, Ph.D., Mechanical Engineering, 2021  
Research Engineer  
Southwest Research Institute  
San Antonio, Texas

## Publications of CMR Faculty Associates & Staff (January 2021 – December 2021)

### Journal Publications

1. Abdelfattah, Sherif, Mohamed Baza, Mahmoud M. Badr, **Mohamed MEA Mahmoud**, Gautam Srivastava, Fawaz Alsolami, and Abdullah Marish Ali. "Efficient Search Over Encrypted Medical Data With Known-Plaintext/Background Models and Unlinkability." *IEEE Access* 9 (2021): 151129-151141.
2. Abdelfattah, Sherif, Mohamed Baza, **Mohamed MEA Mahmoud**, Mostafa M. Fouda, Khalid A. Abualsaud, and Mohsen Guizani. "Multidata-Owner Searchable Encryption Scheme Over Medical Cloud Data With Efficient Access Control." *IEEE Systems Journal* (2021).
3. Adetokun, Bukola Babatunde, **Joseph Olorunfemi Ojo**, and Christopher Maina Muriithi. "Application of large-scale grid-connected solar photovoltaic system for voltage stability improvement of weak national grids." *Scientific reports* 11, no. 1 (2021): 1-15.
4. Afarani, Hajar Taheri, William Carroll, Edward J. Garboczi, and **Joseph J. Biernacki**. "Designing 3D printable cementitious materials with gel-forming polymers." *Construction and Building Materials* 268 (2021): 121709.
5. **Arce, Pedro E., Stephanie Jorgensen, J. Robby Sanders, and Andrea Arce-Trigatti**. "ONLY TWO WEEKS: The Lived Experiences of Four Engineering Educators Transitioning to Virtual Learning during the 21st Century Pandemic." *American Educational History Journal* (2021): 163-171.
6. Chan, Cody Leheng, and **Kwun-Lon Ting**. "Clearance-induced orientation uncertainty of spherical linkages." *Journal of Mechanisms and Robotics* 13, no. 2 (2021).
7. Gupta, Deepti, Smriti Bhatt, **Maanaka Gupta**, and Ali Saman Tosun. "Future smart connected communities to fight covid-19 outbreak." *Internet of Things* 13 (2021): 100342.
8. Ahsan, Md RU, Xuesong Fan, Gi-Jeong Seo, Changwook Ji, Mark Noakes, Andrzej Nycz, Peter K. Liaw, and **Duck Bong Kim**. "Microstructures and mechanical behavior of the bimetallic additively-manufactured structure (BAMS) of austenitic stainless steel and Inconel 625." *Journal of Materials Science & Technology* 74 (2021): 176-188.
9. Ahsan, Md RU, Gi-Jeong Seo, Xuesong Fan, Peter K. Liaw, Seyedamirhossein Motaman, Christian Haase, and **Duck Bong Kim**. "Effects of process parameters on bead shape, microstructure, and mechanical properties in wire+ arc additive manufacturing of Al0.1CoCrFeNi high-entropy alloy." *Journal of Manufacturing Processes* 68 (2021): 1314-1327.
10. Alsabaan, Maazen, Waleed Alsmay, Abdulaziz Alquniah, **Mohamed Mahmoud**, and Mahmoud Nabil. "A distributed surveillance system with full coverage guarantee using positive orthogonal codes." *IEEE Access* 9 (2021): 16837-16848.
11. Amsaad, Fathi, Ahmed Oun, Mohammed Y. Niamat, Abdul Razaque, Selcuk Kose, **Mohamed Mahmoud**, Waleed Alasmay, and Fawaz Alsolami. "Enhancing the Performance of Lightweight Configurable PUF for Robust IoT Hardware-Assisted Security." *IEEE Access* 9 (2021): 136792-136810.
12. Baza, Mohamed, Nouredine Lasla, **Mohamed MEA Mahmoud**, Gautam Srivastava, and Mohamed Abdallah. "B-ride: Ride sharing with privacy-preservation, trust and fair payment atop public blockchain." *IEEE Transactions on Network Science and Engineering* 8, no. 2 (2021): 1214-1229.
13. Baza, Mohamed, Marbin Pazos-Revilla, Ahmed Sherif, Mahmoud Nabil, Abdulah J. Aljohani, **Mohamed Mahmoud**, and Waleed Alasmay. "Privacy-preserving and collusion-resistant charging coordination schemes for smart grids." *IEEE Transactions on Dependable and Secure Computing* (2021).

14. Baza, Mohamed, Ahmed Sherif, **Mohamed MEA Mahmoud**, Spiridon Bakiras, Waleed Alasmay, Mohamed Abdallah, and Xiaodong Lin. "Privacy-preserving blockchain-based energy trading schemes for electric vehicles." *IEEE Transactions on Vehicular Technology* 70, no. 9 (2021): 9369-9384.
15. Balogun, Adeola, **Olorunfemi Ojo**, and Frank Okafor. "Efficiency Optimization Control of Doubly Fed Induction Generator Transitioning Into Shorted-Stator Mode for Extended Low Wind Speed Application." *IEEE Transactions on Industrial Electronics* 68, no. 12 (2021): 12218-12228.
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- Competitive Proposals: A "Group Genius" Approach." In *2021 ASEE Virtual Annual Conference Content Access*. 2021.
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  16. Baza, Mohamed, Ramy Amer, Fathi Amsaad, **Mohamed Mahmoud**, and Waleed Alasmay. "Efficient Privacy-preserving Charging Coordination with Linkability-resistance in the Smart Grid." In *2021 IEEE Globecom Workshops (GC Wkshps)*, pp. 1-5. IEEE, 2021.
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  35. Mamun, Mohammad and **Ali Alouani**, Arrhythmia Classification Using Hybrid Feature Selection Approach and Ensemble Learning Technique" in *2021 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE)*, September 2021, IEEE.
  36. Mithu, M. Rayhan Ahmed, Mike Rogers, **Denis Ulybyshev**, Rajesh Manicavasagam, and Rima Asmar Awad. "Feature Classification for Control System Devices." In *The International FLAIRS Conference Proceedings*, vol. 34. 2021.
  37. Mohammed, H., F. Khalid, P. Sawyer, G. Cataloni and **S. R. Hasan**, "InTrust-IoT: Intelligent Ecosystem based on Golden Dataset Free Power Profiling of Trusted device(s) in IoT for Hardware Trojan Detection", in *Workshop on Hardware and Architectural Support for Security and Privacy (HASP)*, October, 2021.

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In *Proceedings of the 2021 ACM Workshop on Secure and Trustworthy Cyber-Physical Systems*, pp. 13-22. 2021.

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54. Womack, Payton, **Andrea Arce-Trigatti**, **Pedro E. Arce**, **Stephanie Jorgensen**, and J. **Robby Sanders**. "Exploring the Role of Collaboration in the Development of Community Leaders: Student Experiences from a Learning Community in the STEM Foundry Heritage Fellows Program." In *Proceedings of the American Society for Engineering Education Southeastern Conference, Virtual conference*, pp. 1-6. 2021.

### **Book Chapters**

1. **Anton, Steve. R.** and Safaei, M., Piezoelectric Energy Harvesting, chapter in *Encyclopedia of Smart Materials, Volume 4*, Ed. Abdul-Ghani Olabi, Elsevier, United Kingdom, pp. 104-116, 2021.
2. Dua, Shelza, Bharath Nancharla, and **Maanak Gupta**. "Cosine Transformed Chaos Function and Block Scrambling-Based Image Encryption." In *Handbook of Research on Machine Learning Techniques for Pattern Recognition and Information Security*, pp. 121-138. IGI Global, 2021.
3. **Fidan, Ismail**, "Section: Research and Development, Academic Activities and Capabilities in Additive Manufacturing," in *Wohlers Report 2021*, pp. 270-286, ISBN: 978-0-9913332-7-1.
4. Gupta, Deepti, Smriti Bhatt, Paras Bhatt, **Maanak Gupta**, and Ali Saman Tosun. "Game Theory Based Privacy Preserving Approach for Collaborative Deep Learning in IoT." *arXiv preprint arXiv:2103.15245* (2021).
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### **Invention Disclosure**

1. **Ali T. Alouani** and Brandon England, Driverless Systems Using Virtual Roads, submitted Oct. 2021

## External Activations

|   | <b>Project Description</b>                                                                                                                                                                                                       | <b>P.I.</b>                                              | <b>Department</b> | <b>Total Funds</b> |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------|--------------------|
| 1 | Cyber-Physical System Integrity and Security with Impedance Signatures<br>Virginia Tech (via NSF funds) - Subaward Agreement 480322-19C95 - Year 3<br>Account #: 5-31321 843MC-Y3                                                | Mohammad Albakri                                         | ME                | \$16,302           |
| 2 | Intelligent Robot for TVA Substation Inspection<br>Tennessee Valley Authority - PO 7020656 - Year 3 of 4<br>Account #: 5-32605 939MC-Y3                                                                                          | Ali Alouani                                              | ECE               | \$177,473          |
| 3 | Developing an EV Demonstration Testbed in the Upper Cumberland Region of Tennessee, an Economy Distressed Rural U.S. Department of Energy - Award DE-EE0008888 - Year 3 of 3<br>Account #: 5-32601 821MC-Y3                      | Pingen Chen<br>Stephen Canfield<br>Indranil Bhattacharya | ME<br>ME<br>ECE   | \$147,987          |
| 4 | On-board Diagnostic Algorithm Research and Development for Selective Catalytic Reduction System Aging Detection.<br>Cummins Advanced Engineering Controls<br>Account #: 5-35300 927MC                                            | Pingen Chen                                              | ME                | \$64,732           |
| 5 | Mobile Additive Manufacturing Platform for the 21st Century STEM Workforce Enhancement<br>Somerset Community College ( via NSF funds) - NSF Award DUE-1902437 - Year 3 of 3<br>Account #: 5-31314 786MC-Y3                       | Ismail Fidan                                             | MET               | \$92,170           |
| 6 | Improving Technician Skills in Advanced Manufacturing with Low-Cost Virtual Reality Platform<br>Somerset Community College (via NSF funds) - Award 2055722 - Year 1 of 3<br>Account #: 5-31330 871MC-A1                          | Ismail Fidan                                             | MET               | \$49,196           |
| 7 | Improving Technician Skills in Advanced Manufacturing with a Low-Cost Virtual Reality Platform<br>Somerset Community College (via NSF funds) - Year 2 of 3 - Memo of Agreement for PRIME 20555722<br>Account #: 5-31330 871MC-Y2 | Ismail Fidan                                             | MET               | \$59,125           |

|    | <b>Project Description</b>                                                                                                                                                                                                                             | <b>P.I.</b>                | <b>Department</b> | <b>Total Funds</b> |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------|--------------------|
| 8  | Collaborative Research: Sensing by Leveraging Cellular Communication Networks: A Framework of Medium Distance Baseline Interferometry<br>National Science Foundation - Award 2135275 - Year 1 of 3<br>Account #: 5-31329                      903MC-Y1 | Nan Guo<br>Allen MacKenzie | CMR<br>ECE        | \$64,073           |
| 9  | Investigations into the Design Rules for the Control of Wire Arc Additive - Supplement<br>National Science Foundation<br>Account #: 5-31315                      840MC-S                                                                               | Duckbong Kim               | MET               | \$24,735           |
| 10 | Investigations into the Design Rules for the Control of Wire Arc Additive<br>National Science Foundation<br>Account #: 5-31315                      840MC-Y2                                                                                           | Duckbong Kim               | MET               | \$73,386           |
| 11 | Development of Artificial Intelligence-based Generative Process Planning Mechanism in Additive Manufacturing<br>Institute for Information and Communications Technology Promotion, South Korea<br>Account #: 5-35288                      898MC-A1     | Duckbong Kim               | MET               | \$33,333           |
| 12 | Development of Artificial Intelligence-based Generative Process Planning Mechanism in Additive Manufacturing<br>Gwangju University<br>Account #: 5-35289                      898MC-B1                                                                 | Duckbong Kim               | MET               | \$16,667           |
| 13 | Development of Artificial Intelligence-based Generative Process Planning Mechanism in Additive Manufacturing<br>Chonnam University<br>Account #: 5-35290                      898MC-C1                                                                 | Duckbong Kim               | MET               | \$16,667           |
| 14 | CAREER: Fundamental Investigation of Metal Additive Manufacturing Toward Molybdenum Alloy Structures - Award 2131905 Year 1 of 5<br>National Science Foundation<br>Account #: 5-31333                      914MC-Y1                                    | Duckbong Kim               | MET               | \$81,169           |
| 15 | Development of a Near-Optimal Process through Analysis of Microstructure and Mechanical Strength for Component Repair<br>Ki-Tech (Korean Institute of Industrial Technology)<br>Account #: 5-35291                      918MC-R                        | Duckbong Kim               | MET               | \$17,900           |

|    | <b>Project Description</b>                                                                                                                                                                                                                                                      | <b>P.I.</b>                   | <b>Department</b> | <b>Total Funds</b> |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------|--------------------|
| 16 | Proof of Concept of Steel to AL Alloy Transitions Joints by Wire Additive Manufacturing<br>Oak Ridge National Laboratory<br>Account #: 5-32626 947MC                                                                                                                            | Duckbong Kim                  | MET               | \$15,001           |
| 17 | Public-Private Partnership to Promote Efficient, Resilient and Secure Manufacturing and Workforce Development<br>US Department of Energy (DOE) - DE-EE0009722 Cooperative Agreement- Partial<br>Year 1 of 5<br>Account #: 5-32623 901MC-1                                       | Ethan Languri<br>Stephen Idem | ME<br>ME          | \$220,000          |
| 18 | Public-Private Partnership to Promote Efficient, Resilient and Secure Manufacturing and Workforce Development<br>US Department of Energy (DOE) - Cooperative Agreement DE-EE0009722 - Partial Year 1<br>Account #: 5-36323 901MC-M1                                             | Ethan Languri<br>Stephen Idem | ME<br>ME          | \$130,000          |
| 19 | REU Site: Secure and Privacy-Preserving Cyber Physical Systems: Software and Hardware Approaches<br>National Science Foundation<br>Account #: 5-31299 784MC-Y3                                                                                                                  | Mohamed Mahmoud<br>Syed Hasan | ECE<br>ECE        | \$130,577          |
| 20 | Control of Modular Multi-Dual Active Bridge Converters for Integrated Ship-Board Power System<br>Office of Naval Research - Award N00014-21-1-2114 -Modification #1<br>Account #: 5-32618 877MC-M1                                                                              | Joseph Ojo                    | ECE               | \$50,000           |
| 21 | Atmosphere Independent Bipropellant Consuming Additively Manufactured Solid Oxide Fuel Cells (SOFCs) for Assured On-Orbit Space Power<br>Southwestern Ohio Council for Higher Education (SOCHE) via DOD funds - Supplement - RQ19-TN-20-7-AFRL2<br>Account #: 5-39328 868MC-S   | Rory Roberts                  | ME                | \$17,020           |
| 22 | Atmosphere Independent Bipropellant Consuming Additively Manufactured Solid Oxide Fuel Cells (SOFCs) for Assured On-Orbit Space Power<br>Southwestern Ohio Council for Higher Education (SOCHE) via DOD funds - Year 2 of 2 - RQ19-TN-20-7-AFRL2<br>Account #: 5-39328 868MC-Y2 | Rory Roberts                  | ME                | \$69,000           |
| 23 | Cryo Thermal Management of High-Power Density Motors and Drives<br>ARPA-via Hyper Tech<br>Account #: 5-32619 884MC-Y2                                                                                                                                                           | Rory Roberts                  | ME                | \$25,631           |

|    | <b>Project Description</b>                                                                                                                                   | <b>P.I.</b>                     | <b>Department</b> | <b>Total Funds</b> |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------|--------------------|
| 24 | High Power Density Carbon Neutral<br>Electrical Power Generation for Air Vehicles<br>Department of Energy<br>Account #: 5-32620                      CESR-RR | Rory Roberts                    | ME                | \$411,171          |
| 25 | Fiber Reactor Extraction Simulation<br>Visionary Fiber Technologies<br>Account #: 5-35292                      908MC                                         | Holly Stretz<br>Bahman Ghorashi | ChE<br>ChE        | \$75,051           |
| 26 | Manufacturing Testing and Design - 2021-<br>2022<br>Various Industries<br>Account #: 5-38585                      100MC-19                                   | Ying Zhang                      | CMR               | \$7,350            |

***External Activations in FY 2021 – 2022 \$2,085,716***

## Schedule 7

### CENTERS OF EXCELLENCE ACTUAL, PROPOSED, AND REQUESTED BUDGET

Institution **Tennessee Technological University** Center **Center for Manufacturing Research**

|                                        | FY 2021-22 Actual                                                                                                     |                  |                  | FY 2022-23 Proposed |                  |                  | FY 2023-24 Requested |                  |                  |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------|------------------|---------------------|------------------|------------------|----------------------|------------------|------------------|
|                                        | Matching                                                                                                              | Appopr.          | Total            | Matching            | Appopr.          | Total            | Matching             | Appopr.          | Total            |
| Expenditures                           |                                                                                                                       |                  |                  |                     |                  |                  |                      |                  |                  |
| <b>Salaries</b>                        |                                                                                                                       |                  |                  |                     |                  |                  |                      |                  |                  |
| Faculty                                | 261,189                                                                                                               | 255,206          | 516,395          | 360,000             | 396,837          | 756,837          | 390,000              | 340,000          | 730,000          |
| Other Professional                     | 122,671                                                                                                               | 333,395          | 456,066          | 85,000              | 447,694          | 532,694          | 90,000               | 440,000          | 530,000          |
| Clerical/ Supporting                   | 0                                                                                                                     | 45,894           | 45,894           | 0                   | 60,604           | 60,604           | 0                    | 50,000           | 50,000           |
| Assistantships                         | 246,750                                                                                                               | 285,217          | 531,967          | 250,000             | 485,395          | 735,395          | 250,000              | 420,000          | 670,000          |
| Hourly Students                        | 60,354                                                                                                                | 34,358           | 94,712           | 50,000              | 26,001           | 76,001           | 50,000               | 21,000           | 71,000           |
| <b>Total Salaries</b>                  | <b>690,964</b>                                                                                                        | <b>954,070</b>   | <b>1,645,034</b> | <b>745,000</b>      | <b>1,416,531</b> | <b>2,161,531</b> | <b>780,000</b>       | <b>1,271,000</b> | <b>2,051,000</b> |
| Fringe Benefits                        | 273,535                                                                                                               | 399,144          | 672,679          | 275,000             | 535,243          | 810,243          | 300,000              | 420,000          | 720,000          |
| <b>Total Personnel</b>                 | <b>964,499</b>                                                                                                        | <b>1,353,214</b> | <b>2,317,713</b> | <b>1,020,000</b>    | <b>1,951,774</b> | <b>2,971,774</b> | <b>1,080,000</b>     | <b>1,691,000</b> | <b>2,771,000</b> |
| <b>Non-Personnel</b>                   | <b>NOTE: Appropriation Expenditures in Fringe Benefits include \$160,224 for Graduate Student Fees in FY 2021-22.</b> |                  |                  |                     |                  |                  |                      |                  |                  |
| Travel                                 | 44,191                                                                                                                | 10,368           | 54,559           | 75,000              | 26,498           | 101,498          | 75,000               | 21,000           | 96,000           |
| Computer Maint./Software               | 7,980                                                                                                                 | 180              | 8,160            | 40,000              | 8,000            | 48,000           | 25,000               | 7,500            | 32,500           |
| Books & Journals                       | 0                                                                                                                     | 0                | 0                | 0                   | 0                | 0                | 0                    | 0                | 0                |
| Other Supplies                         | 121,683                                                                                                               | 90,918           | 212,601          | 315,000             | 105,853          | 420,853          | 325,000              | 75,000           | 400,000          |
| Equipment                              | 0                                                                                                                     | 55,201           | 55,201           | 300,000             | 152,380          | 452,380          | 370,000              | 80,000           | 450,000          |
| Lab. Upgrades/Mainten.                 | 0                                                                                                                     | 148,375          | 148,375          | 0                   | 20,000           | 20,000           | 0                    | 0                | 0                |
| Scholarships for Service               | 0                                                                                                                     | 0                | 0                | 0                   | 0                | 0                | 0                    | 0                | 0                |
| Consultants/Subcontracts               | 397,580                                                                                                               | 3,055            | 400,635          | 682,703             | 2,500            | 685,203          | 475,000              | 0                | 475,000          |
| Renovation                             | 0                                                                                                                     | 0                | 0                | 0                   | 0                | 0                | 0                    | 0                | 0                |
| Seminars/Workshops/Con                 | 120,440                                                                                                               | 1,865            | 122,305          | 100,000             | 2,500            | 102,500          | 150,000              | 0                | 150,000          |
| <b>Total Non-Personnel</b>             | <b>691,874</b>                                                                                                        | <b>309,962</b>   | <b>1,001,836</b> | <b>1,512,703</b>    | <b>317,731</b>   | <b>1,830,434</b> | <b>1,420,000</b>     | <b>183,500</b>   | <b>1,603,500</b> |
| <b>GRAND TOTAL</b>                     | <b>1,656,373</b>                                                                                                      | <b>1,663,176</b> | <b>3,319,549</b> | <b>2,532,703</b>    | <b>2,269,505</b> | <b>4,802,208</b> | <b>2,500,000</b>     | <b>1,874,500</b> | <b>4,374,500</b> |
| <b>Revenue</b>                         | <b>NOTE: Actual Matching Funds do not include Indirect Costs of \$460,921 for FY 2021-22.</b>                         |                  |                  |                     |                  |                  |                      |                  |                  |
| New State Appropriation                | 0                                                                                                                     | 1,636,900        | 1,636,900        | 0                   | 1,704,100        | 1,704,100        | 0                    | 1,874,500        | 1,874,500        |
| Carryover State Appropriation          | 0                                                                                                                     | 591,681          | 591,681          | 0                   | 565,405          | 565,405          | 0                    | 0                | 0                |
| New Matching Funds                     | 1,643,235                                                                                                             | 0                | 1,643,235        | 2,250,000           | 0                | 2,250,000        | 2,500,000            | 0                | 2,500,000        |
| Carryover from Previous Matching Funds | 295,841                                                                                                               | 0                | 295,841          | 282,703             | 0                | 282,703          | 0                    | 0                | 0                |
| <b>Total Revenue</b>                   | <b>1,939,076</b>                                                                                                      | <b>2,228,581</b> | <b>4,167,657</b> | <b>2,532,703</b>    | <b>2,269,505</b> | <b>4,802,208</b> | <b>2,500,000</b>     | <b>1,874,500</b> | <b>4,374,500</b> |

NOTE: Carryover funds of \$565,405 are committed to the following areas: 1) cost-sharing for external grants; i.e., \$188,461 for Year 1 of a newly funded DOE Project; 2) graduate student support; 3) beginning investigators and early-career faculty (to build a foundation of leadership in manufacturing-related research); and 4) laboratory upgrades.

## **FY 2023 – 2024 Budget Request and Justification**

The CMR is requesting a 10.0% increase in the FY 2023-24 State appropriations to account for increasing salaries, benefits, student support, tuition and fees, supplies, and other costs as well as annual inflationary increases in these budget areas.

Even though the CMR has been successful in securing substantially increased external funding over the past few years, additional State appropriations are being requested to support the research/operational plans listed below.

- While we anticipate continued growth in FY23, there are functions within the Center in support of the research infrastructure and the State manufacturing industry that cannot be paid for with external grants and cost recovery. It is critical for the CMR to allocate partial funding annually to upgrade/replace capital equipment to maintain the state-of-the-art research capabilities.
- The requested budget increase will allow the CMR to continue in an effort to increase the number of graduate students supported by the Center and offer graduate student assistantships at levels consistent with the College of Engineering to remain competitive and compensate students equitably. One of CMR's missions is to prepare the future advanced manufacturing workforce. Attracting and retaining quality graduate students is of high importance for the CMR to fill this mission.
- The increased core funding will also enable the CMR to meet cost sharing obligations for external grants, promote new research initiatives, and incentivize faculty associates for research activities and industry engagement in the areas related to advanced manufacturing.

## **SUPPORTING MATERIALS**

## **CMR Supported Graduate Students Degrees Awarded in 2021-2022 Fiscal Year**

### **Masters**

**Collier-Till, Abigail**

“Creep Behavior of Eutectic Tin-Lead (63SN-37PB) Solder at Low Temperatures  
Spring 2022  
Advisor: Dr. Chris Wilson  
Mechanical Engineering

**Femi-Oyetoro, James D.**

“Prediction of Flexural Properties for Additively Manufactured Short Carbon Fiber Reinforced Composites Using Machine Learning Techniques”  
Summer 2021  
Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Hayes, Jacob R.**

“The Performance of Mn-Co Spinel Cathode-Side Contact Layer and Interconnect Coating for Solid Oxide Fuel Cell Application”  
Fall 2021  
Advisor: Dr. Jiahong Zhu  
Mechanical Engineering

**Lamantia, Maxavier D.**

Summer 2021  
Advisor: Dr. Pinggen Chen  
Mechanical Engineering

**Miller, Brandon A.**

“Investigation into Machine Learning Architectures for Damage Detection and Classification within Simulated Total Knee Replacement Devices”  
Fall 2021  
Advisor: Dr. Steven Anton  
Mechanical Engineering

**Sadler, Hollee S.**

“Aerodynamics of a Damaged Wing”  
Summer 2021  
Advisor: Dr. Ahmad Vasselbehagh  
Mechanical Engineering

**Yilmaz, Ibrahim**

Fall 2021  
Advisor: Dr. Ambareen Siraj  
Computer Science

## **CMR Supported Graduate Student Degrees Awarded in 2021-2022 Fiscal Year**

### **Ph.D.**

#### **Ahsan, Md Rumman**

“Wire + Arc Additive Manufacturing (WAAM) of Bimetallic Structures and High Entropy Alloy (HEA)”

Spring 2022

Advisor: Dr. Duckbong Kim

Mechanical Engineering

#### **Gupta, Ankit**

“Thermo-Mechanical Characterization and Modeling of Short Fiber Reinforced Composite Material Fabricated Using the Fused Filament Fabrication Process”

Spring 2022

Advisor: Dr. Ismail Fidan

Mechanical Engineering

#### **Jaladi, Divya S.**

“Fundamental Study of Sustainable and Efficient Evaporation Methods”

Fall 2021

Advisors: Dr. Ethan Languri and Dr. Sally Pardue

Mechanical Engineering

#### **Taheri Afarani, Hajar**

“Identification and Assessment of Admixtures for Portland Cement-Based Printing Pastes”

Fall 2021

Advisor: Dr. Joseph Biernacki

Chemical Engineering

#### **Yang, Kuo**

“Modeling and Control of Advanced Vehicle Powertrain System”

Fall 2021

Advisor: Dr. Pinggen Chen

Mechanical Engineering

## CMR Graduate Students Supported from State Appropriations

### Masters

**Brady, Kaydn**

Advisor: Dr. Ali Alouani  
Electrical and Computer Engineering

**Buida, Will**

Advisor: Dr. Ying Zhang  
Mechanical Engineering

**Calvert, Chase**

Advisor: Dr. Cynthia Rice  
Chemical Engineering

**Collier-Till, Abigail**

Advisor: Dr. Chris Wilson  
Mechanical Engineering

**Edwards, Tyler \***

Advisor: Dr. Rory Roberts  
Mechanical Engineering

**Gothard, Andrew**

Advisor: Dr. Steve Anton  
Mechanical Engineering

**Hayes, Jacob Ryan \***

Advisor: Dr. Jiahong Zhu  
Mechanical Engineering

**Hines, Brandon**

Advisor: Dr. Steve Anton  
Mechanical Engineering

**Hott, Jacob**

Advisor: Dr. Steve Anton  
Mechanical Engineering

**Lam, Steven**

Advisor: Dr. Cynthia Rice  
Chemical Engineering

**Messerschmidt, Laurie**

Advisor: Dr. Ethan Languri  
Mechanical Engineering

### Ph.D.

**Abdelfattah, Sherif**

Advisor: Dr. Mohamed Mahmoud  
Electrical and Computer Engineering

**Abdulmaged, Magdy**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

**Adeyemo, Adewale**

Advisor: Dr. Syed Hasan  
Electrical and Computer Engineering

**Alkunte, Suhas**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Bain, Aaron \***

Advisor: Dr. Rory Roberts  
Mechanical Engineering

**Bari, Bifta Sama**

Advisor: Dr. Ali Alouani  
Electrical and Computer Engineering

**Dunlap, Caleb**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

**Haris, Anfai**

Advisor: Dr. Robby Sanders  
Chemical Engineering

**Imeri, Astrit**

Advisor: Dr. Chris Wilson  
Mechanical Engineering

**Innis, Cody**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

**Islam, Saiful**

Advisor: Dr. Duckbong Kim  
Mechanical Engineering

\* - Jointly supported by State Appropriations and External Funds

## **CMR Graduate Students Supported from State Appropriations (continued)**

### **Masters**

#### **Midgett, Micah**

Advisor: Dr. Jiahong Zhu  
Mechanical Engineering

#### **Patel, Brandon**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

#### **Wu, Yun**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

### **Ph.D.**

#### **Li, Xuebin**

Advisor: Dr. Alan MacKenzie  
Electrical and Computer Engineering

#### **Odetola, Tolulope**

Advisor: Dr. Syed Hasan  
Electrical and Computer Engineering

#### **Oyekola, Peter**

Advisor: Dr. Mohammad Albakri  
Mechanical Engineering

#### **Patel, Brandon**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

#### **Rashid, Mamunur**

Advisor: Dr. Nan Chen  
Electrical and Computer Engineering

#### **Shuaibu, Musayyibi**

Advisor: Dr. Olorunfemi Ojo  
Electrical and Computer Engineering

#### **Su, Zifei**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

#### **Yilmaz, Ibrahim**

Advisor: Dr. Ambareen Siraj  
Computer Science

## CMR Graduate Students Supported from External Funds

### Masters

**Alshaikh Ali, Mohammad**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Buchanan, Ranger**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Edwards, Tyler \***

Advisor: Dr. Rory Roberts  
Mechanical Engineering

**Femi-Oyetoro, James**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Galbraith, Claude**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Hayes, Jacob Ryan \***

Advisor: Dr. Jiahong Zhu  
Mechanical Engineering

**Meacham, Jimmy**

Advisor: Dr. Rory Roberts  
Mechanical Engineering

**Nevills, Miles**

Advisor: Dr. Ethan Languri  
Mechanical Engineering

**Oliver, Jared**

Advisor: Dr. Ethan Languri  
Mechanical Engineering

**Owu, Taiye**

Advisor: Dr. Olorunfemi Ojo  
Electrical and Computer Engineering

### Ph.D.

**Ahsan, Rumman**

Advisor: Dr. Duckbong Kim  
Mechanical Engineering

**Al Amiri, Wesam**

Advisor: Dr. Alan MacKenzie  
Electrical and Computer Engineering

**Ayeni, Oluwaseyi**

Advisor: Dr. Holly Stretz  
Chemical Engineering

**Bain, Aaron \***

Advisor: Dr. Rory Roberts  
Mechanical Engineering

**Ellicott, Andrew**

Advisor: Dr. Rory Roberts  
Mechanical Engineering

**Femi-Oyetoro, James**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Hasanov, Seymour**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

**Joshi, Sachin**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

**Lamantia, Maxavier**

Advisor: Dr. Pinggen Chen  
Mechanical Engineering

**Nevills, Miles**

Advisor: Dr. Ethan Languri  
Mechanical Engineering

\* - Jointly supported by State Appropriations and External Funds

## **CMR Graduate Students Supported from External Funds**

### **Masters**

**Swiecichowski, Patrick**

Advisor: Dr. Ethan Languri  
Mechanical Engineering

### **Ph.D.**

**Nnadi, Olivia**

Advisor: Dr. Olorunfemi Ojo  
Electrical and Computer Engineering

**Rajeshirke, Mithila**

Advisor: Dr. Ismail Fidan  
Mechanical Engineering

## External Funding – Proposals Submitted

|    | Status                                      | Title                                                                                                                                                     | P.I.                                                            | Dept.                 | Total Funds |
|----|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------|-------------|
| 1  | 917MC<br>8/10/2021                          | Elastic Meta-structures with Local Stress Fields for Low-frequency Bandgaps<br>National Science Foundation                                                | Mohammad Albakri                                                | ME                    | \$339,979   |
| 2  | 920MC<br>11/4/2021<br>59(21-22)             | CPS: Small: Intelligent and Scalable Condition Monitoring of Civil Infrastructure via Mobile Crowd Sensing<br>National Science Foundation                 | Mohammad Albakri<br>Tarek Elfouly<br>Joseph Slater              | ME<br>ECE<br>COE      | \$450,490   |
| 3  | 956MC<br>5/31/2022                          | AIREYES: An AI-based Multi-drone Reconnaissance Platform for Security Applications<br>NATO Emerging Security Challenges Division                          | Ali Alouani<br>Tarek Elfouly                                    | ECE<br>ECE            | \$219,245   |
| 4  | 924MC<br>11/15/2021<br>76(21-22)            | A Computational Framework to Predict Patient Risk of Instability and Aseptic Loosening in Arthroplasty<br>National Institute of Health                    | Steven Anton                                                    | ME                    | \$570,968   |
| 5  | 955MC<br>6/16/2022                          | A Computational Framework to Predict Patient Risk of Instability and Aseptic Loosening in Arthroplasty<br>National Institute of Health - PAR-20-084       | Steven Anton<br>Doug Talbert                                    | ME<br>CSc             | \$577,756   |
| 6  | 957MC<br>6/16/2022                          | Limited View/Sparse Angle Computed Tomography Software for Efficient CT Construction<br>TetraHive Technologies (via DoD funds)                            | Steven Anton<br>Joseph Biernacki<br>Doug Talbert                | ME<br>ChE<br>CSc      | \$57,436    |
| 7  | 904MC                                       | Super Truck 3<br>Phoenix Motorcars (via DOE funds)                                                                                                        | Pingen Chen<br>Indranil Bhattacharya<br>Nan Chen                | ME<br>ECE<br>ECE      | \$737,607   |
| 8  | 907MC<br>7/12/2021<br>5(21-22)              | Rural Reimagined: Building an EV Ecosystem and Green Economy for Transforming Lives in Economically Distressed Appalachia<br>US Department of Energy      | Pingen Chen<br>Arman Sargolzaei<br>JW Bruce<br>Stephen Canfield | ME<br>ME<br>ECE<br>ME | \$4,012,938 |
| 9  | 927MC<br>10/15/2021<br>54(21-22)<br>5-35300 | On-board Diagnostic Algorithm Research and Development for Selective Catalytic Reduction System Aging Detection.<br>Cummins Advanced Engineering Controls | Pingen Chen                                                     | ME                    | \$64,732    |
| 10 | 928MC<br>10/19/2021<br>59(21-22)            | Pilot Demonstration and Evaluation of VW EV for Accelerating EV Adoption in Rural Areas<br>Volkswagen                                                     | Pingen Chen                                                     | ME                    | \$64,732    |
| 11 | 930MC<br>10/27/2021<br>65(21-22)            | Scenario and Capability-aware Safety Training on Advanced Driver-Assistance Systems in Urban and Rural Areas<br>AAA Foundation for Traffic Safety         | Pingen Chen                                                     | ME                    | \$336,747   |
| 12 | 933MC<br>Rejected                           | EcoCAR Challenge<br>US Dept of Energy by Argonne National Laboratory                                                                                      | Pingen Chen<br>Arman Sargolzaei                                 | ME<br>ME              | \$751,433   |
| 13 | 949MC<br>4/29/2022<br>150(21-22)            | Electrify Appalachia: Drivers and Environmental Impacts of E-mobility in Rural and Low-income Communities<br>U.S. Environmental Protection Agency         | Pingen Chen<br>Nan Chen                                         | ME<br>ECE             | \$1,124,978 |

|    | <b>Status</b>                    | <b>Title</b>                                                                                                                                                                                                                        | <b>P.I.</b>                                                                         | <b>Dept.</b>                   | <b>Total Funds</b> |
|----|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------|--------------------|
| 14 | 913MC                            | FAI: Domain Knowledge-aided Explainable and Fair AI<br>University of Hartford (via NSF funds)                                                                                                                                       | William Eberle                                                                      | CSc                            | \$206,948          |
| 15 | 925MC<br>10/14/2021<br>58(21-22) | Applied Research Experience for Technician Education in Additive Manufacturing for Competitiveness in the United States (AMTechEd4C)<br>National Science Foundation                                                                 | Ismail Fidan<br>Duckbong Kim                                                        | MET<br>MET                     | \$649,973          |
| 16 | 935MC                            | Collaborative Research: Track 2: Establishing Industry-Supported PhD Training in the US<br>National Science Foundation                                                                                                              | Ismail Fidan                                                                        | MET                            | \$89,980           |
| 17 | 943MC                            | Create Consortium: Creating Research-and Active Learning-based Teaching Capabilities in Advanced Manufacturing                                                                                                                      | Ismail Fidan<br>Duckbong Kim<br>Ying Zhang                                          | MET<br>MET<br>CMR              | \$2,860,000        |
| 18 | 948MC<br>5/2/2022                | Creating a Sustainable Innovation and Entrepreneurship Framework for the Community College (I&E4CC) Education<br>CUNY New York City College of Technology (via NSF funds)                                                           | Ismail Fidan                                                                        | MET                            | \$481,233          |
| 19 | 951MC                            | Collaborative Research: SWIFT: Secure Spectrum Utilization and Synergic Coexistence Leveraged by Multi-domain Radio Resources<br>National Science Foundation                                                                        | Nan Guo<br>Allen Mackenzie                                                          | CMR<br>ECE                     | \$550,000          |
| 20 | 919MC<br>8/11/2021<br>27(21-22)  | RINGS: Resource Allocation and Hardware Security: Horizontal and Vertical Collaboration for NextG System Resiliency<br>National Science Foundation                                                                                  | Syed Hasan<br>Nan Guo<br>Allen McKenzie                                             | ECE<br>CMR<br>ECE              | \$1,000,000        |
| 21 | 923MC                            | Collaborative Research: SaTC: EDU: Utilizing an Integrated Framework to Develop Modules with Remote Lab Capabilities on Secure Edge Intelligence for Strengthening Future Technology-Ready Workforce<br>National Science Foundation | Syed Hasan<br>Nan Guo                                                               | ECE<br>CMR                     | \$299,999          |
| 22 | 934MC                            | Collaborative Research: CCRI: Planning-C: Toward a Community Cyber Infrastructure for Intuitive and Rapid Federation of NSF-Supported Testbeds.<br>Vanderbilt University (via NSF funds)                                            | Syed Hasan<br>Nan Guo                                                               | ECE<br>CMR                     | \$30,000           |
| 23 | 938MC<br>2/22/2022               | DESTini-TN: Developing Golden Eagle Scholars to enhance STEM education in Rural Under-developed Communities of Tennessee(TN)<br>National Science Foundation                                                                         | Syed Hasan<br>Denis Ulybyshev<br>Ismail Fidan<br>JW Bruce<br>Ahmadreza Vasselbehagh | ECE<br>CSc<br>MET<br>ECE<br>ME | \$1,500,000        |
| 24 | 945MC                            | NSF Convergence Accelerator Track G: SECurity and RESiliency TECHniques for Differentiated 5G OPerationS<br>Vanderbilt University (via NSF funds)                                                                                   | Syed Hasan<br>Nan Guo                                                               | ECE<br>CMR                     | \$120,000          |
| 25 | 914MC<br><br>5-31333             | CAREER: Fundamental Investigation of Metal Additive Manufacturing Toward Molybdenum Alloy Structures<br>National Science Foundation                                                                                                 | Duckbong Kim                                                                        | MET                            | \$526,186          |

|    | <b>Status</b>                              | <b>Title</b>                                                                                                                                                                                                     | <b>P.I.</b>                                         | <b>Dept.</b>      | <b>Total Funds</b> |
|----|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-------------------|--------------------|
| 26 | 915MC                                      | NSF-DFG: Exploring Additive Manufacturing-based High Throughput Method for Designing and Fabricating Superior High Entropy Alloys<br>National Science Foundation                                                 | Duckbong Kim                                        | MET               | \$559,381          |
| 27 | 918MC                                      | Development of a Near-Optimal Process through Analysis of Microstructure and Mechanical Strength for Component Repair Using DED<br>KiTech                                                                        | Duckbong Kim                                        | MET               | \$18,000           |
| 28 | 926MC<br>10/12/2021<br>57(21-22)           | Collaborative Proposal: Digital Twin Based Remote Experimental Learning for Laboratory Georgia Tech (via NSF funds)                                                                                              | Duckbong Kim                                        | MET               | \$315,973          |
| 29 | 932MC<br>1/19/2022<br>94(21-22)            | MRI: Acquisition of an Electron Backscatter Diffraction (EBSD) System for the Newly Installed Field Emission Scanning Electron Microscope (FE-SEM)<br>National Science Foundation                                | Duckbong Kim<br>Ying Zhang<br>Indranil Bhattacharya | MET<br>CMR<br>ECE | \$144,093          |
| 30 | 937MC<br>2/10/2022<br>111(21-22)           | Industrial Metaverse/Digital Twin-based Smart Factory Platform<br>Korea Evaluation Institute of Industrial Technology (KEIT)                                                                                     | Duckbong Kim                                        | MET               | \$333,000          |
| 31 | 940MC<br>3/16/2022<br>132(21-22)           | Developing Digital Twins using eXtended Reality and Digital Thread for Additive Manufacturing Intelligence<br>IITP (Institute for Information and Communication Technology Planning and Evaluation)              | Duckbong Kim                                        | MET               | \$100,000          |
| 32 | 947MC<br>5/2/2022<br>154(21-22)<br>5-32626 | Proof of Concept of Steel to AL Alloy Transitions Joints by Wire Additive Manufacturing<br>Oak Ridge National Laboratory                                                                                         | Duckbong Kim                                        | MET               | \$15,001           |
| 33 | 958MC<br><br>175(21-22)<br>5-35304         | Development of Near Optimal Process through Microstructure and Mechanical Analysis of Steel-based Dissimilar Metals using DED Process<br>KITECH (Korean Institute of Industrial Technology)                      | Duckbong Kim                                        | MET               | \$17,000           |
| 34 | 942MC<br>3/8/2022<br>130(21-22)            | Southeast Regional Smart Manufacturing Technical Assistance Center: Sustaining Industry through Workforce Training in Smart Manufacturing and Energy Management Systems<br>University of Alabama (via DOE funds) | Ethan Languri                                       | ME                | \$80,000           |
| 35 | 911MC<br>10/11/2021<br>56(21-22)           | In-Operando Mass/Structural Analysis of Li-ion Batteries<br>U.S. Naval Research Laboratory                                                                                                                       | Cynthia Rice                                        | ChE               | \$571,157          |
| 36 | 936MC<br>2/16/2022<br>118(21-22)           | Development of Nano-Layer Solid Oxide Fuel Cell Technology that Operates on Various Fuels<br>US Air Force                                                                                                        | Rory Roberts                                        | ME                | \$376,972          |
| 37 | 908MC<br>6(21-22)<br>5-35292               | Fiber Reactor Extraction Simulation<br>Visionary Fiber Technologies                                                                                                                                              | Holly Stretz<br>Bahman Ghorashi                     | ChE<br>ChE        | \$75,051           |
| 38 | 929MC<br>10/25/2021<br>63(21-22)           | Making Computerized Trauma Triage Decision Support Accurate, Fair and Trustworthy<br>National Institute of Health (NIH)                                                                                          | Doug Talbert                                        | CSc               | \$437,536          |

|    | <b>Status</b>                    | <b>Title</b>                                                                                                                                               | <b>P.I.</b>                                                               | <b>Dept.</b>                 | <b>Total Funds</b> |
|----|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------|--------------------|
| 39 | 931MC<br>2/7/2022                | Collaborative Experiential Learning Infrastructure for Advanced Manufacturing<br>Georgia Tech (via Economic Development Administration funds)              | Ying Zhang<br>Duckbong Kim<br>Sally Pardue<br>Ismail Fidan<br>Pingen Chen | ME<br>MET<br>ME<br>MET<br>ME | \$7,523,316        |
| 40 | 939MC                            | Gas Atomization Strategies and Characterization of Titanium-Niobium (TiNb) Powder<br>Consolidated Nuclear Security, LLC (CNS)                              | Ying Zhang<br>Jiahong Zhu<br>Brian Bates                                  | CMR<br>ME<br>CMR             | \$2,306,377        |
| 41 | 941MC<br>3/21/2022<br>135(21-22) | High-Temperature Oxidation- and Erosion-Resistant Coatings for Critical Components in Concentrating Solar-Thermal Power Systems<br>US Department of Energy | Ying Zhang<br>Jiahong Zhu                                                 | CMR<br>ME                    | \$400,000          |

***Proposals Submitted in FY 2021-22      \$30,896,217***