Center for Composite and Hybrid Materials Interfacing (CHMI)

An NSF Industry/University Cooperative Research Center (IUCRC)

Mission and Vision of the CHMI Center

The mission of the **Center for Composite and Hybrid Materials Interfacing (CHMI)** is to leverage collaborations among industry, government, and academic stakeholders in materials and manufacturing industries to advance science and technology, and develop workforce in the field of interface engineering and joining/bonding of hybrid materials and structures. The three-university (Georgia Institute of Technology (GT), Oakland University (OU), and University of Tennessee/Knoxville (UTK) collaborative research team will work closely with the industry members to develop and disseminate basic and applied, pre-competitive research on methodologies, technologies, and tools that will facilitate rapid, reliable, and cost-effective composite and hybrid materials joining and interfacing. The mission scope includes aircraft, automobile/ground vehicles, wind turbine blades, and pressure vessels that are made of hybrid/multiple material systems including, but not limited to reinforced composite, metal, and other structural materials. The vision of the CHMI Center is to transform the current labor-intensive, experience-based joining and repair practice into fast, automated, and reliable processes enabled by advanced analytical, computational, experimental, and digital techniques and tools. The goal of the CHMI Center is to significantly reduce cost, cycle time, and variation (by at least 50%) of related operations within 10 years. Hosted by Georgia Tech Manufacturing Institute (GTMI), the CHMI Center will work closely with the Institute for Advanced Composites Manufacturing Innovation (IACMI) and OU's Fastening and Joining Research Institute (FAJRI) and their industry networks for dissemination and technology transition of the enabling technologies for composite and hybrid materials joining and interfacing.

Economic Relevance and Impact of the CHMI Center and Research

Today, many structures and products from small cars to mega-ton aircraft and wind turbine blades are built using hybrid materials such as high-performance metals, polymer composites, and a wide variety of adhesives. Interface engineering and joining processes are commonly used in manufacturing and maintenance of such structures. Advanced technologies and tools for composite and hybrid materials interfacing are critically needed, as they have significant economic and societal impacts. For example, the total airframe (mostly composites and metals) lifecycle maintenance, repair, and overhaul (MRO) cost for all Airbus A350 and Boeing B787 aircraft delivered by Year 2021 is estimated to be at ~$34 billion, and grounding an Airbus A350 for a day could cost $100,000 or more in lost revenue for the airline company[1]. The composite and hybrid interfacing technologies societal impact includes not only transportation safety, but also the country's ability to improve national security by having well-maintained, ready-to-deploy military equipment. For other applications in automobiles, wind blades, and pressure vessels, joining and repair technologies directly influence lowering the manufacturing cost, reducing embodied energy, and increasing possibilities for post-life recycling of these complex multi-material structures.

Fit of the Center within the Industry and University Collaborative Scope

The GT team recently completed a technology roadmapping effort sponsored by the NIST AMTech Program on composite joining and repair with a consortium (CAIIAC[1]) consisting of over 45 industry, government, and academic organizations. The IACMI has a holistic roadmap for composite materials and manufacturing in areas of automotive, wind, and compressed gas storage - along with detailed mini roadmaps for multi-material joining and repair. These roadmapping exercises concluded that it is imperative to establish a long-term, collaborative industry-government-academic partnership to address the challenges in joining and repair of structures involving composite and hybrid materials due to the rapid

[1] "*A Technology Roadmap for Joining and Repair of Advanced Polymer Matrix Composites*" by the Consortium for Accelerated Innovation and Insertion of Advanced Composites (CAIIAC), Georgia Tech Manufacturing Institute, 2017.

growth in their usage in various industry sectors. The three partnering universities have been very active in R&D in the field of *Composite and Hybrid Materials Interfacing* and have collaborated through IACMI and CAIIAC projects. It is natural for these universities to collaborate through the IUCRC avenue and leverage their existing strength and resources to develop new methodologies, technologies, and tools for CHMI.

Research Thrust Areas and Planned Topics

Design, Modeling and Analysis for CHMI
- ICME and design for CHMI
- Damage tolerance for CHMI
- Digital twin for CHMI applications
- Database, standards and qualification

Testing and Non-destructive Evaluation
- Advanced mtls testing/characterization
- NDI for weak/"kissing" bonds detection
- Advanced sensing and structural health monitoring
- Fast large-area structural inspection

Materials and Process Engineering for CHMI
- Advanced materials (e.g. HT mtls for hypersonics)
- Surface engineering for CHMI applications
- Hybrid-material joining process engineering
- Robotics and automation for CHMI

Data Analytics and Secure Digital Technologies
- IoT and digital technologies (e.g., AR/VR)
- Diagnostics and prognostics
- Cybersecurity for CHMI applications
- AI/machine learning tools for CHMI operations

Center Uniqueness

The CHMI Center is unique in the following aspects:

- It will be the first public-private partnership for RD&D with a special focus on *Composite and Hybrid Materials Interfacing/Joining*;
- It will develop and deploy digital and computational CHMI techniques to transform the current labor-intensive, experience-based industry practice into the new *Digital and Intelligent* paradigm;
- It will build a strong partnership with IACMI, which brings in over 150 industry stakeholders and beneficiaries for the developed technologies. The CHMI Center synergizes with IACMI well, as they are complementary to each other, rather than having an overlapping or competitive existence. Furthermore, CHMI Center addresses R&D challenges of hybrid materials at TRL 2-4 whereas IACMI focuses on technologies for polymer composites in TRL 4-7 spaces.

Benefits to Industry Members

- A full membership will provide the company/government organization a seat in the Industry Advisory Board (IAB) and a full vote for project selection (an associate membership will have a half vote);
- Provides a CHMI technology repository and technology investment priority guide via CHMI technology roadmaps;
- Offers opportunities to collaborate on developing and gaining access to pre-competitive and cutting-edge technologies via CHMI projects and leverage industry dollars by sponsorship from other industry partners and NSF;
- Identifies workforce training requirements in the fast-growing field and opportunities to interact with potential employees by working with CHMI sponsored students;
- Provides cost-effective access to state-of-the-art R&D facilities and testbeds within CHMI; and
- Offers networking opportunities to interact and collaborate with other leaders in the CHMI community.

Point of Contact

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