

# INTRODUCTION TO THE CENTER FOR COMPOSITE MATERIALS

*Internationally Recognized Excellence*



CCM educates the next generation of engineers, advances basic research, and accelerates technology transfer to the composites community. Today, more than 50 faculty, 43 research professionals and post-docs and 70 graduate and undergraduate students are affiliated with UD-CCM.

Founded in 1974, the University of Delaware's Center for Composite Materials (CCM) has been internationally recognized as a center of excellence for interdisciplinary research, education, and technology transfer in the areas of materials and synthesis, multifunctional materials, processing science, mechanics and design, sensing and control, and software. CCM is dedicated to advancing composites technology through lower costs, higher quality, and reduced risk.

## Background

CCM began working with materials suppliers and end users in the aerospace, automotive, civil engineering, and durable goods industries in the mid-1970s. Since then, the Center has collaborated with more than 3,500 small, medium, and large companies who have received benefits afforded with membership in the University-Industry Consortium.

Since 1986, UD-CCM's programs and initiatives have been designated Centers of Excellence eight times by the National Science Foundation (NSF), the Department of Defense (DoD), and the Federal Aviation Administration (FAA).

## Research

During its 50-year history, CCM has developed core competencies in a number of composites science and engineering areas, including liquid molding, sensing and control, re-engineering, interphase science, composites from renewable sources, thermoplastic processing, joining, and cost modeling. Utilizing 58,000 square feet of state-of-the-art facilities and equipment valued at over \$25M, CCM develops models and simulations in a "virtual manufacturing" environment for process optimization and tool design, leading to improved quality, affordability, and innovative new composite manufacturing processes. By controlling the microstructure and molecular architecture of

existing and next-generation materials, new composites are designed to accomplish multiple performance objectives in a single system.

The Center also develops online sensors and devices for monitoring composites manufacturing to end-of-life and validates control schemes using simulations and manufacturing work cells. Our unique manufacturing science laboratory provides facilities for the synthesis of new materials, chemical and mechanical characterization from nano-scale to large-scale structures, computation, design, re-engineering, and manufacturing work cells on existing and next-generation processes that are ready for transition to our sponsors.

CCM leads in the implementation of Artificial Intelligence within composites research, with a primary objective of accelerating the discovery, design, and manufacturing processes

of advanced composites. This goal is attained by utilizing both physics-based and data-driven methodologies to explore the material–process–microstructure–performance (MP<sup>2</sup>) relationships. These insights facilitate the development of adaptive and intelligent techniques aimed at discovering innovative materials and hybrid manufacturing systems.

## Technology Transfer

Center researchers view industry and government as partners rather than patrons. Technology transfer thus becomes a logical outgrowth of the research rather than a separate activity. CCM's current research programs are being carried out with the support of and in collaboration with industry, federal agencies such as AFOSR, ARL, ARO, DARPA, DOE, DOT, NASA, NSF, ONR, TARDEC, and others, as well as the State of Delaware.

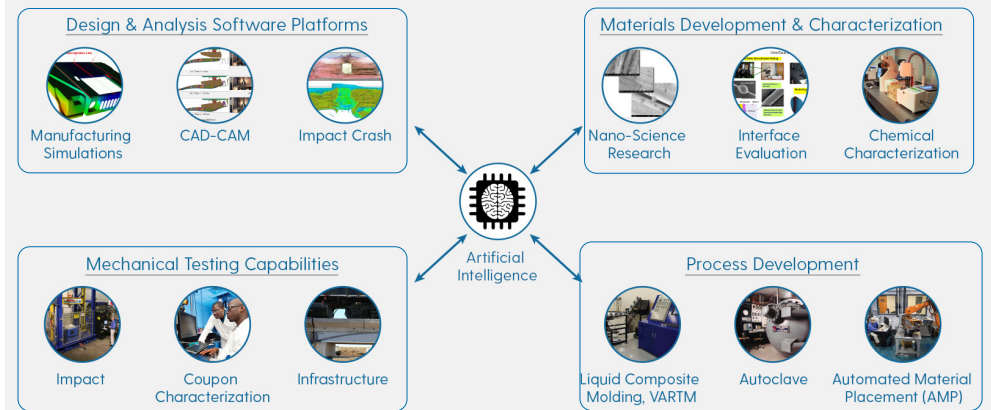
Examples of recent technology transfer include an automated thermo-plastic lamination process using induction heating by the largest U.S. user of carbon prepreg, design and prototype development for various vehicle components, and implementation of our SMARTMolding automated infusion station in 12 production sites.

## Education

Students and faculty in the Center

# 21<sup>ST</sup> CENTURY DESIGN & MANUFACTURING

## Basic Research to Product Development



are affiliated with the University of Delaware departments of Chemical & Biomolecular Engineering, Civil & Environmental Engineering, Electrical & Computer Engineering, Materials Science & Engineering, Mechanical Engineering, Physics & Astronomy, and Chemistry & Biochemistry, as well as the College of Business & Economics.

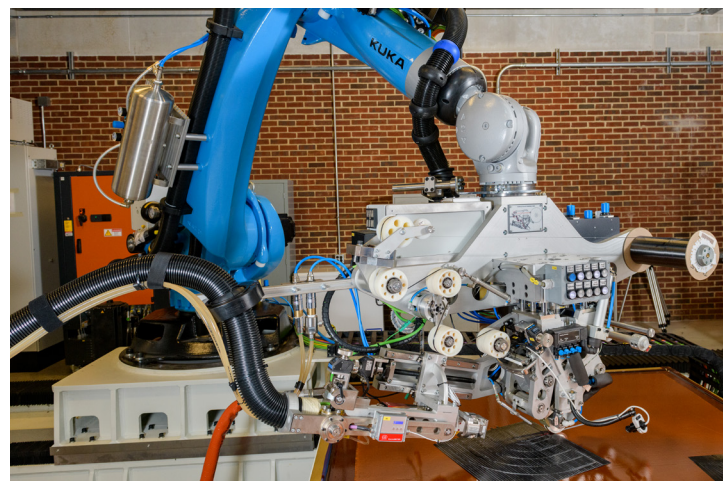
CCM students at all levels actively participate in interdisciplinary research teams. In addition to a solid grounding in the fundamentals, composites students at UD gain practical insight into solving real-world engineering problems. They also have the opportunity to interact with visiting students, faculty, and researchers from industry, government agencies, and other uni-

versities in the U.S. and abroad. Continuing education opportunities include Engineering Outreach programs, CCM workshops, symposia, and seminar series.

CCM is dedicated to the comprehensive development of the next generation of professional engineers and researchers. Our commitment extends beyond fostering proficiency in advanced composite materials and manufacturing; we aim to integrate a strong foundation in contemporary artificial intelligence techniques as well. Furthermore, our training places significant emphasis on instilling professional ethics that are crucial for success and integrity in the careers of these future professionals



TEC – 1000°F, 515 psi Processing Autoclave



Automated Tape Placement

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