



UD-CCM MANUFACTURING AND PROTOTYPING CAPABILITIES

Manufacturing Science has been one of the unique capabilities at the University of Delaware Center for Composite Materials (UD-CCM). The importance of manufacturing in being able to translate constituent properties into composite performance led to the establishment of the first NSF Engineering Research Center in manufacturing science at UD-CCM in 1985. Since then, UD-CCM has conducted research in all types of composite manufacturing processes, including prepregs and autoclaves, pultrusion, compression molding and its variants, liquid molding and its variants, tape placement processes and filament winding. In all these processes, we have also developed the associated process modeling capability to enable model-based parametric studies of the process variables for optimization, process monitoring sensors and automation, cost models and tooling concepts. UD-CCM continues to be at the forefront of new process developments for composite materials, including evaluation of new heating methods, tooling concepts, sensors, process automation and scaling issues for very large structures.

Our current manufacturing capabilities are divided between two facilities: the 34,000 sq ft Composites Manufacturing Science Laboratory (CMSL) that is more focused on basic and applied manufacturing science research, and the 18,000 sq ft Applications and Technology Transfer Lab (ATTL) that primarily focuses on subcomponent and full-scale prototyping of composite structures.

COMPOSITES MANUFACTURING SCIENCE LABORATORY (CMSL)

Over the years, CMSL has hosted a variety of manufacturing capabilities,



with initial focus on processes such as prepreg fabrication, autoclave processing, pultrusion etc. Our current focus is on manufacturing science for fabrication of very large scale components. A brief summary of the relevant capabilities is listed below:

- ◆ **Autoclave:** Thermal Equipment Corporation autoclave, with capability to 1200 F and 500 psi. Chamber working size is approximately 20" diameter and 4 ft in length
- ◆ **Compression Molding Press:** 2 ft x 2 ft 50 ton Wabash heated platen (800 F) press
- ◆ **Liquid Molding:** Multiple VARTM workcells with all necessary accessories, RTM injection systems, a SMARTmolding fully automated VARTM workcell, Elevated temperature VARTM workcell, Co-Injection Workcell, process monitoring sensors, and all associated process control hardware
- ◆ **Robotic Tape Placement:** ABB 6400 six-axis robot with custom designed heads – Hot gas heating based thermoplastic tape placement head
Induction heating based head for thermoplastic welding and metal matrix tape placement, IR and other heat sources, all necessary hardware and process control systems
- ◆ **Thermoplastic Extrusion and Film line:** DACA Micro-Compounder (5 cc max capacity), Twin screw Haake Extruder (480 C, 14 kg/hr) and Film line
- ◆ **Microwave Processing:** 3kW microwave processing system
- ◆ **Induction Heating:** 5kW and 10 kW Huettinger Induction heaters as heat sources for polymer and metal matrix composite processing
- ◆ **Automated Lamination System:** Roller based heating and consolidation system for automated processing of thermoplastic and thermoset prepregs
- ◆ **Ovens:** Multiple ovens and furnaces ranging from benchtop systems to a large walk-in convection oven



COMPOSITE TECH BRIEF

MANUFACTURING AND PROTOTYPING CAPABILITIES (cont.)

APPLICATIONS AND TECHNOLOGY TRANSFER LABORATORY (ATTL)

CCM-ATTL was established in 2005 to provide additional space for sub-component and full-scale part manufacturing and prototyping. Facilities at ATTL are more geared towards “industry-ready” capabilities and a brief summary is listed below. Processing oriented capabilities include:

- ◆ **Tooling fabrication** composite and metallic tooling design and fabrication capabilities
- ◆ **CNC automated ply cutting** with an American GFM Model US15 Ultrasonic ply cutter, and preform fabrication capabilities with all variations of fibers and a variety of binder systems for dry performs
- ◆ **Liquid molding processing:** VARTM workcells including SMARTMolding, elevated temperature capability, and a dedicated 14w x 34l x 11h dedicated climate controlled booth for process condition control and ventilation

- ◆ **Armor Processing capability** for tile and backing integration, adhesive and coating application, ceramic tile array encapsulation and VARTM processing of armor with in-house developed tooling and process methods

- ◆ **Polymer casting and low pressure injection** capabilities for tooling and master fabrication as well as for processing and fabrication of components

- ◆ **Filament winding** capability including ENTEC wet winder and 5-axis large scale ENTEC automated winding capability

- ◆ **Aqueous Prepreg Line** allows custom runs for a range of thermoplastic polymers (including nano-additives)

- ◆ **Pultrusion processing** using high pressure injection system for viscous polymer processing

Prototyping and integration capabilities include:

- ◆ **Component trimming and finishing** using specialized composite cutting equipment and dust collection controls

- ◆ A fully equipped **conventional machine shop** with various saws, vertical mill and two manual lathes

- ◆ **CNC machining** capabilities centered around a HAAS VF9 machining center with 5-axis capability; specialized capabilities in the cutting and machining of composites and embedded ceramics

- ◆ **Welding and fabrication** capabilities for integration with metals, tool and fixture fabrication, and custom work to support integration projects

- ◆ **Assembly and integration** capabilities for large scale composite structures and vehicle applications, including systems integration for electronics and electro-mechanical systems

The state-of-the-art facility provides a unique capability for all aspects of prototype fabrication, assembly and integration.

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