OMIC R&D TECHNOLOGY BOARD
CONCEPTUAL ABSTRACT

TITLE: **Additive Manufacturing of Carbon Fiber Epoxy Composites**

RELATED ROAD-MAPPING DESIGNATION ID#: **AM69**

SUPPORTIVE INDUSTRY: Impossible Objects, Boeing, Oregon UAV.

PROJECT TYPE: General Project

PROBLEM STATEMENT (What Are We Trying to Solve?): Additive manufacturing provides a straightforward pathway for the on-demand fabrication of carbon fiber composites that can be used as tooling surfaces or directly implemented as replacement components. Current commercial approaches primarily rely on high-cost fused deposition modeling (FDM) systems which must be heated to very high temperatures for successful printing. Moreover, FDM is restricted to thermoplastics, which suffer from severe shape warpage upon cooling, reduced mechanical strength, low glass-transition temperatures, and poor surface finish.

OMIC R&D is proposing the use of Direct Ink Write (DIW) 3D printing for room-temperature fabrication of epoxy-based composites reinforced with continuous carbon fiber tow. This approach enables high-fidelity deposition of thermosetting matrices, which cure into mechanically robust structures as they use the same material as traditionally molded composites. Our preliminary results indicate that DIW-printed carbon fiber composites can achieve comparable stiffness and strength to hand lay-up laminates, while offering finer geometric control and reduced porosity. The industries that can benefit from this research are aerospace, naval, and automotive.

PROJECT DESCRIPTION: This project carries with it a very specific focus as outlined below:

OMIC R&D is proposing the use of Direct Ink Write (DIW) 3D printing for room-temperature fabrication of epoxy-based composites reinforced with a continuous carbon fiber tow. This approach enables high-fidelity deposition of thermosetting matrices, which cure into mechanically robust structures as they use the same material as traditionally molded composites. Research shows that DIW-printed carbon fiber composites can achieve comparable stiffness and strength to hand lay-up laminates, while offering finer geometric control and reduced porosity.

The proposed research will work closely with industry partners to:

(1) Develop epoxy formulations with tunable viscosity and cure kinetics compatible with fiber integration

(2) Establish process–property relationships through in-situ monitoring.

(3) Evaluate mechanical and thermal performance relative to autoclave-cured composites. Finite element modeling will be used to predict interfacial stress transfer and optimize fiber orientation strategies. This work should aim to demonstrate DIW as a viable route to fabricate structural-grade, high-performance composites without the need for elevated-temperature curing or expensive tooling.

Identify Related OMIC R&D Resources: Proposing researchers should use their best judgment in deciding on the optimal resources for the research. To further aid in this decision, the OMIC staff has taken the initiative to best identify on-site resources (machines, equipment, and staff) that may relate to the scope of this research. Please recognize that researchers are not limited to these resources.

- Machines and equipment at OMIC can be reviewed at:
  http://omic.us/applied-research/additive/
  http://omic.us/applied-research/subtractive/
  http://omic.us/applied-research/materials/
  http://omic.us/applied-research/robotics/
  http://omic.us/applied-research/inspection/

- OMIC Staff or SMEs
  http://omic.us/applied-research/

PROJECT DELIVERABLES:

- Final report
- Final presentation
- Final machined parts

SPECIAL NOTE: It should be recognized that this Conceptual Abstract is written based on comments collected during OMIC R&D Road-mapping workshop and based on industries need for applied research. However, researchers as SMEs, are encouraged to lend specific technical feedback to further refine the Project Description and/or Project Outcomes. The proposing researcher may do so either directly to OMIC R&D, or in the submitting proposal.

UTILIZATION OF OMIC RESOURCES: Researchers are encouraged to utilize the capital and personnel resources available on the OMIC R&D campus in their proposals. Use of OMIC time and machines should be included in the Proposal funding request. If use of OMIC resources are

not identified in a proposal and are requested during the project, sponsor will be responsible for requesting a costed project amendment from the Tech Board.

PROJECT UPDATE EXPECTATIONS: Researchers are required to have monthly update discussion with OMIC R&D to provide a summary update on project status. This is done by way of a user-friendly format known as the OMIC 6-Block update. Depending on the scope of the project, OMIC R&D's industry Tech Board representatives are often interested in periodic project updates, and even in project participation. Researchers are required to communicate with supportive industry and facilitate communications as required.

ADDITIONAL COMMITMENTS TO FACTOR: Researchers may be asked to present their final project at an OMIC R&D biennial Technology Exchange Symposium. This symposium is an in-person event, held at the OMIC R&D campus in Scappoose Oregon. The Symposium is held in the spring, and researchers should factor in their availability when bidding on projects.

Researchers may be invited to participate in OMIC R&D's marketing efforts that showcase the working history of the project.

PROJECT DURATION: It's OMIC R&D's strong preference that duration of a General Project aligns with the academic calendar cycle (July 2026 to June 2027). It is preferred that the project be completed by June 2027. Researchers are encouraged to factor in variables such as contracting, student hiring (if needed), procurement, holidays, and travel. It has been OMIC R&D's experience that a project's useful working duration is typically 9 to 10 months. Researchers are also encouraged to give feedback, and to adjust the scope of work to best fit this preferred timeframe. Additionally, it is reasonable to even recommend phasing breakdowns to the project. In some unique circumstances, if the project is to take significantly longer than the duration of the academic year, this reasoning should be explicitly explained in the proposal.

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