October Virtual Technical Meeting

Tuesday – October 12, 2021

Tailorable Universal Feedstock for Forming (TuFF): Overview and Performance

By Dirk Heider, PhD

University of Delaware, Center for Composite Materials

Location: Virtual meeting with RingCentral:
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Networking 6:30 PM, Presentation 7:00 PM

Abstract: Under the Defense Advanced Research Projects Agency (DARPA) Tailorable Feedstock for Forming (TFF) program, the University of Delaware - Center for Composite Materials (UD-CCM) led-team developed a manufacturing process and pilot facility to produce novel discontinuous carbon fiber composite feedstock for forming, with the potential to revolutionize the use of composite materials, as a cost-effective replacement for small complex geometry metal parts. The *TuFF* (Tailored Universal Feedstock for Forming) feedstock consists of a highly aligned discontinuous carbon fiber preform in thin-ply format, which can be combined with thermoplastic or thermoset resins for prepreg, or used in dry form for infusion-based manufacturing processes. A patented discontinuous fiber alignment and preforming process has been developed and implemented in a pilot facility at UD-CCM. The alignment process is fiber agnostic and *TuFF* preforms have been manufactured with aerospace grade fiber (IM7, T800), pitch carbon fiber, and recycled carbon fiber. Using discontinuous IM7 carbon fiber and Polyetherimide (PEI) thermoplastic resin, TuFF composites with aerospace quality requirements (<1% voids, up to 63% fiber volume fraction) have demonstrated 100% translation of fiber stiffness and strength in tension, and >40% bi-axial in-plane strain capability during forming. The in-plane stretchability of *TuFF* preforms enables conformability of simple planar preforms to complex geometries, eliminating the need for darting and complex ply patterns while minimizing associated scrap during composite layup. Closed-loop recycling and reuse strategies are possible for the first time with the ability to reuse fiber and preform scrap, prepreg scrap and recycled composite parts.

Bio: Professor Heider is Assistant Director for Technology of the Center for Composite Materials and Associate Professor at the Electrical & Computer Engineering Department at the University of Delaware. He received his Ph.D. in electrical engineering at the University of Delaware in 1998, and he holds the equivalent of bachelor's and master's degrees from the Technical University of Aachen in Germany. Prof. Heider's research interests include advanced composite manufacturing, novel sensing methods and the use of artificial intelligence in composites manufacturing. He has published more than 150 papers and has taught various workshops for industry and academia in these areas. Currently, he is Principal or Co-Principal Investigator of several programs with the Department of Defense, Department of Energy and ARPA-E to develop manufacturing processes and to evaluate novel materials for high-performance applications. He is co-inventor of the TUFF technology, which has shown full property translation with mm-long short fibers for the first time. He is founder of Composites Automation LLC (CA), a small business co-located at the Center for Composite Materials. CA has licensed the TuFF technology and is actively pursuing scale-up, application development and sub-licensing of the technology to third parties.

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