SELF-HEALING OF IMPACT DAMAGE IN 3D MICROVASCULAR COMPOSITES

K.R. Hart [1,4], E.D. Wetzel [2], N.R. Sottos [3,4], and S.R. White [1,4]

[1] *Department of Aerospace Engineering, University of Illinois at Urbana-Champaign, 104 S. Wright St., Champaign, IL, 61820, USA. – e-mail: hart22@illinois.edu; swhite@illinois.edu*
[2] *US Army Research Laboratory, Weapons and Materials Research Directorate, Aberdeen Proving Ground, MD, 21005, USA. – e-mail: eric.d.wetzel2.civ@mail.mil*
[3] *Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, 1304 W. Green St., Urbana, IL, 61801, USA. – e-mail: n-sottos@illinois.edu*
[4] *Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, 405 N. Mathews Ave., Urbana, IL, 61801, USA.*

Keywords: Self-healing, fiber-reinforced composite, microvascular, impact

ABSTRACT

Fiber-reinforced composites are susceptible to micro- and macro-scale damage due to a number of different damage modes including out-of-plane impact events. Transverse impact damage causes a reduction in material stiffness and strength by introducing interlaminar delaminations and intralaminar transverse cracking and is one of the most limiting design considerations preventing widespread acceptance of composites in structural applications. To combat reductions in material properties, microvascular based self-healing composites have been explored as a means to repair damage in the host material after an impact event.

Here we report on a vascularized 3D fiber-reinforced composite capable of recovering mechanical properties following an impact event. Vascular networks are fabricated by inserting nylon monofilament in the composite preform before resin infusion and subsequently removing them manually after composite processing. Vascularized composites are then sectioned into flexure specimens and impacted across the sample width using a cylindrical impact tup to introduce damage. After impact damage, the samples are allowed to heal and mechanical properties are evaluated using a four point flexure-after-impact (FAI) protocol.

Prior to impact, two-part epoxy based healing agents are injected into the isolated, embedded networks, individually sequestering the two components. During impact, damage bridges isolated channels and provides a pathway for mixing of the healing agents. Results of autonomic healing tests are compared with control tests in which pre-mixed healing agents are pumped after impact through the entire network(s).