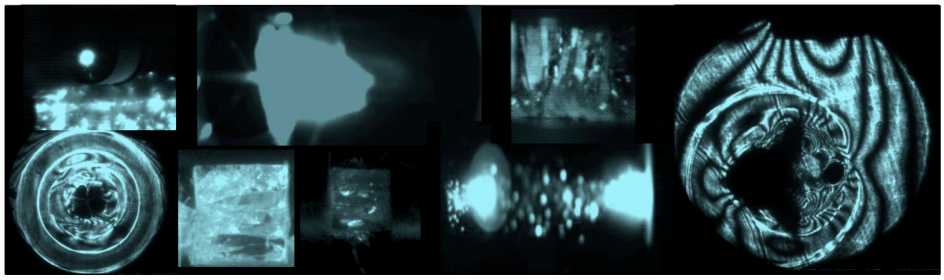
When the going gets tough:
A Dynamic Look at Polymer Matrix Composites

Dr. Leslie Lamberson
http://dynamic.mem.drexel.edu



ABSTRACT

Beyond classical laminate composites, woven polymer matrix composites (PMCs) are currently being utilized as next-generation materials in aerospace applications. In this regard, accurately predicting their impact performance and dynamic behavior is necessary; yet the influence of the matrix material on the continuum response due to the complex fiber-matrix interplay during dynamic damage evolution remains largely unknown. Three types of high performance fiberglass with the same woven structure, but different resin binders, are presented and compared with carbon fiber composite. Under quasi-static and dynamic uniform loading, the materials exhibited localized shear band formation with characteristic geometry stemming from an instability in the weave interface. In addition, unique two-stage light-gas gun investigations reveal that at 1 km/s (2237 mph) impact, the epoxy resin fiberglass reaches its ballistic limit with fiber breakage dominating; whereas the melamine resin fiberglass does not by spreading energy via delamination. Mesoscale simulations of these hypervelocity impacts utilizing the experimentally determined dynamic compressive and cohesive shear strengths were able to capture more realistic deformation and failure mechanisms than using quasi-static and approximated values. Dynamic fracture behavior of the brittle polymer constituents, as well as a proposed micromechanics model for dynamic PMC compression will also be presented.

Leslie Lamberson is a currently the PC Chou Assistant Professor in Mechanical Engineering and Mechanics, with affiliated appointment in Materials Science and Engineering at Drexel University. In 2013, she was a NASA Glenn summer faculty fellow in the Materials and Structures for Extreme Environments Division. Leslie received her B.S. in Aerospace Engineering from the University of Michigan, her M.S. in Aerospace Engineering at the Georgia Institute of Technology, and her Ph.D. in Aeronautics at the California Institute of Technology, mentored by Professor Ares Rosakis. Prior to her faculty appointment, she was a postdoctoral research scholar with Professor K.T. Ramesh at the Johns Hopkins University, as part of the now-titled Hopkins Extreme Materials Institute. Her expertise lies in microstructurally-informed and analytically-motivated dynamic experimental mechanics.