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Structural composites from high performance bioepoxies

Daniel Schmidt
University of Massachusetts Lowell, daniel_schmidt@uml.edu

STRUCTURAL COMPOSITES FROM HIGH PERFORMANCE BIOEPOXIES

Daniel F. Schmidt, Department of Plastics Engineering, University of Massachusetts Lowell
1 University Avenue, Lowell, MA, USA
T: ++1-978-934-3451, Daniel_Schmidt@uml.edu

The increased utilization of structural composites has had a significant and tangible impact on everyday life, enabling real progress in a broad range of application areas from transportation to wind energy to sporting goods. Unfortunately, however, the vast majority of these materials are petroleum derived, and tend to be difficult or impossible to truly recycle, with downcycling, landfilling or even incineration much more common. This represents both a major waste and a lost opportunity.

In this talk, an overview is provided of our efforts to date aimed at addressing these issues, as well as some of our most recent results in three focus areas serving the goal of creating high performance, bio-based, reworkable structural composites:

First, we present our current state of progress as far as the creation of high-performance bioepoxies are concerned. Using epoxidized linseed oil (ELO) as a basis, and having explored a range of curing chemistries and formulations, we find that blended anhydride curatives produce systems with the best mechanical properties, and that proper selection of catalyst and cure cycle are absolutely essential when working with these materials.

Second, we discuss our efforts to prepare continuous glass fiber reinforced composites based on our optimized bioepoxy formulations, shifting from vacuum bagging to vacuum-assisted resin transfer molding (VARTM) and presenting critical data on process rheology. We further provide evidence of good consolidation, a high level of mechanical performance and damage tolerance in our bioepoxy composites, with additional improvements available via process optimization as well as a hybrid reinforcement strategy involving properly selected nanoparticles.

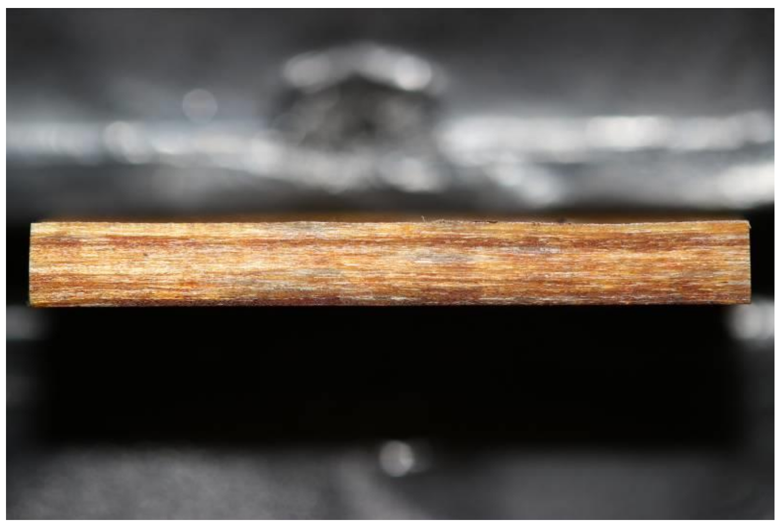

Figure 1. The cross-section of a well-consolidated glass fiber reinforced bioepoxy network.

Third, we expand on the work of Liebler et al (2011) in the area of reworkable thermosets, demonstrating the applicability of this approach to high performance anhydride cured epoxies. The results of a concentrated effort to identify appropriate catalysts for reworkability in these systems will be presented, as well as complementary research aimed at applying this approach to composites and identifying industrially relevant processes that enable the utilization of reworkability in practice.