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Bio-based thermosets from star-like highly functional reactive resins

A challenge faced with transitioning from polymer materials derived from petrochemical sources to bio-based sources is in designing materials having the performance properties required for today's applications. High performance thermoset polymers are used in applications such as coatings, composites, and adhesives and are made in-situ from the reactions of functional low molecular weight resins or functional oligomers. While vegetable oils are a readily available and amenable to functionalization to be used in thermosets, their long aliphatic hydrocarbon chains tend to result in materials that are soft and flexible. However, we have found that by creating multifunctional resins from vegetable oil fatty acids and a highly functional polyol, thermosets can be formed that have the strength and stiffness for use in high performance coatings and composites. For example, epoxidized sucrose esters crosslinked with cyclic anhydrides yield thermosets having modulus values exceeding 1 GPa. Polyurethanes made using highly functional soy polyols have glass transition temperatures exceeding 100°C, much higher than typical soy-based polyols. Methacrylated sucrose esters can be used to form high performance composites using either glass or natural fibers. It has also been discovered that 100% bio-based thermosets can be made from the water-catalyzed crosslinking of epoxidized sucrose soyate with naturally-occurring acids.

Biography

Dean C Webster is Professor and Chair in the Department of Coatings and Polymeric Materials at North Dakota State University (NDSU). He received a BS in Chemistry and a PhD in Materials Engineering Science both from Virginia Tech. Prior to joining NDSU in 2001, he worked for Sherwin-Williams and at Eastman Chemical Company. He is the recipient of the 2011 Roy W Tess Award in Coatings Science given by the American Chemical Society, the 2013 Joesph Mattiello Lecture award given by the American Coatings Association, and the Waldron Research Award given by the NDSU Alumni Association. His research is in the area of new high performance polymer systems for coatings and composites, nanocomposites, polymers for marine antifouling coatings, and use of renewable resources in polymers and coatings systems.

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