

Sustainable Engineered Materials from Renewable Resources

FY10

Our nation's public and private forests have potential to be a sustainable source of renewable materials well beyond the 21st century and provide a viable ecosystem with minimal reliance on petroleum-based resources. The key to achieving this ideal is connecting sustainable forest management practices with composite material science. The Sustainable Engineered Materials from Renewable Resources (SEMRR) project was established in July 2002 to form that crucial connection – a link from intensive forest management practices to advanced wood and cellulose composite technology for development of innovative products from renewable raw materials.

What Virginia Tech is doing: Because it is critical that we expand our scientific approach to creation of renewable materials, the College of Natural Resources formed the Sustainable Engineered Materials Institute (SEMI) specifically to direct research efforts within the SEMRR project. Personnel associated with SEMI are researchers with diverse backgrounds who have come together because of a shared enthusiasm for wise management of timber resources. An additional emphasis is to link SEMRR research with three industry cooperatives at Virginia Tech - the Wood-Based Composites Center, the Loblolly Pine Growth and Yield Research Cooperative, and the Forest Nutrition Cooperative. Members of these industrial cooperatives are listed below. Collectively, they represent most of the major players in the U.S. private wood-processing and tree-growing businesses.

American Forest Management	ArborGen, Inc	Arclin	Armstrong Floor Products
BASF	Campbell Group, LLC	Forest Capital Partners	Forest Investment Associates
FORSight Resources	Georgia-Pacific Chemicals, Inc	GMO Renewable Resources	H2H Innovations, LLC
Hancock Forest Mgmt, Inc	Henkel Corporation	Hexion Specialty Chemical	Jordan Lumber
Larson & McGowin, Inc	Lee Forestry	MeadWestvaco Corp	Milliken Forestry
Molpus Timberlands Mgmt	Plum Creek Timber Company	Potlatch Forest Holdings	Rayonier
Regions Morgan Keegan Trust	Resource Mgmt Service, Inc	Sonoco Products	Superior Pine Products Co
TimberSTAR	Westervelt Company	Weyerhaeuser Company	Woods Family

We are pursuing a systematic, multi-phase integrated approach because creation of advanced bio-based products encompasses more than any one isolated research project, industry, agency, or discipline. Our team is uniquely multi-disciplinary in the field of renewable materials in the United States because of the diverse mixture we bring together. Essentially, expertise within our group is providing an unbroken connection from the molecule to the market.

Our most significant potential is invention of wood and cellulosic products that rival the strength and lightness of metals and plastics and yet come from a completely renewable and sustainable raw material – trees.

Objectives: Our SEMRR project goal is to help insure an economically and environmentally sustainable supply of renewable resources to match future demand for building construction materials and allied products. Specific objectives are to: 1) develop procedures for designing, evaluating, and implementing new composite wood and fiber products, 2) establish methods for advanced forest management practices consistent with future demand for wood products, and 3) communicate our research results to the above-listed industries and incorporate their needs back into our research activities.

Accomplishments (selected): The process we have pioneered for creation of nano-structured wood fiber composites without added petroleum products is poised for the next phase of scale-up to an industrial operation. Adoption of our research processes could result in significant energy savings for current plants and new businesses can be started specifically to fabricate the new biobased products we are inventing. A typical fiber composite manufacturing plant employs from 50 to 100 people, depending on production output levels. Biobased materials such as wood and plant fibers are susceptible to destruction from many sources including insects and microorganisms. Current estimates show that replacement materials needed to repair damage caused by decay fungi alone account for nearly 10 percent of U.S. annual wood production and it is estimated to cost U.S. homeowners over \$1 billion annually for preventative and remedial treatment to repair damage caused just by one insect, the Formosan termites. We have developed an environmentally-safe coating that kills invading organisms and inhibits their growth for long periods of time. Increasing the service life of wood products exposed to outdoor conditions would result in savings over \$50 million annually, plus our coating does not interfere with other treatments such as water repellants or paint, it is non-toxic to our environment, and it reduces harvesting pressures on our nation's vital natural resources. Several novel laboratory techniques were developed to investigate the structure/property relationship of wood polymers using the smallest possible specimen size. This small specimen size is critical for certain size-constrained sample types, such as from the stem of genetically modified saplings, or from a tree increment bore, or even from within an adhesive bondline. As a result of our discoveries, researchers are no longer required to wait for decades of tree growth to determine impacts and sustainability of forest management strategies. In another phase, we have discovered a very promising new chemical compound that has shown unusually remarkable adhesive properties with glass and metal. Our new adhesive does not rely on petroleum-based resources and will be very cost effective when expanded to substrates including wood and other biobased composites.

Funding: Financial support for the SEMRR project has come from extramural grants and contracts, and allotments from the Congressional Agriculture Appropriations Committee. Our current request is that Congress fully funds the SEMRR project at \$789,500 for FY10. Virginia Tech will contribute faculty time and indirect costs, estimated at \$435,000 annually, to support the SEMRR project. Associated industry funding through the companies listed above is set aside for student fellowships, and is projected to be \$297,000 for 2010.