Advancing Sustainable Forestry by Using Engineered Wood or Bio-composites

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As worldwide demand for timber and bio-fiber resources grows, sustainable resource management and industrial utilization must collaborate to develop a shared vision for both long-term sustainable management of forest and bio-resources and sustainable economic development. Engineered wood- and bio-composites offer a tool that can both achieve resource sustainability and meet user needs in our ever-more affluent societies and for our growing populations [1]. Biocomposite technology provides a tool for resource managers because it can add value to low- or no-value fiber resources and thereby promote demand for diverse bio-fiber feed-stocks including small-diameter timber, fast plantation-grown timber, removals of exotic-invasive species, removals of hazardous forest-fuels, and agricultural residues. At the same time, engineered wood composite serve as a tool for economic development of rural communities and provide for value-added commodity and non-traditional products. Wood composite technologies promote value-added uses for under-valued or waste materials

As the problems associated with sustaining and enhancing the world's forest and agricultural resources compete with the needs of a rapidly increasing population, the management of our land becomes a much more complex and important issue. Wood and other biofibers are both renewable and can be sustainably produced. Composite wood and natural biofiber products are effective alternatives to non-renewable or non- or less-recyclable mineral- or petrochemical-based materials. We must commit ourselves to developing the fundamental and applied science and technology necessary to provide improved value, service-life, and utility while at the same time meeting the needs of consumers for sustainable building materials. We need to network with international collaborators to provide a broad range of tools to resource managers that, regardless for resource type or quality, promote sustainability and recyclability and reduce adverse environmental impacts.

We must develop tools to address resource sustainability, enhance recyclability, and minimize the environmental impacts of composite processing. Then whenever forest resource options change, or as excess (e.g., discarded wood and fiber) waste-stream wood resources become available, or as alternative non-wood and non-lignocellulosic materials become more economical and available, or as air and water quality regulations become more stringent, we can adapt and sustainably address each of these issues. Engineered biocomposites assembled from small pieces of wood or natural biofiber materials provide technology that is very adaptable to a changing resource base. These products can incorporate a variety of wood and natural biofiber-based raw materials in the form of fibers, particles, flakes, strands, and veneers. But engineered biocomposites must also be durable, have specific properties and generally perform as expected when manufactured from a variety of natural fibrous sources alone or when combined as hybrid products with non-wood materials like cement, plastics, or fiberglass.

We must focus on fundamentally understanding the relationship between performance and contribution of constituent pieces of lignocellulosic materials, ranging from veneer, flakes, particles, fibers, and flour-like materials and from the marriage of lignocellulosics and advanced high-performance materials, like Kevlar, polyamides and fiberglass. The challenge is to meet the needs of growing populations with biocomposites from under-utilized low- or no-value virgin or waste biomass materials. The science and technology for engineering bio-based composite materials needs to be improved to (1) allow for the use of changing wood and alternative biofiber resources, (2) develop highly adaptable processes to meet consumer needs while simultaneously sustaining and improving the forest resource, and (3) continue the development of engineered structural lumber, panel composites and three-dimensional molded and/or extruded composites from small diameter, low quality timber derived from mixed species and previously unused lignocellulosic fiber sources.

Sustainable biomass utilization may involve a series of sequential integrated processing approaches that may include an initial biorefinery stage to obtain biofuels, followed by production of bio-based products from the biorefinery residues, and then production of electrical bioenergy from bioproduct residues. Such an integrated resource solution will also offer the optimum long-term solution to meeting both user needs and sustainable development. Nanotechnology presents another tool to improve structural performance and extend serviceability by orders of magnitude. Nanotechnology will help us manipulate and control fiber-to-fiber bonding, and it will also offer an opportunity to control material interactions at the nanoscale. It will provide a tool to control relationships between "Materials-Process-Performance".

In summary, the utilization of engineered biocomposite materials that meet user needs and maximize the environmental sustainability is fast becoming a reality. We must commit ourselves to developing the fundamental and applied science and technology necessary to provide improved value, service-life, and utility so the world can use sustainable building materials. Then as forest resource options change, as excess (e.g., discarded wood and fiber) waste-stream wood resources become available, as alternative non-wood and non-lignocellulosic materials become more economical and available, and as air and water quality regulations become more stringent, we will have the tools to address the problem of achieving resource sustainability and enhancing economic development through biomass utilization.

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