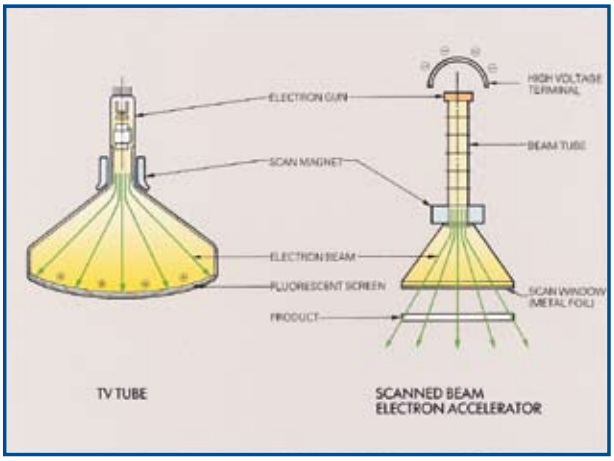
Rapid, Low Temperature Electron-beam, X-ray, and Gamma Ray Curable Resins for Wood Composites

Radiation Treatment Lowers Resin Curing Temperatures and Reduces Energy Use

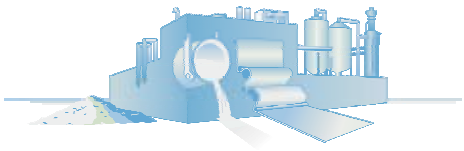
Approximately 50 percent of all wood construction products used today are comprised of some type of glued-wood assembly. Current U.S. production of panel products is around 30 billion ft^2 per year. Glued-wood products are referred to as wood composites, and range from structural laminated beams and flat-pressed panels (such as plywood and fiberboards) to furniture assemblies and non-structural wooden assemblies. The manufacture of most glued-wood assemblies requires process heat to dry the parent wood material, to consolidate flat-pressed panel products, and to polymerize and cure the resin system.

Polymerization and resin system curing requires that the moisture content of the wood materials be reduced to low levels. Moisture must be carefully controlled during manufacture to avoid generation of excessive steam vapor pressure internal to the product. Drying the wood furnish materials and controlling the substrate moisture content is a major consumer of energy in the manufacturing plant. "Hot-pressed" wood panels such as oriented strand board, medium density fiberboard (mdf), and particleboard can be mismanufactured by lack of moisture control.

E-beam resins can be cured at lower temperatures (250-300°F) than conventional systems (450°F). These lower temperatures reduce heating time, use less energy, emit fewer volatile organic carbons, and create less spoilage. In addition, e-beam treatment can process wood products with higher moisture, increase process throughput rates, and enhance wood-resin bond durability. This technology could save 65 trillion Btu/yr if implemented industry-wide.



E-beam curing allows the precise delivery of energy to wood products.



Benefits for Our Industry and Our Nation

- Reduce curing temperatures from 450°F to 250°F
- Reduce the energy used to dry wood products
- Faster curing rates could allow mills to double throughput rates
- Lower curing temperatures will reduce the emissions of volatile organic carbons
- Higher product yields can be achieved by recycling uncured wood materials
- The potential cost savings to industry is $3.2 billion with a current U.S. production of panel products of around 30 billion ft^2/yr
- Potential energy savings of 65 trillion Btu/yr (British thermal units per year) at full market penetration

Applications in Our Nation's Industry

Glued wood assembly products including:

- Structural laminated beams
- Flat-pressed panels
- Furniture assemblies

Process heat can be reduced in operations including:

- Drying wood
- Product consolidation
- Polymerization and curing the resin system

Project Goals

- Development of e-beam curable resin systems, which lower processing temperature and reduce the energy required to produce a wide range of consumer wood products
- Investigate alternative beam technologies including X-ray or gamma ray
- Evaluate chemical compounds that can initiate the cure of resin systems in response to e-beam or gamma radiation

Pathways

The objectives of this project will be achieved through the determination of (1) test protocols for e-beam curable resins, (2) adhesion properties of new e-beam curable resins used in glued wood composites, (3) curing ability of alternative beam application methods, including gamma rays and X-rays, and (4) protocols for scale up from test samples to large sections and large-scale systems.

Progress and Milestones

- Evaluated initial resin systems and developed test protocol for block-tests (Completed December 2002)
- Initiated adhesion studies (Completed March 2003)
- Evaluated ethylenic and acetylinic bond systems (Completed September 2003)
- Conducted downselect promising resin systems (Completed May 2004)
- Evaluated properties of glued wood assemblies (Completed August 2004)
- Completed evaluation of process energy balance (Completed September 2004)
- Initiated testing of large sections (Completed January 2005)
- Evaluated alternative beam application methods including X-rays (Completed September 2005)
- Selected large-scale test sections (Completed January 2006)

Commercialization

In order to obtain the critical data necessary to implement this breakthrough technology, the project team will work with industrial partners to validate and operate the e-beam technology at a prototype-scale. During this effort, a commercialization plan will be developed.

Project Partners

Virginia Polytechnic Institute and State University

University of Tennessee

Dow Chemical Company

Sartomer Chemical Company

UCB RadcureChemicals

IBA SteriGenics International, Inc.

J. M. Huber Corporation, Engineered Woods

Trus Joist

Morris Johnson, Consultant

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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