

## FOOD TECHNOLOGY FACT SHEET

Adding Value to Oklahoma

405-744-6071 • [www.fapc.biz](http://www.fapc.biz)

# What is Wood Plastic Composite?

**Salim Hiziroglu**

FAPC Value-added Wood Products Specialist

Wood plastic composite (WPC) is panel or lumber product made from recycled plastic and small wood particles or fibers. Wood plastic composites are relatively new products as compared to the long history of natural lumber or traditional wood composites such as particleboard or fiberboard.

This fact sheet summarizes some of the basic manufacturing steps, physical and mechanical properties, as well as major uses of WPC.

Wood plastic composites are widely used in the U.S. They are manufactured by mixing wood particles as fine as flour and recycled plastics. North American WPC market have reached almost \$1 billion in sales. This is an increase of 200% between 2001 and 2006, and it is expected that 20% annual growth will take place within the next 5 to 6 years. As WPC capacity increases, new products are being developed such as door stiles, rails and window lineal.

### Main production steps and properties of WPC

In general, manufacturing of WPC is a two-step process. Combination of wood and thermoplastic such as high density polyethylene (HDPE), low density polyethylene (LDPE) and polyvinyl chloride (PVC) are mixed together dough-like-consistency called compounding. Mixing can be handled by either batch or continuous process.

In addition to the main ingredient wood with grain size ranging from 20 to 60 mesh, plastic coupling agents, stabilizer, foaming agents or dyes also are added to enhance properties of the final product for a particular use.

For example, lubricants improve appearance of the surface. There are three common forming methods for

WPC. Extrusion method, which forces molten composite through a die, is shown in Figure 1. In the case of injection molding method, molten composite is forced into a cold mold. The third one presses molten composite between mold halves.

The majority of WPC is produced by extrusion process, which uses variety of extruder types such as single screw or double screw to form final shape of the material. Figures 2, 3 and 4 illustrate examples of WPC products and a flowchart of a typical manufacturing process, respectively.

Most of the physical and mechanical properties of WPC depend mainly on the interaction developed between wood and thermoplastic material. One of the most efficient ways to improve this interaction is by incorporating a coupling agent as an additive. In general, such additives help the compatibility between hydrophilic wood, which absorbs moisture easily, and hydrophobic plastic, having lack of affinity for water, allowing the formation of single phase composite and resulting in a product with better dimensional stability than solid wood.

Traditional pressure treated wood with mostly chromate copper arsenate (CCA) is facing growing dissatisfaction among the user due to health reasons and environmental pollution. Additionally, as of December 2002, wood treated with arsenic-based compounds has been banned when there is a direct contact with humans such as decking material, playground equipment or picnic tables.

Use of WPC lumber, either in the form of solid cross section or with tubular structure as shown in Figure 2, has been very popular material as a substitute for treated wood products. Table 1 also shows typical mechanical

properties including modulus of elasticity (MOE) and modulus of rupture (MOR) of WPC. MOE and MOR are described in a previous factsheet FAPC-162 Strength Properties of Wood for Practical Applications.

**Some advantages and disadvantages of WPC**

The greatest advantage of WPC is its environmentally friendly approach of using waste wood and recycled plastic material. Wood composite plastics have low maintenance cost as compared to that of solid wood. One of the main reasons responsible for the fast growth of WPC is its low-life cycle cost.

In general, WPC deck has a production cost of about 15% more as compared to that of pressure-treated lumber, but requires a lower maintenance cost. The actual payback period is estimated at 3 to 5 years compared to pressure-treated decking material. Its excellent dimensional stability along with less variability also can be considered as another main advantage of WPC products.

Most of the research in many countries is concentrating on the durability and extended service life of WPC due to large interest in its outdoor use.

In fact, WPC was originally marketed as being naturally decay resistance against fungi or insect attack. However, it has been shown that WPC will still absorb some moisture and eventually decay but at much slower rate than solid wood.

Thermal expansion, creep (time dependent deformation), high density and difficult application of paint would be some of the other disadvantages of WPC.

**Other information about WPC**

Clemons, C. Wood-Plastic Composites in the United States. 2002. Forest Products Journal. 52 (6)10-18.

Forest Products Society. 2001. Proc. Sixth International Conference on Woodfiber-Plastic Composites. Forest Products Soc. Madison, Wisconsin 289 p.

Smith, P. and M. Wolcott. 2006. Opportunities for Wood/ Natural Fiber-Plastic Composites in Residential and Industrial Applications. Forest Products Journal 56 (3) 4-11.

Smith, P. and K.D. Bright. 1999. New market development for wood plastic composite decking products. Proc. Fifth International Conference on Woodfiber-Plastic Composites. Forest Products Soc. Madison, Wisconsin 257-268 p.

Robbins, A.E. 2002. State of recycled plastics lumber industry 2001-2002. Plastic lumber industry in competitive markets. Annual Meeting of Plastic Lumber Assoc., Akron, OH. 10 p.

**Table 1. Mechanical properties of typical wood plastic composite.**

| WPC   | Bending (psi) |        | Tensile (psi) |       |
|---|---------------|--------|---------------|-------|
|   | MOE           | MOR    | MOE           | MOR   |
| 60% polypropylene<br>40% wood particles<br>Density 0.90 g/cm <sup>3</sup>                       | 439,000       | 6,410  | 561,000       | 3,680 |
| 60% polypropylene<br>40% hardwood fibers<br>Density 1.05 g/cm <sup>3</sup>                      | 471,000       | 6,950  | 609,000       | 4,090 |
| 57% polypropylene<br>40% hardwood fibers<br>3% coupling agent<br>Density 1.03 g/cm <sup>3</sup> | 467,000       | 10,500 | 613,000       | 7,580 |

*From C. Clemons 2002. Wood-Plastics Composites in the United States. Forest Products Journal. 52(6):10-18*

Figure 1. Extrusion manufacturing process of wood plastic composite.

Figure 2. Different type of wood composite products.

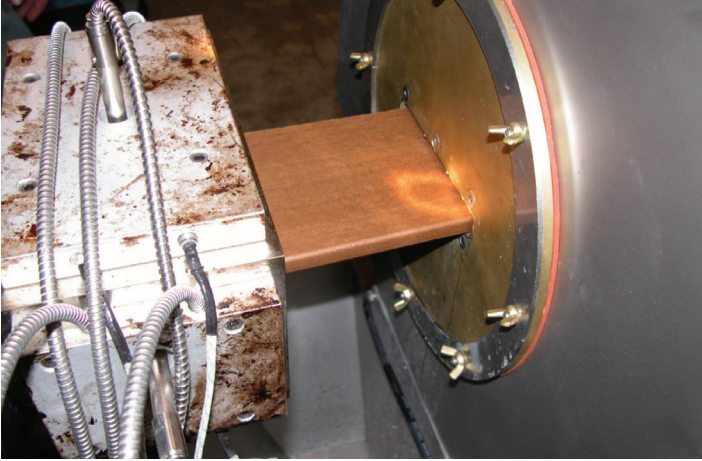
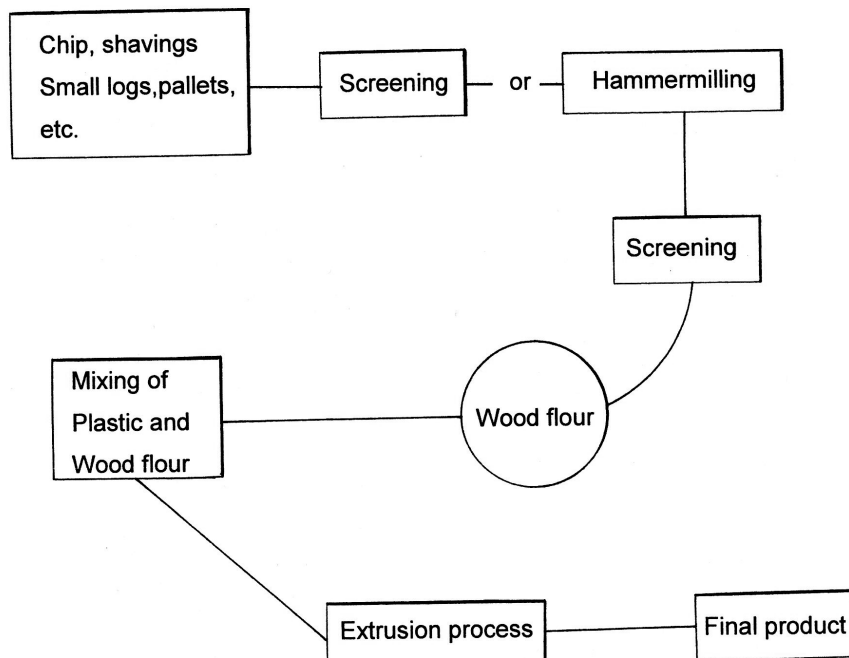


Figure 3. Application of wood plastic composites as decking.



Figure 4. A typical production flowchart of wood plastic composite.



## The Oklahoma Cooperative Extension Service Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; home economics; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of Cooperative Extension are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and based on factual information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

Oklahoma State University, in compliance with Title VI and VII of the Civil Rights Act of 1964, Executive Order 11246 as amended, Title IX of the Education Amendments of 1972, Americans with Disabilities Act of 1990, and other federal laws and regulations, does not discriminate on the basis of race, color, national origin, gender, age, religion, disability, or status as a veteran in any of its policies, practices or procedures. This includes but is not limited to admissions, employment, financial aid, and educational services.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 74 cents per copy. 1209