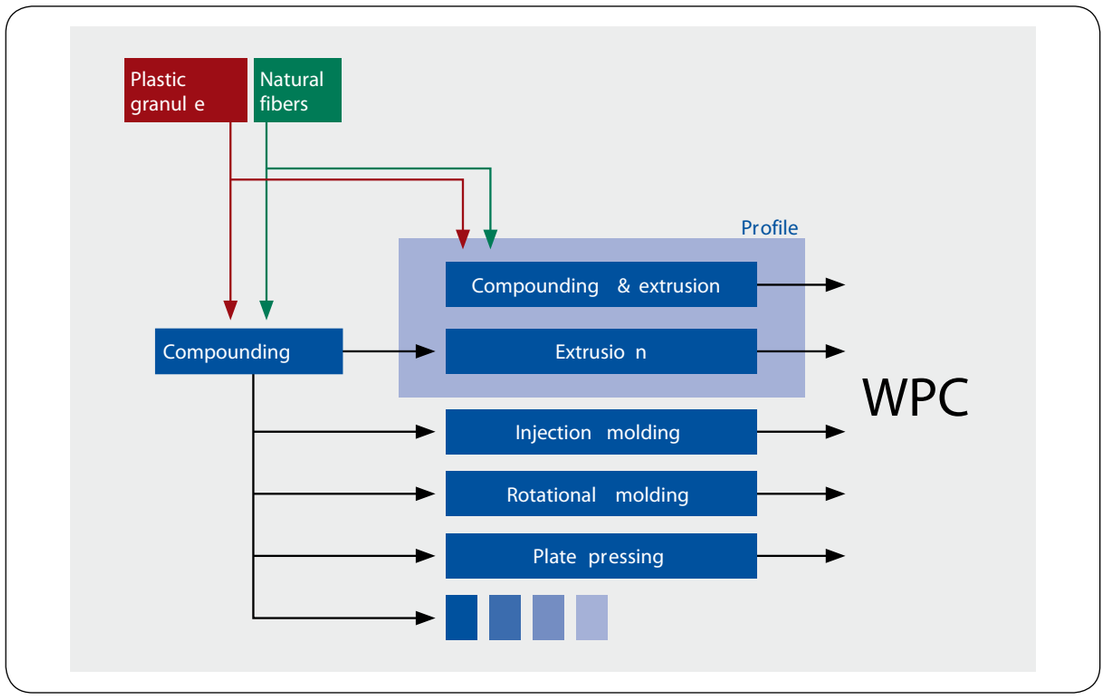
# Bound For Longevity

## Modifier for High Performance Wood Plastic Composites

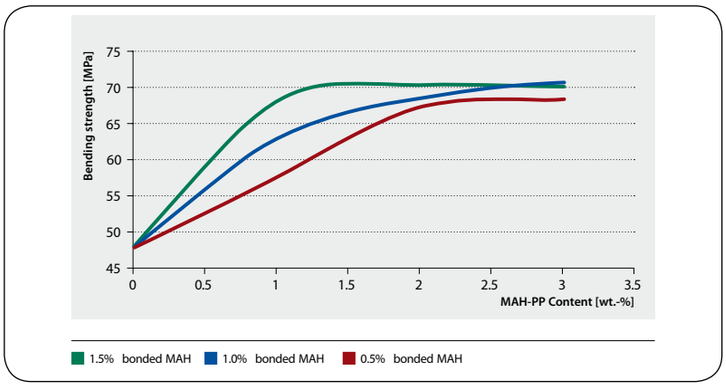
Reinforced By Nature – Polymer-bound wood composites represent an interesting new class of materials, which has gained significantly in importance in recent years because of its unique properties. Thanks to improvements in the manufacturing process and the use of high-performance modifiers, extremely high quality and thus sustainable products can now be manufactured.

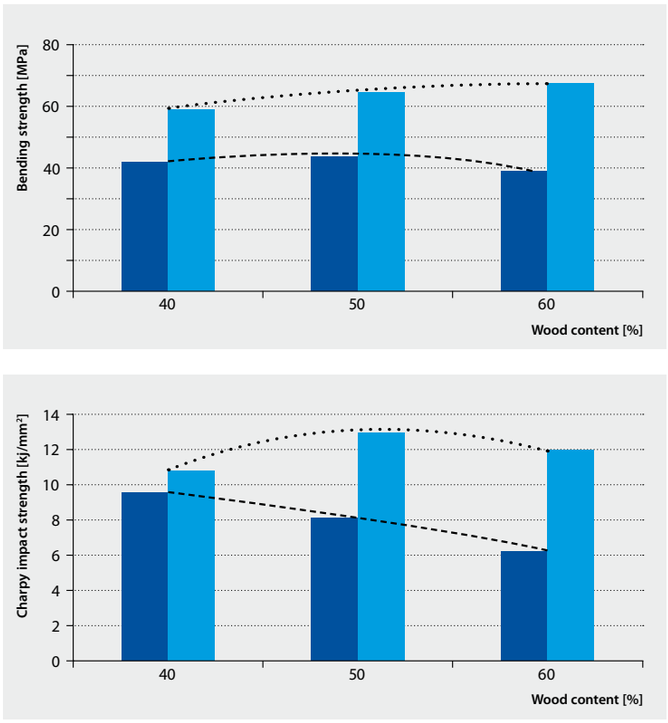
Jochen Wilms,
Byk




Wood Plastic Composites (WPCs) are part of the group of natural-fiber-reinforced compounds. Wood fibers are used as reinforcing fillers in these materials to widely varying degrees, from 30% to well in excess of 70%. A range of other natural fibers is in use for comparable applications, e.g., hemp, flax, sisal and coconut fibers. In terms of volume, wood fibers are most used, however. Polymeric materials such as polyethylene (PE), polypropylene (PP) and polyvinyl chloride (PVC) are used as binders for the fibers.

In comparison with wood and plastics, WPCs have a number of advantages. Besides being much easier and more versatile to form, they also have a much longer shelf life because of their greater resistance to weathering. Compared with pure plastic products, the wood content of the WPCs makes them decidedly more cost-effective. Frequently, they are used as a substitute for tropical timber on account of their longevity and thus help preserve the ecologically vital tropical rainforests.






## Applications

Polymer-bound wood composites are used wherever wood has traditionally been employed. First and foremost in this regard is their use for interior flooring and, in particular, exterior decking. However, you will also find WPCs being used for railings, fencing, wall cladding, furniture and more. In addition, these materials are increasingly being employed in automobile manufacture, e.g., in vehicle interiors for large-surface linings. Materials such as WPCs with their wood content are thus making an important contribution to improving the carbon footprint and thereby protecting our natural resources.

## WPC Production

In volume terms, WPC profiles that are produced using either a single- or two-stage extrusion process are most common.

Single-stage extrusion involves a so-called direct extrusion process. In this process, the mixing of the wood fibers with the plastic granulate (compounding) and the extrusion of the profile take place in one step. As a rule, conical, counterrotating twin-screw extruders are used. They are capable not only of mixing wood and plastic intensively but also of facilitating the pressure build-up necessary for extruding the required profile.

In two-stage extrusion, the compounding and extrusion of the profiles occur in two separate processes. To synthesize the compound, a variety of extruder types may be used. Most commonly, counterrotating, parallel twin-screw extruders are employed. But planetary gear extruders for low shear production of highly filled compounds and heating/cooling mixer combinations are also used. Other mixing processes include pelletizing presses and special milling processes, where the wood and the plastic material are ground in the range of the melt temperature of the plastics.

The production of the profile then occurs by large on single-screw extruders.

## Use of Modifiers In WPCs

With an increasing wood fiber content, the elastic modulus increases and the impact strength decreases. The increase in the elastic modulus is desirable, but the reduction in the impact strength is not, of course. The use of modifiers, which appreciably increases the dispersion of the wood fibers in the polymer matrix, also enables the mechanical properties such as the bending strength and impact strength of the composite to be improved quite considerably. Furthermore, the load-bearing capacity at higher temperatures and the surface finish are clearly enhanced. The modifiers substantially reduce water absorption, which leads to better dimensional stability and is of major significance for the longevity of the end products. This is hugely important for outdoor applications, for instance, such as decking boards.

## Chemistry of The Modifiers

The modifiers in most cases involve nonpolar base polymers that are functionalized with various monomers in a grafting process. With the modifiers used in WPCs, the base polymers are mostly polypropylene (PP) and polyethylene (PE), the polymers normally being modified with maleic anhydride. This functionalization brings about the necessary polarity and facilitates the chemical bonding of the wood fibers to the polymer matrix.

## Mode of Action

The maleic anhydride groups of the modifier react with the OH groups of the wood fiber to form a chemically stable compound. The fibers are optimally integrated in the polymer matrix, which brings about the essentially improved mechanical properties of the compound.

## Solid-Phase Grafting Technology

The modifiers of Byk Kometra are grafted in the solid phase in accordance with a patented process, whereas normally the grafting reacting is carried out in the melt by a reactive extrusion process. Solid-phase grafting allows higher degrees of functionalization to be achieved, which in turn leads to significantly improved effectiveness of the modifiers produced in this way. The volatile organic compound (VOC) content and the unbound maleic anhydride content are extremely low for products manufactured by the solid-phase grafting method. Moreover, the low process temperature has less effect on the base polymer, thereby facilitating a WPC compound with improved mechanical characteristics.

All this signifies that Scona modifiers with their high level of modification are especially suited for use in WPCs.

## Application In Polypropylene (PP)

For polypropylene-based WPCs SCONA TPPP 8112 FA as an adhesion promoter is recommended. The mechanical properties and the water absorption of a WPC are influenced by the technology of the adhesion promoter used. The values are consistently more favorable using SCONA TPPP 8112 FA than with an adhesion promoter that has been manufactured by the melt grafting process.

To illustrate how important a high degree of functionalization is, a series of tests was carried out using modifiers with different grafting levels to determine what effect the particular modifiers have on the mechanical property level of the manufactured WPCs. The use of highly functionalized modifiers leads to a considerably higher level of properties even with lower doses.

## Conclusion

In recent years, the use of modifiers grafted in the solid phase has made it possible to develop polymer-bound wood composites that satisfy the highest quality standards in the relevant industries. Besides having a high level of properties, the WPCs are characterized as resource-efficient and thus environmentally friendly materials because of the use of sustainable raw materials.

**Author:**
Jochen Wilms, BYK

**Contact:**
Julia Kleist
BYK-Chemie GmbH, Wesel/Germany
Tel.: +49 151- 5189057
julia.kleist@altana.com
www.byk.com