

Definition

Wood modification leads to a permanent change in essential material properties across the entire cross-section, in particular to an improvement in biological durability and dimensional stability. The principle of protection against biotic hazards is non-biocidal. The internationally used abbreviation for ther-

mally modified wood is TMT and is, not protected by trademark law. ThermoWood® is the trademark for processes and products of the International ThermoWood Association (ITWA). The normative basis for TMT is the European technical specification CEN/TS 15679:2007.

Principle of action and manufacturing process

The basic principle of thermal modification is the effect of elevated temperatures between 160 – 250 °C with reduced oxygen content. Partial pyrolysis leads to a change in the chemical composition of the cell wall substance. From 140 – 150 °C, the degradation of hemicelluloses begins, followed by amorphous celluloses and volatile accessory, which increases the relative lignin content in the wood. Organic acids (especially acetic acid) are produced as degradation products in the wood, which lowers its pH value. The degradation products do not exert a biocidal effect; the increased durability against wood-destroying fungi is mainly due to the degradation of hygroscopic wood

components (especially hemicelluloses) and thus lower equilibrium moisture content.

The various types of industrial processes differ primarily in the type of oxygen closure as well as the temperature and pressure conditions. Depending on the specific process conditions, certain effects are achieved in wood. The open process with an atmosphere of water vapour and wood gases at normal pressure (e.g. ThermoWood®) is the most widespread. Other processes work with overpressure and steam (autoclave principle) as well as with vacuum. The modification processes are in principle suitable for all types of wood.

Properties and machinability

Similar effects are achieved with all process types, but the TMT products differ in their specific property profile, which also depends on the specific process parameters or the treatment intensity as well as on the wood species, wood grading and cutting. In general, TMT can be regarded as a separate “wood

species group”, and a certain TMT as a technically produced “wood species”. In general, TMT shows an increased biological durability against wood-destroying fungi, increased dimensional stability, lower equilibrium moisture content and darker colours (in new condition), compared to untreated wood.

Biological durability

TMT is characterised by increased durability or resistance to wood-destroying fungi. This is mainly based on the degradation of wood components, especially hemicelluloses (“wood sugars”), as well as lower equilibrium moisture content. This property is expressed in durability classes (DC, see EN 350-2); TMT is usually found in the range of classes 1 “very durable” to 3 “moderately durable”; information on specific products can be found in the technical data sheets of the manufacturers or

test reports.

The risk of infestation with wood-discolouring mould and blue stain fungi is lower with TMT than with untreated wood, or an infestation/growth is less intense, but cannot be ruled out under unfavourable conditions. TMT can also have increased resistance to wood-destroying insects. Detailed explanations can be found in the TMT-Leaflet 02 “Durability”.

Strength properties

TMT has a reduced strength and impact resistance compared to untreated wood. The reduction is greater, the more intensive the treatment is (high temperature level of the modification). The bending strength can be reduced by 30 – 50 %, and the

dynamic strength (breaking impact work or impact resistance) may be even more. The stiffness (bending modulus of elasticity) is usually less affected.

Moisture properties

By reducing the number of hydrophilic OH groups, TMT has lower equilibrium moisture content than untreated wood, and swelling and shrinkage are also reduced. As a rule of thumb

Colour and smell

Depending on the type of wood, process type and treatment intensity, brand-new TMT has light to dark brown shades. When used outdoors, TMT turns grey like untreated wood, possibly even faster than it. Indoors, on the other hand, it is lightened,

Reaction to fire

TMT – like other modified wood – is generally to be regarded as treated wood. It is not possible to classify the fire behaviour without further testing on the basis of the bulk density and thickness alone. Subject to test results and classifications for

Processing

When processing TMT, the increased brittleness compared to untreated wood and a higher proportion of particulate matter must be taken into account. The suitability of adhesives or coating materials should be tested or approved by the corresponding manufacturer. In the case of physically curing adhesives such as PVAc, the low moisture absorption by the wood must be taken into account; if necessary, D4 adhesives should be used. PU adhesives, for example, have proven effective. Glazes and oils can usually be used without any problems.

Areas of application

The main areas of use are (in order of importance):

- Exterior decking (see TMT-Leaflet 03)
- Façade cladding and shading (see TMT-Leaflet 04)
- Wooden windows (see TMT-Leaflet 05)
- Interior wall and ceiling cladding, sauna, etc.
- Furniture and everyday objects

TMT is preferably applied in use class (UC) 3 according to EN 335; here the wood is weathered, but is not in constant contact with soil or fresh water. UC 3 includes UC 3.1 with moderate exposure (e.g. windows, facades) and UC 3.2 with heavier exposure (e.g. decking). Since TMT can be attacked by wood-destroying fungi during long-term or constant moistening, its use

for these properties, a reduction of about 50 % can be assumed. Practical experience shows that this positive effect may decrease over time.

especially with very dark products. Immediately after production or processing, TMT can have a product-typical odour that usually disappears after some time. This may be important to consider in interior applications.

specific TMT products, a fire behaviour similar to that of untreated wood can be expected. Experience from tests shows that TMT has a less favourable smouldering fire behaviour.

When applying liquid coatings, intermediate sanding can be dispensed with if necessary, as very smooth surfaces are created during planing or milling that contain hardly any fibres that stand up when moistened. When processing or assembling, the increased brittleness or tendency to split must be taken into account. For example, screw holes should be pre-drilled and countersunk, or self-tapping screws should be used very well. Likewise, leave enough pre-wood (distance to the end of the board).

in UC 4 (in ground contact) is not recommended.

Appropriate information should be provided on the suitability of a TMT product, preferably by indicating a recommended use class or by indicating a durability class (for more information, see TMT-Leaflet 02).

The use of TMT for load-bearing purposes would only be permissible with a proof of usability. However, this application is unlikely and is also not recommended, as TMT has a reduced strength and a changed fracture behaviour compared to untreated wood; in addition, there are no reliable strength values for designs, etc.

Key uses for TMT

Usage	Use class	Note
Decking (outdoor)	3.1/3.2	for terraces, balconies, landings; in the case of poor construction, conditions of use class 4 may occur; in the case of use for load-bearing purposes, a suitable proof of usability is required
Façade cladding	3.1	proven application; proof of usability may be required in conjunction with sub-structure and fasteners (curtain wall as a construction product according to harmonized EN 13830)
Shading	3.1	Advantage due to low tendency to deformation even with slim profiles
Windows	3.1	for laminated scantlings or as a core (PU window), usually coated; advantages due to dimensional stability and reduced thermal conductivity; the heat transfer resistance of the entire window U_w can be improved by 0.1 – 0.2 W/m ² K
Flooring (indoor)	1	Colour as the main feature, advantage of low swelling tendency for damp areas; possible emissions must be taken into account

Standardisation and quality assurance

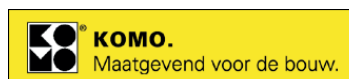
A normative basis for TMT is the European Technical Specification CEN/TS 15679:2007 “Thermally modified wood – Definitions and properties“. If TMT is declared with reference to this CEN/TS, the manufacturer must ensure a factory production control (FPC), document production data and identify the products with information: name of the manufacturer, traceability

- ThermoWood® Production and Product Quality Control
Award: International ThermoWood Association (ITWA)
- Quality Mark TMT
Award: Entwicklungs- und Prüflabor Holztechnologie GmbH (EPH)
- KOMO® product certificate “Timber modification“
Award: Stichting KOMO

of production plant and FPC, grading or designation, wood species and use class or area of use.

In addition to the in-house production control of the TMT manufacturers, there are quality assurance systems with external monitoring:

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Disposal

The options for disposal of TMT are described by the example of Germany. Here, the disposal of waste wood is regulated by the German Waste Wood Regulation (AltholzV, 2020) in its current version. TMT and other modified woods are not explicitly mentioned in the Regulation; nor is there any official assignment to the waste wood categories mentioned there. According to the definitions of the waste wood categories, TMT is to be assigned to category AII, which is defined there as follows:

“glued, painted, coated, varnished or otherwise treated waste wood without halogen-organic compounds in the coating and without wood preservatives“.

This classification means that it is possible to recycle TMT by both material and energy recovery. Depending on the type of TMT product, the waste code number can be found in Annex III of the German Waste Wood Regulation.

Bibliography

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