



Borates for wood treatment

Borate based preservatives play an important role in meeting the dual performance needs of modern renewable materials: Durability + fire safety, without compromising physical and mechanical performance.

Durability

High-purity borate products are widely recognized for their:

- Proven efficacy against decay fungi and insects (termites, beetles)
- Low mammalian toxicity and favorable environmental profile
- Compatibility with both traditional and modern processing technologies
- Long history of use backed by extensive laboratory and field data
- Dual functionality: Durability and fire resistance
- Registration in several countries including China

Fire retardancy and smoke suppression

Borate compounds—including boric acid, borax, zinc borate and disodium octaborate tetrahydrate (DOT)—have a long history of use as fire retardants in wood.

Borates enhance fire safety through multiple, well documented mechanisms in wood:

- Promotion of char formation, creating a protective carbonaceous layer that insulates the substrate
- Cellulose and hemicellulose catalyzed dehydration, reducing the generation of flammable volatiles
- Formation of a glass like (vitreous) surface layer, limiting oxygen diffusion
- Reduction in flame spread, heat release rate, and smoke production

These mechanisms interrupt the combustion cycle by acting on the fuel and heat components of fire development.

Borates in bamboo

As bamboo becomes more prevalent in structural and urban building applications, researchers have started to study flame retardancy and smoke suppression in bamboo construction.

Literature reviews presented at IRG demonstrate that borate based treatments, especially DOT based systems, can:

- Significantly reduce peak heat release rate (pk HRR)
- Lower total heat release (THR)
- Provide effective smoke suppression

Cone calorimeter studies show substantial improvements in fire behavior of borate treated bamboo compared to untreated material. This confirms borates as one of the most effective and environmentally compatible flame retardant chemistries for bamboo.

Bamboo + Borates*

72% Heat release reduction **95%** Smoke reduction

*Sources

1. He Y, et al. 2024. Mechanical and fire properties of flame-retardant laminated bamboo lumber glued with phenol formaldehyde and melamine urea formaldehyde adhesives. *Polymers*. 16(6):781.
2. Jin XB, et al. 2017. Flame-retardant bamboo lumber. *BioResources*. 12(3):5071-5085.
3. Yu L, et al. 2017. Effects of boric acid and/or borax treatments on the fire resistance of bamboo filament. *BioResources*. 12(3):5296-5307.

BROCHURE: BORATES FOR WOOD PROTECTION

U.S. Borax wood treatment products

For a more than 150 years, U.S. Borax has provided refined borates vital to industrial processes and agricultural and commercial applications. Mined and made in America, our products set the global standard for quality and purity, ensuring the best performance in your process.



Protects engineered wood

Borogard[®] ZB is an inorganic zinc borate engineered for demanding applications where long-term durability and low leachability are required.

- Effective against termites and decay fungi
- Low water solubility means enhanced durability in exterior or humid environments
- Excellent compatibility with resins and composite manufacturing (high thermal stability up to 290 °C)
- Uniform distribution when added during blending
- Extensive long term field performance data
- Contributes to fire retardancy and smoke suppression
- No negative effects on strength



Diffusive borate protection

Tim-bor[®] Industrial (DOT) is a highly water-soluble borate preservative optimized for deep penetration and uniform distribution by pressure or nonpressure treatment making it particularly effective for solid wood.

- Broad spectrum protection against termites, wood boring beetles, and decay fungi
- High solubility means rapid dissolution and excellent treatability
- Colorless, odorless, non corrosive
- Environmentally responsible alternative to conventional preservatives
- Extensive global track record in wood protection
- Contributes to fire retardancy and smoke suppression

Benefits

Typical applications

- Oriented strand board (OSB)
- Particle strand board (PSL), laminated strand board (LSL)
- Fiberboard (MDF), particleboard
- Wood plastic composites

- Solid wood protection (interior/above ground)
- Pressure and dip treated lumber and plywood
- Millwork, windows, and doors
- Railroad crossties (sleepers)
- Cross-laminated timber (CLT)
- Laminated veneer lumber (LVL)
- Bamboo

Properties

Chemical	Zinc borate ($2ZnO \cdot 3B_2O_3 \cdot 3.5H_2O$)	Sodium borate ($Na_2B_4O_7 \cdot 4H_2O$)
Water solubility	Low	High
Protection mechanism	In matrix preservative	Diffusive preservative
Target organisms	Termites, beetles, decay fungi	Termites, beetles, decay fungi
Leach resistance	High	Moderate
Fire performance	Flame spread and smoke reduction	Flame spread and smoke reduction
Typical substrates	Wood and bamboo composites	Solid wood, bamboo
Processing method	Additive during blending	Pressure treatment / dip diffusion / spray

About U.S. Borax

U.S. Borax is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving our customers with more than 1,800 delivery locations globally. We supply around 30% of the world's need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles.

About 20 Mule Team products

U.S. Borax produces the *20 Mule Team*[®] borates family of products from naturally occurring minerals and have an excellent reputation for purity and safety when used as directed. Borates are key ingredients in a number of industrial applications including fiberglass, glass, ceramics, batteries and capacitors, wood preservatives, and flame retardants.

High quality, high reliability, high performance borate products. It's what we're known for.



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