

Microwaves and wood processing

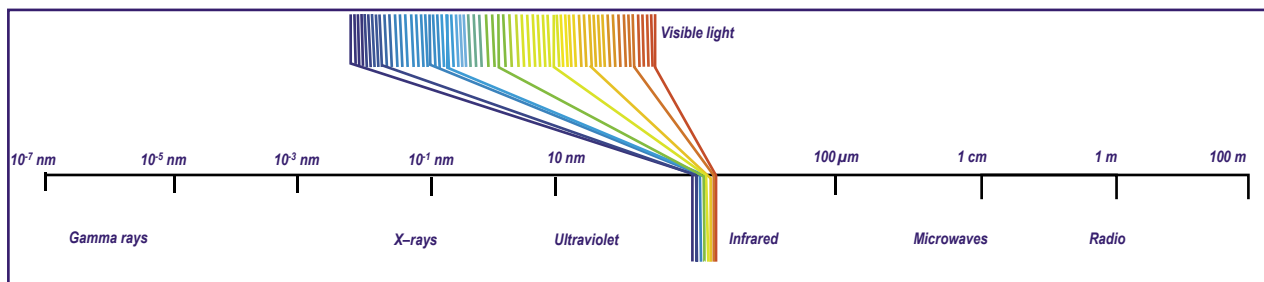
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This fact sheet has been generated as educational material by CRC Wood Innovations. It provides information about what microwaves are and the way in which they work, the microwave research programs being undertaken by CRC Wood Innovations, and some of the ways in which microwaves are used in industry and medicine.

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The electromagnetic spectrum. Microwaves lie between radio waves and infrared rays.

How microwaves work

Microwaves are part of the electromagnetic spectrum, which includes radio waves and visible light. Microwaves are not ionising radiation.

Microwaves are very high-frequency radio waves, possessing an electric field that rapidly reverses direction at about 2 billion cycles per second. Polar molecules (such as water) try to orient in the direction of the field, and the rapid cycling of the field in opposite directions causes the water molecules to flip backwards and forwards. These very rapid vibrations of water molecules generate heat. As a result, any material containing water will heat up when placed in a microwave field.

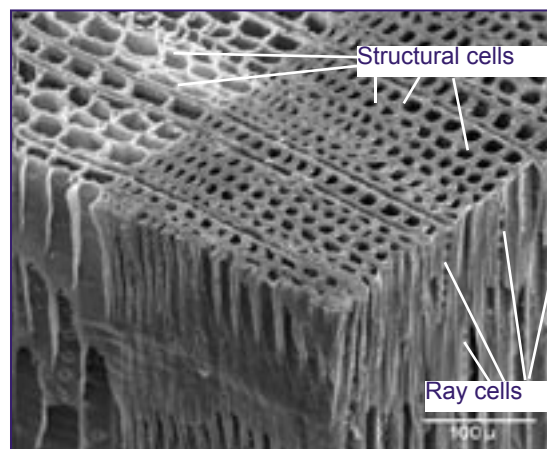
Microwaves heat the interior of materials more efficiently than conventional heating methods, and their heating properties are used in a number of industrial and medical fields.

How microwaves affect wood

Wood contains moisture that absorbs heat when placed in a microwave field. Inside the wood, microwave energy is converted to heat, creating steam pressure in the wood cells. Different wood cells absorb heat to different extents. Wood contains heavy-walled structural cells (tracheids, libriform vessels and fibres) and thinner walled ray cells, which transport nutrients throughout the tree.

Microwave heating affects the thin-walled ray cells most. As the microwave-induced steam pressure increases, they begin to rupture, creating microvoids within the wood structure and increasing the permeability of the wood. These microvoids form pathways for easy transportation of liquids and vapours.

CRC Wood Innovations researchers investigate the effect of exposing wood to microwave fields of varying intensities. As the intensity of microwave treatment increases, more ray cells rupture, creating



Wood structure, showing thick-walled structural cells and thin-walled ray cells.

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tiny channels within the wood. These channels act as ducts to speed up the removal of residual water from wood, but they can also be used to evenly infuse the timber with a variety of liquids—such as stains or colours, resins or preservatives.

How microwaves can benefit the timber industry

CRC researchers have developed microwave treatment schedules that increase timber permeability of different timber species. Working together with CRC engineers and Australian industry, they have developed a process that enables very fast and efficient penetration of preservative solutions throughout a piece of timber—a significant benefit to manufacturers of posts for fencing and vineyards. The process uses less preservative solution than traditional methods.

The same rapid penetration process can be used to apply dyes or wood finishes either to timber pieces or to finished timber products, such as furniture.

Complete drying of Australian hardwood (eucalypt) timbers takes several months under controlled conditions. The drying process is controlled so that loss of moisture is gradual and the timber shrinks evenly. CRC research indicates that low intensity microwave conditioning can speed up this process from months to a matter of days or weeks.

CRC researchers have developed schedules to speed up drying sawn timber boards, and are now working with Australian sawmills to develop schedules for products such as floorboards and parquetry pieces.

Working with microwave-treated wood of increased permeability, CRC researchers are synthesising environmentally friendly resins that can be infused through the wood. After infusion of the resin, the wood is compressed and cured to create a wood-resin composite material. The composite has the appearance of untreated wood. The aim is to use this process to create a wood substitute from low-value wood pieces, that will have improved strength and stiffness, but can still be worked like wood.

All these processes offer commercial and environmental benefits, and the prospect of new products that extend our existing timber resource.

How microwaves are used in other industries

Food processing

Microwave generated heat is widely used in food processing (baking, curing, blanching and drying foods), and to disinfect grains from fungi and insects. A low-level microwave tool has also been suggested for pinpointing perfect ripeness for fruit harvesting.

Solvent-free chemistry

Microwave heating speeds up chemical reactions and increases efficiency, allowing chemists to complete reactions in the absence of solvents. Since solvents are often toxic and a significant source of chemical waste, microwave chemistry offers a way of significantly reducing industrial wastes. Microwave chemistry is of particular interest for the synthesis of new pharmaceuticals.

Waste processing and environmental clean-up

Microwave technology is used in recycling and removal of toxic chemical wastes such as polychlorinated biphenyls (PCBs), and also in the recovery of metals (gold, silver, copper) from electronic circuit boards.

Materials processing

Microwaves are used in the rapid synthesis and curing of polymers (such as rubber and plastics) and in manufacture of glass and ceramic materials (sintering). Microwaves are also used in the mining industry, to extract metals from ores. They are used in the manufacture of semiconductors, and also in heat sealing and welding of materials.

Medicine

Microwaves are part of the next wave of minimally invasive surgery. Doctors are using microwaves to kill breast cancer cells prior to surgery, to treat enlargement of the prostate gland, and to treat irregular heart beats (arrhythmias).

Telecommunications

Microwave beams are used to transmit information, both sound and pictures. Microwaves have made possible televised transmissions around the world via satellite links, and the rapid growth of mobile telephone technology.