

Crystallinity Changes of Wood by Heat or Steam Treatment*¹

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(Received May 31, 1996)

Keywords: permanent fixation, heat treatment, steam treatment, crystallinity

The permanent fixation of compressed wood could be achieved by heating for 20 hours at 180°C or by steaming for 10 minutes at the same temperature^{1,2)}. In this study, to clarify the fixation mechanism, the crystallinity changes of sugi (*Cryptomeria japonica*) wood powder by heat or steam treatment was investigated.

Heat treatments were done in an oven for 20 hours at 120 to 220°C, whereas steam treatments were conducted in an autoclave for 10 minutes at the same temperature levels. Then, the powder was compressed into a disk for X-ray diffraction measurement. Diffraction pattern was obtained over the range of 5 to 40 degree by the reflection method. The degree of crystallinity was calculated by the ratio of the areas corresponding to crystalline region to that of both crystalline and amorphous regions in the diffractograms. The peak width of the (200) diffraction³⁾ at half maximum intensity was determined to evaluate the crystallite width: the larger peak width is, the smaller the crystallite size results. In addition, the infrared absorption was measured to know the chemical changes of wood constituents by heat as well as steam treatments.

As shown in Fig. 1, the degree of crystallinity of steamed powder increased while that of the heated powder decreased with increasing temperature. The peak width of heated powder increased while that of the steamed powder decreased as shown in Fig. 2. Significant changes in the bands assigned to carbonyl and carboxyl groups at 1736, 1719 and 1698 cm⁻¹ in the infrared spectra were detected, which were more apparent in heat treatment than in steam treatment.

It was reported that hemicelluloses degraded by both the treatments at 180°C⁴⁾, so that the stresses stored in the matrix substance and the microfibrils might be released. At the

*¹ This paper was presented at the 46th Annual Meeting of the Japan Wood Research Society in Kumamoto, April 1996.

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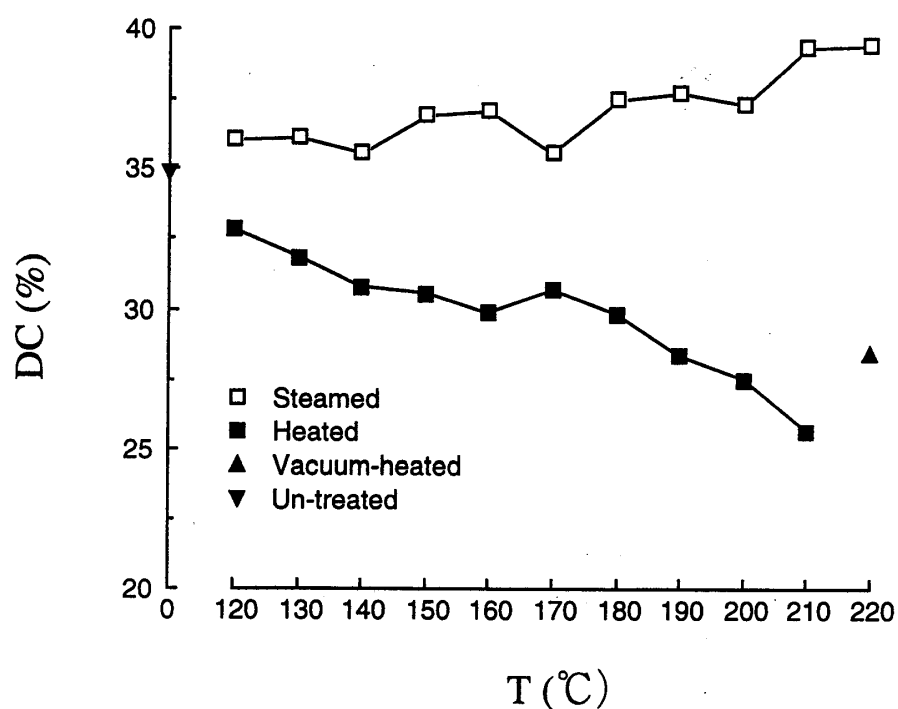


Fig. 1. Relationship between degree of crystallinity (DC) and treating temperature (T) of heated or steamed specimens.

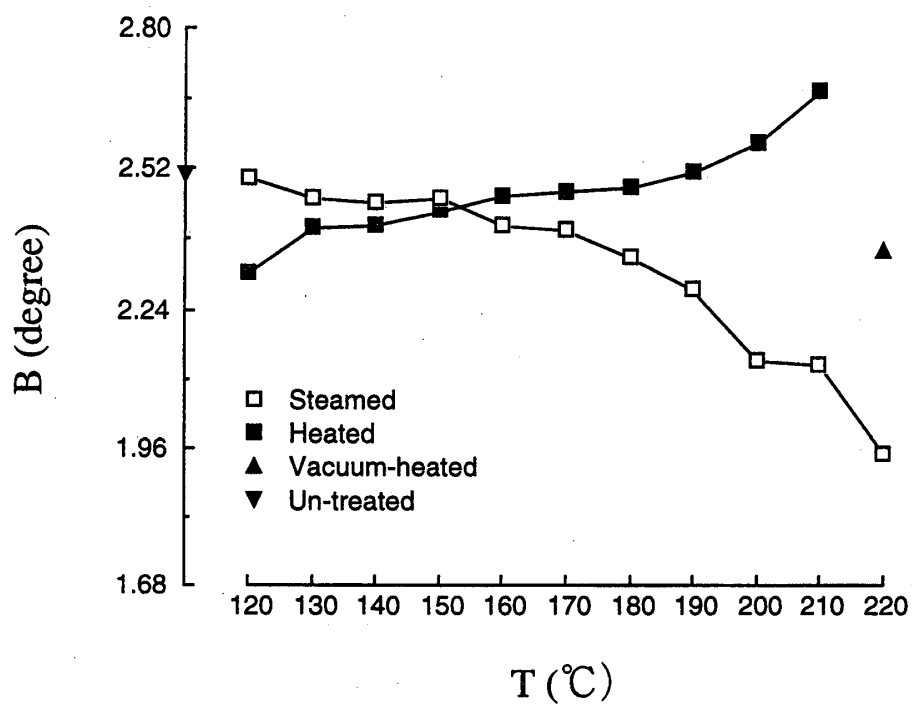


Fig. 2. Relationship between half width of (200) peak (B) and treating temperature (T) of heated or steamed specimens.

same time, the cross-linking reactions in the matrix substance and the crystallization of microfibrils, which act to fix the deformation, likely be possible. The results of X-ray diffraction and infrared absorption measurements showed that the former mechanism was dominant in the heat treatment and latter one was in the steam treatment. However, the compressive deformation was also fixed to some extent by pre-steaming and pre-heating. Therefore, it was reasonably supposed that the fixation of compressive deformation by heat treatment resulted mostly from the release of stresses stored in both microfibrils and matrix substance by the degradation of constituents. On the other hand, the fixation by steam treatment was considered probably because of the cross-linking reactions in matrix substance and the crystallization of microfibrils as well as the relaxation of stresses stored in microfibrils and matrix substance.

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