

## Abstracts

**Plant regeneration from long-term cultured callus of poplar (*Populus nigra*)**, K. SUMIYA, T. SUNAKAWA, T. ISHIMOTO and Z. KASAI: Mokuzaigakkaishi, **34**, 354–358 (1988)

Plant regeneration abilities of short-term (8 months) and long-term (40 months) cultured calluses of *Populus nigra* L. were compared using two green strains. These calluses were induced from petioles originating from the same tree and subcultured under the same conditions.

The optimal hormonal combinations for shoot regeneration from a callus as well as for root formation from the shoot were determined in these two strains.

The long-term cultured callus retained the capacity for shoot formation only within a very narrow range of concentration of kinetin, but its regenerated shoot could barely induce roots. These findings, therefore, suggest that plant regeneration is difficult from the callus of poplar subcultured over a long period of time.

**Quantitative variation of monoterpenes in the foliage of *Thujaopsis dolabrata* var. *hondai***, T. ASADA, H. KURODA and K. SUMIYA: Mokuzaigakkaishi, **34**, 443–450 (1988)

Steam distilled extract of hinokiasunaro (*Thujaopsis dolabrata* S. et Z. var. *hondai* Makino) foliage was analyzed by gas chromatography using a capillary column and an integrator. Fifteen monoterpenes were identified by mass spectrometry and twelve of them were quantitated by the internal standard method. Quantitative variation of the monoterpenes among five hinokiasunaro cultivars, including wild (Aomori-hiba) and cultivated types (atte), were evaluated statistically.

The ma-atte cultivar was distinguished from the other atte cultivars by the relatively large contents of  $\alpha$ -terpinyl acetate and  $\alpha$ -terpineol. The limonene content made it feasible to distinguish the eso-atte cultivar. Tree to tree variation in the wild type cultivar was relatively greater than in the cultivated type cultivars. The ratio of cyclic to acyclic monoterpenes was nearly the same in every tree examined. The ratio of C<sub>4</sub>-hydroxylated to C<sub>8</sub>-hydroxylated monoterpenes also is discussed.

**Things involved in trees but not in grasses —Bioscientific strategies for utilization of a tree trunk—**, H. KURODA: Mokuzaigakkaishi (Wood Research and Technical Notes), No. **23**, 1–13 (1987) (in Japanese)

This review article outlined physiological studies on tree trunks, and considered what kind of studies are useful for elucidating wood formation in the viewpoint of a bioscientific strategy. Trees are rather difficult samples to analyze biochemical

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and physiological processes comparing with grasses. This is mainly because of the large and hard body, long life-cycle etc. The model systems for studying wood-formation in vitro and in vivo were critically outlined. The autor pointed that the systems are unsatisfactorily developed to adopt it to study trunk-formation.

It is generally accepted that plants acquired trunks as a morph during the evolution after aquatic plants were landed and trees are generally earlier morph than grasses. Therefore, one of the way to study wood-formation is comparing trees with grasses especially with in a genus at molecular level, e. g. proteins and genes. Such an example was pointed in this article.

**Tree species of excavated wooden relics from Ootsuka old tomb,** S. HAYASHI and K. SHIMAJI: Settsu Toyonaka Ootsuka Old Tomb, Chap. 5 (2), 130, Toyonaka City, Educational Committee (1987) (in Japanese)

Excavated two coffin wood samples and one sheathe sample were identified. The coffins were made by *Sciadopitys verticillata* and the sheathe was made by *Zelkova serrata*. Ootsuka old tomb is a site of 5th century.

**Tree species of coffins excavated from Kitoragawa site,** K. SHIMAJI, S. HAYASHI and T. ITOH: Report of Kitoragawa Site, Twelveth Excavation, Section VI, 45, Plate 64, Higashiosaka City, Educational Committee and Cultural Properties Association (1987) (in Japanese)

Excavated thirteen coffin wood samples were identified. Two are *Sciadopitys verticillata*, one is *Zelkova serrata* and ten are *Chamaecyparis obtusa*. This site placed in Nishi-ishikiri town, middle of Yayoi era. *Zelkova* for coffin material is the first excavation in Kansai district.

**Tree species of root samples excavated from Kitoragawa site,** K. SHIMAJI, S. HAYASHI and T. ITOH: Report of Kitoragawa Site, Twelveth Excavation, Section VII, 49, Plate 66, Higashiosaka City, Educational Committee and Cultural Properties Association (1987) (in Japanese)

Excavated ten samples were identified. The result were as follows; *Morus bombycis* (4), *Calpinus sp.* (2), *Quercus sp.* (Cyclobalanopsis), *Aphananthe aspera*, *Zelkova serrata* and *Maackia sp.* These root samples are collected from natural growing trees. According to the pollen analysis, it is thought that the site is in the laurel forest. *Quercus* is the only one species of laurel forest. There are some questions between laurel forest and identified species.

**Tree species of wooden implements excavated from Kitoragawa site (7th excavation),** K. SHIMAJI, S. HAYASHI and Y. UEDA: Wooden Relics of Kitoragawa,

Report of 7th Excavation, Part 4, Chap. 4, 39, Higashiosaka City, Cultural Properties Association (1987) (in Japanese)

Wooden 297 samples that excavated from agricultural site of Yayoi era are identified. Hoe and spade are main implements and made from *Quercus* sp. (*Cyclobalanopsis*), and next is thrust tool and made from *Abies firma*. It is clear that the right species were put the right implements.

**Identification of wooden relics excavated from Hirai site**, K. SHIMAJI, S. HAYASHI and S. FUKUDA: Hirai Site, Investigation Report of Sakai Cultural Properties, No. 25, Chap. 4, 105, Plate 36, Sakai City, Educational Committee (1986) (in Japanese)

Excavated wooden cup, clog, piles, boards and so on are identified. *Pinus* sp. (*Diploxylon*) are main species and this indicate the site placed in the second-growth forest. This compound site includ the relics from 5th century to 15th century. Other identified species are as follows; *Chamaecyparis obtusa*, *Quercus* sp. Sect. *Prinus*, *Fagus crenata* and *Cleyera japonica*.

**Tree species of excavated charoal from Shiido site**, S. HAYASHI: Summarized Report of Shiido and Tsukagoshi-hiratsubo Site, Chap. VII, Natural Scientific Investigation, 1, 41, Kosugi-Town, Educational Committee (1988) (in Japanese)

Wooden charcoal excavated from Shiido A site (Toyama Pref., 9th century) are identified. Charcoal samples of 172 are collected from six charcoal-kilns and two iron-foundries and 12 samples are collected from residua of iron-foundries. Identified species are all broad leaved trees and the half are occupied with *Quercus* sp. Sect. *Prinus*. This indicate that the charcoal of *Quercus* is the best for the iron-foundry. The reason is not clear that none the conifer species founded in the near sites.

**Wood species and their use excavated from Japanese relics**, T. ITOH, K. YAMAGUCHI, S. HAYASHI, T. NUNOTANI and K. SHIMAJI: Wood Research and Technical Notes, 23, 42-210 (1987) (in Japanese)

This gives the first comprehensive list on wood species and their use of wooden articles excavated from Japanese relics, and extant wooden buildings and image of Buddha. The list covers more than 40,000 identified wood and wooden articles, which are based on the survey of ca. 380 previous reports relevant to the identification of wood excavated from Japanese relics so far. These old wood and wooden articles are divided into 26 groups according to their purpose for use. Each group is arranged in order with name of wooden articles, wood species, identified number, historic era, name of relics, place of relics and literature.

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**A comprehensive survey of wooden articles excavated from Japanese relics**, K. SHIMAJI and T. ITOH: ed., Yuzankaku-Syuppan, 1988. (in Japanese)

The book describes and discusses the wood species and their use based on the comprehensive list of wood and wooden articles excavated from Japanese relics which are arranged in order with articles, species, number identified, historic era, name of relics, place of relics and literature.

The book includes the following contents

Introduction

1. History on the identification of excavated wood
  2. Dendrochronology in Japan based on the data from Japanese cypress
  3. Methodology on the identification of excavated wood
  4. The use of processed-wood in ancient era of Japan
  5. Restoration of ancient vegetation in Japan based on the survey of non-processed wood
- appendix 1. A comprehensive list of wood and wooden articles excavated from Japanese relics
- appendix 2. Literatures on the identification of excavated wood in Japan
- appendix 3. Literatures on wood anatomy and wood identification
- appendix 4. The other literatures
- appendix 5. Photomicrographs of 96 species of wood and their description

**Development of cellulose synthesizing complexes in *Boergesenia* and *Valonia***, T. ITOH and R.M. BROWN, Jr.: *Protoplasma* **144**, 160–169 (1988)

The development of linear cellulose synthesizing complexes (=TCs) of two selected siphonocladalean algae, *Boergesenia forbesii* and *Valonia ventricosa* was investigated by following the time course of the regeneration of cell walls with the freeze fracture technique after aplanospore induction. The following structural changes of TC development were examined: (1) TCs initiate *de novo*; (2) the first nucleation of TC subunits occurs within 2 hr in *Boergesenia* and 5 hr in *Valonia* after aplanospore induction, immediately followed by the assembly of cellulose microfibrils; (3) TCs increase their length during the assembly of randomly oriented microfibrils; and, (4) TCs stop increasing in length after the assembly of ordered microfibrils begins, with some time lag. The data demonstrate that linear TCs are not artificial products but dynamic entities which are involved in the assembly of cellulose microfibrils.

**Orientation of microtubules during regeneration of cell wall in selected giant marine algae**, S. HAYANO, T. ITOH and R.M. BROWN, Jr.: *Plant Cell Physiol.* **29**, 785–793 (1988)

The microtubules in highly synchronized aplanospores of two giant marine algae, *Boerghesia forbesii* and *Valonia ventricosa*, were examined by immunofluorescence microscopy throughout the regeneration of the cell wall. Microtubule orientation was always random up to 20 h after wounding, although the orientation of cellulose microfibrils changed from random to parallel within that time period. When the rhizoid cells were in the stage of elongation at 7 to 10 days after wounding, highly ordered microtubules were always observed along the longitudinal cell axis except at the very tip of the cells where random ones were found. In contrast, the microfibrils in the innermost lamellae of newly synthesized cell walls showed three different orientations, that is, transverse, longitudinal and oblique to the longitudinal cell axis. These observations suggest that microtubules may control cell shape, but not the orientation of microfibrils. The mechanism of cell wall construction in these algae is discussed in relation to the self-assembly mechanism thought to operate in the construction of helicoidal cell walls.

**Biogenesis of cellulose microfibrils in green algae**, T. ИТОH: Proceedings of the Third Chemical Congress of North America, Part I, Cell-5, (1988)

Recent progress on the biogenesis of cellulose microfibrils have come through the structural analysis of cellulose synthesizing particle complexes (TCs) and their possible products, microfibrils. Giant marine algae among a variety of green algae give us good model organism for the investigation of the biogenesis of cellulose because they have large and highly crystalline cellulose microfibrils. This presentation will discuss the structure and distribution of TCs among a diversity of marine algae as well as the biogenic pathways of TC assembly during the regeneration of cell wall in selected marine algae. In view of the increased attention of microtubules on the orientation mechanism for the assembly of cellulose microfibrils, recent investigation by immunofluorescence microscopy on the orientation of microtubules in selected marine algae will also be discussed.

**Arabinogalactan-proteins in different layers of cabbage leaves (water-soluble glycoconjugates of vegetables. Part II)**, H. YASUFUKU, S. KIDO, J. AZUMA and T. KOSHIJIMA: Nippon Nogeikagaku Kaishi, **61**, 809-815 (1987) (in Japanese)

This communication describes the distribution and chemical variations of water-soluble arabinogalactan-proteins in three layers of cabbage leaves. The inner and outer leaves contained two arabinogalactan-proteins (A-I and A-II) differing in molecular weight, whereas the green leaves and veins were devoid of high molecular weight A-I and contained a lower amount of lower molecular weight A-II. In

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addition, veins from green leaves were completely devoid of A-I and A-II. The ratio of galactose/arabinose and contents of glycine and arginine in arabinogalactan-proteins increased with leaf hardening, while hydroxyproline decreased with leaf hardening. It was also found that the amounts of arabinose, galactose and hydroxyproline in water extracts of cabbage leaves decreased with their concomitant increase in extraction residues as leaf hardening progressed. This suggested that water-soluble arabinogalactan-proteins are transformed into insoluble forms with leaf hardening.

**A Convenient method for preparing lignin-carbohydrate complex from *Pinus densiflora* wood**, T. WATANABE, J. AZUMI and T. KOSHIJIMA: Mokuzaigakkaishi, **33**, 798–803 (1987)

A convenient new method was developed to isolate lignin-carbohydrate complex (LCC-WE). A large amount of LCC-WE was prepared by sequential extraction with cold (20°C) and hot water (80°C) from residual pine wood-meal previously extracted with 80% aqueous dioxane, yielding 9.3% LCC-WE. Fractionation of the LCC-WE resulted in neutral (C-1-M), acidic (C-1-A), and lignin rich (C-1-R) sub-fractions by using ion-exchange chromatography as in the case of Björkman LCC and a water-soluble LCC (HWF) which is isolated after the extraction of Björkman LCC. Because the chemical properties of the three fractions from LCC-WE were found to be identical to those from Björkman LCC and from HWF, this easy method of preparation is recommended to replace the original Björkman method.

**Analysis and determination of wood polysaccharide components by gas-liquid chromatography (1)**, E. MAEKAWA and T. KOSHIJIMA: Mokuzaikenkyu shiryo No. 23, (1987) (in Japanese)

Based on the recovery after acid hydrolysis of neutral monosaccharides, analytical conditions for the analyses of wood polysaccharides by gas-liquid-chromatography were determined.

**Microwave-irradiation of lignocellulosic materials and ethanol fermentation**, T. KOSHIJIMA and A. AZUMA: Reports of special project research on energy under grant in aid of Joint Research of the Ministry of Education Science and Culture, Japan **SPEY 19**, 89–94 (1987)

A new process for the production of ethanol from lignocellulosic materials is proposed on the basis of experiments in microwave-irradiation, saccharification and fermentation. Based upon a comparative analysis of the yields of ethanol obtained by fermentation after enzymatic and acid saccharification, and by simultaneous enzymatic saccharification and fermentation, microwave-irradiation followed by simultaneous

enzymatic saccharification and fermentation was recommended for the production of ethanol from lignocellulosic materials.

**Immobilization of  $\beta$ -glucosidase using wood residue of enzymatic hydrolysis**, S. FUJISHIMA, F. YAKU and T. KOSHIJIMA: *Mokuzai Gakkaishi*, **33**, 992–993 (1987)

Wood meal prepared by 3 hr ball-milling was digested with a commercial enzyme mixture (1:1) of Cellulase Onozuka R-10 (*Trichoderma viride*) and Cellulosin AP (*Aspergillus niger*).  $\beta$ -Glucosidase was found to be immobilized on the undigested residue of the wood meal. The specific activity of the  $\beta$ -glucosidase on milled Karamatsu adsorbent was 0.161 U/mg, decreasing only 4% in six months.

**Properties of enzyme-unhydrolyzable residue of lignin-carbohydrate complexes isolated from beech wood**, N. TAKAHASHI and T. KOSHIJIMA: *Wood Research*, **74**, 1–11 (1987)

Water-soluble lignin-carbohydrate complexes (LCC-W) isolated from beech MWL were treated twice with commercial cellulase (ONOZUKA R-10). The unhydrolyzable fraction precipitated by enzyme treatment was divided into three fractions according to the previous report. All fractions contained neutral sugars and uronic acid. Composition and methylation analysis of sugars remaining in each fraction indicated that xylose, arabinose and galactose residues are linked to lignin possibly by benzyl ether linkage at C-2 or C-3, C-5 and C-6 positions, respectively. The results from alkaline treatment also suggested that these sugars are directly linked to lignin. The existence of alkali-stable linkage between lignin and carbohydrate also was characterized. An analysis of phenolic hydroxy group of lignin moiety suggested that phenol-glycoside linkage is not involved. The results of spectroscopic analysis indicated that lignin moiety in LCC-W consisted of typical hardwood lignin.

**Molecular properties of lignin-carbohydrate complexes from beech (*Fagus crenata*) and Pine (*Pinus densiflora*) woods**, N. TAKAHASHI and T. KOSHIJIMA: *Wood Sci. Technol.* **22**, 177–189 (1988)

Lignin-carbohydrate complexes (LCC) were isolated from pine (*Pinus densiflora*) and beech (*Fagus crenata*) milled-wood lignins. The LCCs were treated with enzyme to obtain precipitates (A-P, B-P) and water soluble fractions. The water soluble fraction from beech LCC was subjected to gel filtration to give LCC fragments (B-E-I). In order to protect the phenolic hydroxyl group, B-E-I and B-P were methylated with diazomethane, resulting in nonphenolic LCC fractions B-E-Ip, and B-Pp respectively. On treatment of B-E-I and B-P with sodium hydroxide, a remarkable amount of xylose and a trace of arabinose were detected as monomeric

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sugars. However, the same alkaline treatment of B-E-Ip and B-Pp gave only a faint trace of xylose. With DDQ treatment of acetylated B-E-I and B-P, monomeric sugars were released in the same amount as those obtained on alkaline treatment. Methylation of the monomeric sugars gave monomethylated xylose. From these results, it was concluded that xylose residues participate in lignin-carbohydrate linkages, and that lignin is linked to xylose at the 0-2 or 0-3 positions through an alkalilabile benzyl ether bond. The molecular-weight distributions of the lignin moieties, measured by HPLC, indicate that the lignin moieties of beech LCC are 100 times larger but less frequent than those of pine LCC.

**Microwave irradiation of lignocellulosic materials IX. Conversion of microwave-irradiated lignocellulose into ethanol,** K. MAGARA, S. UEKI, J. AZUMA and T. KOSHIJIMA: *Mokuzai Gakkaishi*, **34**, 462-468 (1988)

A suitable process for the production of ethanol from lignocellulosic materials, in which a continuous microwave-irradiation system is included as a pretreatment is proposed. The removal of hemicellulosic polysaccharides required a temperature above 210°C when water was used as an irradiation medium. However, the use of a 0.5% acetic acid solution as the medium reduced the threshold temperature for removal of hemicellulosic polysaccharides by 10°C. Saccharification was made by enzymatic hydrolysis and reducing sugar was obtained in a 55.7% yield from akamatsu (Japanese red pine) wood and in a 61.0% yield from buna (Japanese beech) wood, whereas the values changed to 42.1% and 86.1%, respectively, when 0.5% acetic acid was used in the pretreatment. Alcohol fermentation was done by two methods. One was simple fermentation and the other was simultaneous saccharification and fermentation (SSF process). Yield of ethanol in the SSF process depended upon the irradiation temperature, whereas it was independent in the simple fermentation method. From the viewpoint of producing a large quantity of ethanol per unit of time, the advantage was in the SSF process.

**An analytical method for the determination of acidic sugars in wood hemicelluloses by gas-liquid chromatography,** E. MAEKAWA and T. KOSHIJIMA: *Mokuzai Gakkaishi*, **34**, 359-362 (1988)

Acidic sugars were separated from acid hydrolyzates of xylans isolated from buna wood and bamboo culms. They were subjected to methyl esterification, followed by reduction with lithium borohydride, and then the reduced monosaccharides analysed and determined by gas-liquid chromatography after conversion into the alditol acetates. As a result, this method is believed to be applicable for the analysis and determination of acidic sugars containing uronic acid groups in various acidic polysaccharides.

**Chemistry and Biochemistry of Bamboo**, T. HIGUCHI: Bamboo Journal No. 4, 132 (1987)

Differences of chemical properties of hemicelluloses and lignin of bamboo from those of conifers and hardwoods, and biochemistry of lignin formation of bamboo are reviewed based on respective original papers.

**Biomimetic approach to lignin degradation II. The Mechanism of Oxidative C-C Bond Cleavage Reactions of Lignin Model Compounds with Natural Iron (III) Porphyrin Chloride as a Heme-Enzyme Model System**, M. SHIMADA, T. HABE, T. HIGUCHI, T. OKAMOTO and B. PANIJPAN: Hofzforsch., **41**, 277 (1988)

Biomimetic oxidation of lignin model compounds such as  $\beta$ -1,  $\beta$ -O-4, and  $\beta$ -5 substrates was investigated with a natural iron-prophyrin which mimicks the ligninase catalysis.  $^{18}\text{O}$  from molecular oxygen and water were found to be incorporated, to different degrees, into the C-C bond cleavage product (p-methoxyphenylglycol) formed from  $\beta$ -1 substrate (1, 2 bis (p-methoxyphenyl) propane 1, 3-diol) under aerobic or anaerobic conditions. Kinetic experiments for catalytic degradation of the  $\beta$ -1 and its deuterated substrates supported the one-electron transfer mechanism for the oxygenative C-C bond cleavage previously reported. Other model compounds were also found to undergo C-C bond cleavages in the hemin-catalyzed reaction, yielding aromatic aldehydes, ketols and acids.

**Selective carbon-carbon carbon bond cleavage of 1,2-diols by molecular oxygen in the presence of iron porphyrin catalysts and dihydropyridine**, T. OKAMATO, K. SASAKI, M. SHIMADA and S. OKA: In, "The Role of Oxygen in Chemistry and Biochemistry" (Eds., W. Ando and Y. Moro-oda), Proceedings of an International Symposium on Activation of Dioxygen and Homogeneous Catalytic Oxidations, Tsukuba, 12-16 July 1987, Studies in Organic Chemistry, **33**, 499-502 (1988) Elsevier Science Publishers, Amsterdam.

Aerobic cleavage of saturated C-C bond of 1, 2-diaryl-1, 2-ethanediol was examined in the presence of tetraarylporphyrinatochloroiron (III) complex as the catalyst and 3-carbamoyl-1-benzyl-1, 4-dihydropyridine as the reductant in  $\text{CH}_2\text{Cl}_2$  at room temperature. Selective cleavage of saturated C-C bond took place to give arylaldehyde in preference to dehydrogenation, which leads to diarylketol and/or diarylketone (benzil) as the reaction products. The effect of additives is reported.

**Biomimetic approach to lignin degradation: mechanism for aromatic ring cleavage of 3, 4-dimethoxybenzyl alcohol with natural iron (III) porphyrin systems**, M. SHIMADA, T. HATTORI, T. UMEZAWA, T. HIGUCHI and T.

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OKAMOTO: In, "Lignin enzymic and microbial degradation" (Ed., E. Odier INRA Publ., Paris, pp. 151 (1987)

Oxygenation mechanism for the ring cleavage of veratryl alcohol as a natural non-phenolic lignin model compound was investigated with the biomimetic porphyrin (BMP) and lignin peroxidase (LPO) systems. The experiments with  $^{18}\text{O}$ -enriched water and dioxygen clearly showed that one oxygen atom each from water and dioxygen is incorporated into the ring cleavage products in both LPO and BMP systems. However, in contrast to BMP, LPO exhibits the greater incorporation with much higher selectivity in the oxygenation modes, i. e., one oxygen atom from water or dioxygen is introduced specifically to  $\text{C}_3$  or  $\text{C}_4$  position of 3, 4-dimethoxybenzyl water on the aryl cation radical, and subsequent addition of dioxygen rationally explains the oxygenative ring cleavage of veratryl alcohol in good harmony with the one-electron transfer mechanism proposed.

**Regiospecific oxygenations during ring cleavage of a secondary metabolite, 3, 4-dimethoxybenzyl alcohol catalyzed by lignin peroxidase,** M. SHIMADA, T. HATTORI, T. UMEZAWA, T. HIGUCHI and K. UZURA: FEBS Lett., **221**, 327 (1987)

Enzymatic oxidation of veratryl alcohol yielded a new ring cleavage product ( $\delta$ -lactone) in addition to the two known  $\gamma$ -lactone products. The experiment with  $^{18}\text{O}$ -enriched water and dioxygen clearly showed that one oxygen atom each from water and dioxygen is specifically incorporated into the cleavage product at the original  $\text{C}_3$  or  $\text{C}_4$  position of 3, 4-dimethoxybenzyl alcohol. A new type of reaction mechanism proposed for the ring cleavage of this compound is rationally explained in good accord with the one-electron transfer mechanism.

**Transformation of native cellulose crystals induced by saturated steam at high temperatures,** F. HORII, H. YAMAMOTO, R. KITAMARU, M. TANAHASHI and T. HIGUCHI: Macromolecules, **20**, 2946–2949 (1987)

Transformation of cellulose crystals between cellulose Ia and Ib induced by saturated steam at high temperature was observed by CP/MAS  $^{13}\text{C}$  NMR measurement at 50 MHz in the hydrate state. The spectrum of original valonia cellulose exhibits typical cellulose Ib type to multiplets. These multiplets are converted to different multiplets (new type of the crystalline Ia', which seem to be almost identical with cellulose Ia type, with increasing steam annealing temperature. The feature of the cotton-ramie type spectrum (cellulose Ia) is almost unchanged except for a slight decrease in intensity of the central line. It is concluded that both cellulose Ia and Ib are transformed into cellulose Ia' by the treatment with saturated steam above 260°C.

**New mechanism for oxygenative ring cleavage of 3,4-dimethoxybenzyl alcohol catalyzed by the ligninase model**, T. HATTORI, M. SHIMADA, T. UMEZAWA, T. HIGUCHI, M.S.A. LEISOLA and A. FIECHTER: *Agric. Biol. Chem.*, **52**, 879 (1988)

Aerobic or anaerobic oxidation of 3,4-dimethoxybenzyl alcohol (veratryl alcohol) as a natural lignin model compound in the presence of hemin and *tert*-butylhydroperoxide yielded *cis*- and *trans*- $\gamma$ -lactones and  $\delta$ -lactone as the ring cleavage products. The results obtained with  $^{18}\text{O}$ -water and dioxygen clearly showed that only one  $^{18}\text{O}$ -atom was incorporated from either water or dioxygen into the cleavage products. Furthermore,  $^{18}\text{O}$  from water and dioxygen were demonstrated to be regiospecifically incorporated into 3- and 4-position, respectively, of the 3,4-dimethoxybenzyl alcohol in formation of the  $\gamma$ -lactones, whereas such regiospecific oxygenation was not clearly observed in the case of  $\delta$ -lactone formation.

**Organic acid pulping of wood IV. Reactions of arylglycerol- $\beta$ -guaiacyl ethers**, JAMES L. DAVIS, F. NAKATSUBO, K. MURAKAMI and T. UMEZAWA: *Mokuzai Gakkaishi*, **33**, 478 (1987)

Arylglycerol- $\beta$ -guaiacyl ethers were used as model compounds to study the delignification reactions that occur during acetic acid pulping. Guaiacylglycerol- $\beta$ -guaiacyl ether was 90% consumed during a 10 minute reaction with 75% acetic acid at 165°C, but less than 60% of the ether bonds in veratrylglycerol- $\beta$ -guaiacyl ether were cleaved during a 4 hour reaction under the same conditions. However, the latter ether reacted completely within 1 hour at 200°C.

Ether cleavage primarily followed two reaction paths. The first route leads to the production of Hibbert's ketones, which are also produced by a standard acidolysis treatment, while the second route ultimately yields an enol acetate. Intramolecular condensation occurred to a significant degree at both low (165°C) and high (200°C) reaction temperatures.

**Application of gas chromatography-mass spectrometry to lignin biodegradation study**, T. UMEZAWA and T. HIGUCHI: *Shimadzu Kagakukikai News*, **28**, No. 3, 7 (1987) (in Japanese)

Application of gas chromatography-mass spectrometry to lignin biodegradation study was described in connection with lignin biodegradation study by the authors.

**Degradation mechanisms of phenolic  $\beta$ -1 lignin substructure model compounds by laccase of *Coriolus versicolor***, S. KAWAI, T. UMEZAWA and T. HIGUCHI: *Arch. Biochem. Biophys.*, **262**, 99 (1988)

Phenolic  $\beta$ -1 lignin substructure model compounds, 1-(3,5-dimethoxy-4-hy-

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droxyphenyl)-2-(3, 5-dimethoxy-4-ethoxyphenyl) propane-1, 3-diol (**I**) and 1-(3, 5-dimethoxy-4-ethoxyphenyl)-2-(3, 5-dimethoxy-4-hydroxyphenyl) propane-1, 3-diol (**II**) were degraded by laccase of *Coriolus versicolor*. Substrate **I** was converted to 1-(3, 5-dimethoxy-4-hydroxyphenyl)-2-(3, 5-dimethoxy-4-ethoxyphenyl)-3-hydroxypropanone (**III**), 1-(3, 5-dimethoxy-4-ethoxyphenyl)-2-hydroxyethanone (**IV**), 1-(3, 5-dimethoxy-4-ethoxyphenyl)-3-hydroxypropanal (**VI**), 2, 6-dimethoxy-*p*-hydroquinone (**VII**), and 2, 6-dimethoxy-*p*-benzoquinone (**VIII**). Furthermore, incorporations of  $^{18}\text{O}$  of  $^{18}\text{O}_2$  into ethanone (**IV**) and  $^{18}\text{O}$  of  $\text{H}_2^{18}\text{O}$  into hydroquinone (**VII**) and benzoquinone (**VIII**) were confirmed. Substrate **II** gave 1-(3, 5-dimethoxy-4-hydroxyphenyl) ethane-1, 2-diol (**IX**), 1-(3, 5-dimethoxy-4-hydroxyphenyl)-2-hydroxyethanone (**X**), and 3, 5-dimethoxy-4-ethoxybenzaldehyde (**XI**). Also  $^{18}\text{O}$  of  $\text{H}_2^{18}\text{O}$  was incorporated into glycol (**IX**) and ethanone (**X**). Based on the structures of the degradation products and the isotopic experiments, it was established that three types of reactions occurred via phenoxy radicals of substrates caused by laccase: (i)  $\text{C}\alpha\text{-C}\beta$  cleavage (between C1 and C2 carbons); (ii) alkyl-aryl cleavage (between C1 carbon and aryl group); and (iii)  $\text{C}\alpha$  (C1) oxidation.

**Influence of alkoxy ring substituents on the degradability of  $\beta$ -O-4 lignin substructure model dimers by *Phanerochaete chrysosporium*, S. YOKOTA T. UMEZAWA and T. HIGUCHI: Mokuzai Gakkaishi, 34, 65 (1988)**

The effects of alkoxy substituents on the aromatic ring in fungal degradation are discussed, based on a quantitative analysis of degradation products of three types of  $\beta$ -O-4 lignin model dimers, 4-ethoxy-3-[D<sub>3</sub>] methoxyphenylglycerol- $\beta$ -phenyl ether (**II'**), 4-ethoxy-3-[D<sub>3</sub>] methoxyphenylglycerol- $\beta$ -guaiacyl ether (**II'**), and 4-ethoxy-3-[D<sub>3</sub>] methoxyphenylglycerol- $\beta$ -(2, 6-dimethoxyphenyl) ether (**III'**) by *Phanerochaete chrysosporium* Burds. When (**I'**), (**II'**), and (**III'**) were used as substrates, degradation products derived from initial attacks on the guaiacyl ring (**Z**-ring), both A-ring and the aromatic ring etherified at the  $\beta$ -position (**B**-ring), and B-ring, respectively, were detected by gas chromatograph-mass spectrometric analysis. Most of the products were identical with those in the degradation of Substrates (**I'**), (**II'**), and (**III'**) by lignin peroxidase of the fungus. Thus, it is conceivable that the degradation of  $\beta$ -O-4 lignin model dimers by intact cells of *P. chrysosporium* is catalyzed by lignin peroxidase of the fungus, and that the aromatic ring with more alkoxy substituents is attacked more preferentially by the enzyme.

**$\text{C}\alpha\text{-C}\beta$  cleavage of phenolic  $\beta$ -1 lignin substructure model compound by laccase of *Coriolus versicolor*, S. KAWAI, T. UMEZAWA, M. SHIMADA, T. HIGUCHI, K. KOIDE, T. NISHIDA, N. MOROHOSHI and T. HARAGUCHI: Mokuzai Gakkaishi, 33, 792 (1987)**

$\beta$ -1 Lignin substructure model compound, 1, 2-bis (4-hydroxy-3, 5-dimethoxyphenyl) propane-1, 3-diol (**I**), was degraded by laccase of *Coriolus versicolor* (Fr.) Quél. Syringylglycol (**III**),  $\alpha$ -hydroxycetosyringone (**IV**), syringaldehyde (**V**), and 2,6-dimethoxy-*p*-bezoquinone (**VI**) were identified as degradation products by gas chromatograph-mass spectrometry.

The structure of degradation products indicated that the C-C linkage between C $\alpha$  and C $\beta$  of the propyl side-chain was cleaved by laccase via the phenoxy radical intermediate.

The non-phenolic  $\beta$ -1 model compound, 1, 2-bis (4-ethoxy-3, 5-dimethoxyphenyl) propane-1, 3-diol (**II**), was not degraded by laccase.

**The status quod of forest resources in Brasil and advantageous utilization of bamboos**, T. NOMURA: Bamboo Journal, No. 5., 92 (1987) (in Japanese)

The exhaustion of forest resources in South America include Amazon basin is giving a great menace to the environment on the earth. But, a concrete countermeasure for it's prevention have made little progress. This report mentioned the status quod of forest resources in Brasil and proposed one of the countermeasure by using of bamboos.

**Biophysical properties of bamboo**, T. NOMURA: In "Study of main bamboo in Japan", ed., T. Aoki (Ashi shobo), pp. 27-59 (1987) (in Japanese)

Biophysical and mechanical properties of bamboo on it's growing stage reviewed.

**Coming of the time to enjoy wood with sensitivity, "Design give life to wood"**, T. NOMURA: Woodmic, No. 5., 38 (1988) (in Japanese)

As advancing with a functional differentiation of articles which used in our life we should considered wood not only as a ordinary material but also as a material for using to mental and psychological standpoint. So, how to design of wood is getting more important.

**Common perception on article's made of wood**, T. NOMURA: Mokuzaï Kenkyu Shiryo (Wood Research and Technical Notes), No. 23, 240 (1987) (in Japanese)

Common perception on articles made of wood was analyzed by means of the semantic differential method. The forms of articles made of wood were as follows; (1) some decorative log, (2) solid and thick board construction, (3) abstract and (4) toys. It made a great different recognition between man and woman to the form of log and abstract. As to toy's form, there was no different perception between both of them.

## ABSTRACTS

**Structural observation on seedling bamboo (*Phyllostachys pubescens* *Mazel*) by scanning electron microscope**, T. NOMURA: Bamboo Journal, No. 5, 43 (1987)

A morphological change of cell tissue on seedling bamboo from 1 year old to mature was observed by scanning electron microscope.

**Acetylation of bamboo fiber**, R.M. ROWELL and M. NORIMOTO: Mokuzaï Gakkaishi, 33, 907–910 (1987)

Bamboo (*Phyllostachys bambusoides* Sieb. et Zucc.) fiber was acetylated with acetic anhydride alone to various levels of acetyl weight gain. Acetylation causes the bamboo fiber to become more hydrophobic as evidenced by a lowering of the equilibrium moisture content as the level of cell wall bonded acetyl increased. Acetylated bamboo at acetyl weight gains of about 17 percent had an equilibrium moisture content less than half that of unreacted fiber at the relative humidities tested. Acetylated bamboo fiber could be used to produce fiberboard with greatly improved dimensional stability and resistance to biological attack.

**Recovery of compression set**, I. IIDA and M. NORIMOTO: Mokuzaï Gakkai, 33, 929–933 (1987) (in Japanese with English summary)

The purpose of this study was to experimentally confirm an interpretation of the mechanisms of the formation and recovery of drying set proposed in the previous paper<sup>1)</sup>. After the test specimens of two different wood species were soaked in water of a temperature of 90°C, they were compressed in the radial direction and were tested for stress relaxation during one hour. Also, using the woods subjected to the compression set, the recovery-stress occurring when the set-woods were subjected to heating in water under restraint were measured. Then, the residual stress,  $\sigma_{s60}$  at 60 minutes in the relaxation experiment, and the recovery-stress of set,  $\sigma_{r60}$  at 60 minutes, were compared to confirm the existence of a driving force for set-recovery.

The results obtained were as follows:

- 1) The values of  $\sigma_{s60}$  did not equal zero but were in the range of two-thirds to one-half of initial stress. Moreover, the applied compressive strains almost disappeared after unloading at the end of the relaxation experiment.
- 2) The specimens dried under the compressive strains further increased their strains. The amount of the increased strain: namely, shrinking strain, was more than the range of 1.5–4.0% on the basis of the original dimensions of wet wood.
- 3) The values of  $\sigma_{r60}$  increased with increasing amounts of set, and the residual set (residual strain) after unloading was small.
- 4) The value of  $\sigma_{r60}$  was only slightly smaller than that of  $\sigma_{s60}$ , and the reverse

relationship was obtained from a comparison of the values of  $\varepsilon_r$  and  $\varepsilon_s$ . Therefore, the difference between both stresses is attributed to the difference in both residual strains; and for that reason, both stresses are regarded as being approximately equal.

- 5) These results suggested that the driving force of set-recovery has been frozen during the drying process and explains satisfactorily the mechanism of set described in the previous paper.

**Development of new teaching materials on woodworking study in junior high school, Manufacture of bending wood by home electron range,** K. IMADA, T. AOKI and M. NORIMOTO: Bull. Japan Soc. Ind. Techn. Education, **29**, No. 3, 1-8 (1987) (in Japanese with English summary)

A method of wood bending using home electron range was developed, and bending quality of various kinds of wood species and the improvement of the hand bending equipment were investigated.

The results obtained were as follows:

- 1) Matters that demand special attention in the bending operation were
  - (1) to put a vessel with water in the range to absorb an excessive electric power (Photo. 3),
  - (2) to bend the wood sample and the strap of the equipment in a body to prevent tensile failures on concave side of the sample,
  - (3) to adjust a gap between the sample and the end-stop of the equipment during the bending operation to avoid compressive failures on concave side of the sample, and
  - (4) to leave the bent sample with the equipment for several hours to release the internal stresses and to prevent the twisting of the sample after its removal from the equipment.
- 2) Japanese hard woods such as mizunara, urihadakaede, uwamizusakura, yamaguwa, yurinoki, nigaki, simatoneriko and buna were suitable for wood bending, while Japanese soft woods such as matsu and sugi except for rakuushou and himuro, and tropical woods such as lauan and teak were difficult to bend.
- 3) By using the bending equipment with a spring on the stop-end developed in this investigation, a good result was obtained.

From these results, it was considered that it was technically possible to use the bent wood samples for a teaching material.

**Suppression of creep of wood under humidity change through chemical modification,** M. NORIMOTO, J. GRIL, K. MINATO, K. OKAMURA, J. MUKUDAI and R.M. ROWELL: Mokuzai Kogyo (Wood Industry), **42**, 504-508 (1987)

## ABSTRACTS

(in Japanese with English summary)

It is well known that the creep of wood is greatly accelerated when humidity is changing and sometimes it leads to failure. We attempted to suppress this creep deformation of wood in the longitudinal direction through chemical treatments such as acetylation and formaldehyde crosslinking. Acetylated samples were prepared by soaking dry samples in acetic anhydride, and crosslinked samples by the HCl catalyzed vapor phase system. When a high load was applied to the untreated sample, whilst the first humidity increase and all reductions in humidity caused increases in deflection, the second and all later humidity increases produced some recovery of deformation. However, in the case of a low load the opposite trend was observed after first humidity increase. On the other hand, the deflection of the treated samples was increased by humidifying and decreased by drying after first humidity increase regardless of the applied load level. The creep deformation of wood under humidity change was remarkably reduced by both the treatments. Formaldehyde crosslinking was more effective to suppress the creep deformation under humidity change. However, the treatment was accompanied by color change and a pronounced reduction in the strength properties of the samples.

**Improvements in the piano pinblock**, H. YANO, J. MUKUDAI and M. NORIMOTO: *Mokuzai Gakkaishi*, **34**, 94–99 (1988) (in Japanese with English summary)

To stabilize piano tones under humidity changes, it is very important for a pin block to have dimensional stability. For this purpose, we investigated changes of the resonance frequency and the tuning torque with humidity cycling for full-scale models of the string-sustaining part at the 72th key with four types of three-ply laminated wood pin-blocks, that is a cross-laminated untreated block, a parallel-laminated untreated block, a cross-laminated acetylated block, and a crosslaminated polyethylene-glycole (PEG) impregnated block.

The decrease of the resonance frequency for the model with the cross-laminated untreated block was large compared with that with the parallel-laminated block. Both acetylation and PEG impregnation greatly reduced the changes of resonance frequency. Especially with acetylation, the decrease of the tuning torque was suppressed remarkably. From these results, it is expected that a parallel-laminated acetylated pin-block is extremely effective in reducing the changes of resonance frequency and tuning torque with humidity changes.

**Humidity-proof, quasi-isotropic wood diaphragm for loudspeakers**, T. ONO, Y. KATOH and M. NORIMOTO: *J. Acoust. Soc. Jpan.* (E), **9**, 25–33 (1988)

A flat wood diaphragm 105 × 105 mm in size for a low to middle range loud-

speaker was developed using the wood for soundboards of musical instruments. It is necessary for the wood diaphragm to be humidity-proof and isotropic. For the former, coating with varnish, which was the same as that used for the soundboards, and acetylation, which was essential in the conversion of hydrophile property, were carried out. The humidity-proof performance of these treatments was tested, and each treatment showed the characteristic effect. For the latter, rectangular wood bars for reinforcing radial (R) direction, which was lower in strength, were glued to both edges of the square wood board, one side of which was parallel to longitudinal (L) direction, in L direction. It was found that the wood board with the bars, wood diaphragm, had a circle node at quasi-isotropy, and it was clarified that the circle node was produced by the degeneration of both vibrations in each direction of L and R. Loudspeakers with the developed wood diaphragm showed acceptable performance.

**Humidity conditions by wall papers for decorative finish II**, T. OHGAMA, M. NORIMOTO and J. KOHARA: 14–18 (1988) (in Japanese with English summary)

Both the absolute humidity and the temperature in the closed steel boxes lined with various interior wall materials were measured when the external temperature of the closed steel boxes was changed. The relationship between the extent of humidity conditions caused by these materials and the ratio of the lined area of the material to the volume of the steel box,  $A/V$ , was investigated. The extent of humidity conditions was estimated by the slope  $b$  of the logarithm of absolute humidity-temperature curve; the larger the value of  $b$  is, the better are the humidity conditions. The materials used were four kinds of wall papers; cloth, paper, olefin and vinyl, and two kinds of sheathings; plywood and polyester overlaid plywood. From the results, it was shown that the extent of humidity conditions due to wall papers depended remarkably on both  $A/V$  and the kind of sheathing. As an application of the results, the lined area of wall material equivalent to that of wood in humidity conditions was calculated.

**Suppression of creep of wood by acetylation**, M. NORIMOTO: Nihon Reoroji Gakkaishi (J. Soc. Rheology, Japan), **16**, 87 (1988) (in Japanese)

It was introduced that acetylation is effective to reduce the creep deformation of wood under humidity changes and to improve the acoustical properties of wood.

**Wood bending**, M. NORIMOTO: Mokuzai Kogyo (Wood Industry), **43**, 239–240 (1988)

Methods of wood bending utilizing hygro-thermal treatment and chemical treatments were introduced.

## ABSTRACTS

**Present situation of acetylated wood**, M. NORIMOTO: Woodmic, **6**, No. 4, 30–33 (1988) (in Japanese)

Recent information on acetylation of wood, properties of acetylated wood and improvement of acoustical properties of wood through acetylation were described.

**Dimensional stability of bamboo particleboards made from acetylated particles**, R.M. ROWELL and M. NORIMOTO: Mokuzai Gakkaishi, **34**, 627–629 (1988)

Bamboo (*Phyllostachys bambusoides* Sieb. et Zucc.) particles were acetylated with acetic anhydride alone, and the acetylated particles were pressed into particleboards using a phenolformaldehyde adhesive. In liquid-water tests, boards made from acetylated particles swelled at a much slower rate and to a less extent than did control boards after 5 cycles of wetting and oven drying. In humidity tests, all boards made from acetylated particles had much lower equilibrium moisture contents than the control boards.

**Improvement of acoustical properties of wood through chemical modifications**, M. NORIMOTO, J. GRIL, T. SASAKI and R.M. ROWELL: Proc. European Scientific Colloquium on the Mechanical Behavior of Wood, Bordeaux, p37–44 (1988)

It was attempted to improve the acoustical properties of wood through chemical treatments such as acetylation and formaldehyde cross-linking. Acoustical properties were evaluated by specific Young's modulus and by  $\tan \delta$  in longitudinal direction using free-free flexural vibration method. Acetylated specimens were prepared by soaking dry specimens in acetic anhydride and cross-linked specimens by the HCl catalyzed vapor phase system. Specimens with weight percent gains due to acetylation of 19.0–19.6% and formaldehyde cross-linking of 0.47–0.86% were produced. Dynamic Young's modulus and  $\tan \delta$  of wood in longitudinal direction varied considerably even when compared at same specific gravity. There was a good correlation between  $\tan \delta$  and specific dynamic Young's modulus and the relation could be expressed an exponential equation at any moisture content.  $\tan \delta$  both during moisture absorption and desorption was higher compared to that in the equilibrium moisture condition when compared at same moisture contents, especially in the early stage of moisture absorption. The chemical treatments reduced not only  $\tan \delta$  but also its variation with relative humidity change. Furthermore, the treatments suppressed the creep deformation during humidity change. The results of this study indicated that these treatments were effective to improve the acoustical properties of wood.

**Studies on mechanical and dielectric relaxation processes in cellulose derivatives**, T. MOROOKA: Wood Research, **74**, 45–107 (1987)

This is a three-part article. Part I describes relaxation processes in a series of conventional cellulose acylates. Part II discusses relaxation processes for a series of acylated cellulose prepared by using paraformaldehyde (PF)-DMSO medium. Polymers in this series are substantially different in character from conventional series of the acylates. In Part III, application of PF/DMSO medium to cyanoethylation of cellulose is introduced. The resulting products are quite different in physical properties from the conventional cyanoethylcellulose and are characterized on the basis of the result obtained in Part II.

**Viscoelastic properties of (cellulose oligo-oxymethylene ether) acylates with bulky side chain**, T. MOROOKA, M. NORIMOTO and T. YAMADA: J. Applied Polym. Sci., **35**, 717–726 (1988)

A series of (cellulose oligo-oxymethylene ether) acylates (COAs) are characterized by the presence of the micro-Brownian motion of the side chain ( $\beta$  process) which appears separately from that of the main chain ( $\alpha$  process). Both the  $\alpha$  and  $\beta$  processes are largely affected by the kind of acyl groups introduced in the side chain. To clarify the effect of the acyl group on these processes, we investigated the dynamic mechanical properties of newly prepared COAs with acyl side chain, bulky in chemical structure (iso-butyrate, privalate, and benzoate) in relation to those for COAs with linear acyl side chain (acetate, butyrate, and valerate). By substituting bulky acyl isomer for linear acyl group in COAs, we observed that the temperature region of both the  $\alpha$  and  $\beta$  processes moved to higher temperature. Furthermore, with an increase in molecular size of bulky acyl group, the  $\beta$  region shifts were much larger than the  $\alpha$  region, indicating that the mobility of the side chain became comparable to that of the main chain. Finally, when such a large bulky group, for example, benzoate was introduced, the micro-Brownian motion of the side chain prior to that of the main chain ceased. The apparent activation energy for a third process ( $\gamma$ ) due to the motion of the oligo-oxymethylene parts in the side chain was estimated to be 10.3 kcal/mol.

**On the Wood-produced environment and its estimation**, T. YAMADA: Woodmic, No. 5, 24–27 (1988)

The action of wood for living comfort is described in relation to the controlling effect of house climate and to the human feeling.

**Present state and tomorrow with wood-composition boards**, H. SASAKI: Mokuzai Kogyo (Wood Industry), **42** (12), 2–10 (1987) (in Japanese)

## ABSTRACTS

Classification and definition of wood-composition boards and the raw materials were proposed. The present state of production of these materials and construction or expansion of the plant were reviewed. Then the future development of these materials was discussed, where the boards were thought to polarize into two categories: a) Low- or medium-density thick board produced by steam-injection pressing, b) High-density and high quality thin board produced by continuous pressing.

**Research field on composite wood and the recent development**, H. SASAKI: Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 23, 22-31 (1987) (in Japanese)

Discussion was made on subjects which were important in the research field of composite wood. Most of excellent properties of composite wood are based on the orientation of wood fiber cells which are composed of helically winding cellulose microfibrils. Efforts which have been made on dispersion or elimination of defects of wood as knots in the production of well-oriented composite woods were introduced. Some recent development on combination with other materials was also introduced. A new classification of composite woods was proposed and the recent tendency of the production and development of the materials was discussed.

**Excellent properties of wood-cell structure and the practical application on development of wood composites**, H. SASAKI: Shaho (Dai-Ichi Industrial Pharmacy) No. 453, 4-11 (1988) (in Japanese)

Excellent mechanical properties per weight in longitudinal direction of wood is due to the cell wall composed of helically winding cellulose microfibril and lignin matrix. This article is a lecture notes on the properties of wood and the practical application in wood composites. How to disperse or eliminate defects of wood in the process of wood composites, especially oriented products such as glued-laminated wood, laminated veneer lumber and oriented strand board was explained. Application of these materials as building components in the form of complex beam was introduced.

**Physical conversion and utilization of low-grade logs with small diameter and residues from wood industries**, H. SASAKI and H. SUGIHARA: Proc. 6th Seminar on Science and Technology, Utilization and processing techniques of plantation forest timbers, October 22-23, Tokyo, 117-127 (1987)

Two developmental studies have been made on physical conversion and utilization of low-grade logs produced by thinning operation of softwood plantations.

- 1) High-yield veneer lathe for peeling thinnings.

In order to produce LVL with high yield from small diameter logs like thinnings, a new-type of 4-foot veneer lathe with powered back-up rolls was designed and manufactured for trial. Veneer of good quality were successfully peeled from small diameter logs without spinning-off until core diameter reached the target of 45 mm. Properties of LVL made of veneer from the juvenile part of sugi thinnings were inferior to those from the mature part. With hinoki thinnings, no difference in properties was observed between LVL made of sapwood veneers and that of heartwood veneers.

2) Continuous press with radio-frequency heating.

A new type continuous press with electrodes for RF heating on the surfaces of top and bottom caterpillar platens was designed and manufactured for trial. The relation among the capacity of RF oscillator and the velocity of feed, the dimension of pressing part and the properties of materials pressed is discussed. The proposed formula was verified to be useful for practice.

**Producing particleboard by steam-injection pressing and gelation of adhesives in the process**, H. SASAKI, S. KAWAI, BAMBANG SUBIYANTO and T. HATA: Mokuzaï Kogyo Gijutsu Tanshin (Wood Processing Technical Digest), 6 (1), 1-14 (1988) (in Japanese)

Heat transfer in a particle mat during hot-pressing with steam-injection from the surface of hot-platen was exemplified, and high efficiency of this process of shortening pressing time was shown. In this process, adhesive is exposed to high pressure (temperature) condition. Simultaneous chemical reactions of condensation and decomposition of adhesive occurred in such condition was verified by a specially designed experiment. Optimum condition of adhesive gelation in hot-pressing particle mat with steam-injection was discussed.

**Tensile shear creep test of steel-balsa-steel sandwich panel as floor deck (I). Stress distribution and deformation of specimen**, M.T.R. REZENDE, H. SASAKI and P. YANG: Wood Research, No. 74, 12-22 (1987)

Stress analysis by finite element method of tensile shear test specimens of steel-balsa-steel sandwich panel for creep test was made statically. The stress distribution of five different shapes of sandwich panel specimens, two of them in accordance with ASTM-C-273, were analysed through the calculation of normal stress ( $\sigma_Y$ ), maximum principal stress ( $\sigma_1$ ), shear stress ( $\tau_{XY}$ ) and principal shear stress ( $\tau_{max}$ ). The presence of stress singularities at the reentrant corners made by specimen and loading plates suggests fracture occurrence in balsa core near the corner. Stress intensity factors ( $K_A$ ) in balsa core near the corner were calculated under assumption of similarity with that in homogeneous body. The results obtained were as follows:

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1)  $\sigma_Y$ ,  $\sigma_1$  and  $\tau_{\max}$  of balsa core concentrated near the reentrant corners, and  $\tau_{XY}$  distribution was uniform throughout the balsa core, 2) Comparing  $K_A$  of various specimens it was suggested that the estimated fracture load on specimens shaped within the range specified by ASTM standard (length  $l$ /thickness  $t \geq 12$ ) did not vary. Fracture load of specimens with  $l/t=8.2$ , 6.3 and 4.2 were lower than those of the standard specimens. Therefore, the standard shape will be utilized in the further investigation: tensile shear creep test of sandwich panel as floor deck (II).

**Tensile shear creep test of steel-balsa-steel sandwich panel as floor deck (II). Development of simple shear creep test machine**, M.T.R. REZENDE, H. SASAKI, Y. SHIRAKI and Y. TANAKA: Wood Research, No. 74, 23-32 (1987)

A simple shear creep test machine was proposed and creep test was made with ASTM standard shape specimens. Also comparative measuring method of shear deformation was discussed. The results obtained were as follows: 1) The test machine made as a prototype for tensile shear creep test was capable to transmit more than 1,300 kgf to the specimens so it would be suitable for test about 69% of shear strength ( $P_{\max}=1,896$  kgf), 2) The measuring method of shear deformation, which had the measurement points mounted on brass tips placed on loading plates edge, can be considered practical. Although the glue-line deformation between specimen and loading plates tested have been neglected. Prototype with accuracy and lower costs was achieved. Therefore, it is possible to extend the creep test period or to make simultaneous tests on many specimens when constructing several test machine.

**Manufacture of particleboards from man-made forest timbers, oriented particleboards from *Cryptomeria japonica***, T.Y. CHEN, H. SASAKI, S. KAWAI and Y. YOSHIDA: Wood Industry Series 8. Harvest, utilization and processing technology of plantation forest timbers (R.O.C), 110-128 (1988) (in Chinese with English summary)

Wood thinnings from *Cryptomeria japonica* tree plantations were used as raw materials in the manufacture of particleboards. Average dimensions of particles were 0.33 mm-0.50 mm thick, 12.2 mm long, and 1.23 mm wide. Two experiments were conducted using an isocyanate compound resin (20% acetone added) at 10% resin content level based on oven dry wood weight as adhesive. These were as follows:

1. Influence of electrostatic and mechanical orientation on the properties of particleboards — In the electrostatic method of particle orientation, electrostatic field intensity was varied at 4, 3, and 2 kV/cm while particle free fall distance was varied at 5, 10, and 15 mm in the mechanical orientation method. Board thickness was 12 mm and specific gravity (SG), 0.4 and 0.6, respectively. Pressing conditions were set at 160°C and 3.5 minutes at 10 kg/cm<sup>2</sup> initial pressure.

2. Influence of specific gravity of wood raw material on the properties of low density particleboards — In this investigation, comparisons were made on particleboards from *Cryptomeria japonica* (SG=0.346) with those from other raw materials, i. e. *Shorea* spp. (SG=0.321), *Dryobalanops* spp. (SG=0.675), and *Dillenia* spp. (SG=0.692). Twenty millimeter thick particleboards at 0.3–0.4 g/cm<sup>3</sup> density were manufactured by the same glue blending condition as in the first experiment. Pressing conditions were 160/C and 5 minutes at 10 kg/cm<sup>2</sup> initial pressure.

The experimental results are summarized as follows:

1. Oriented particleboards from *Cryptomeria japonica* showed effective improvement in moduli of rupture (MOR) and elasticity (MOE) in the direction parallel to target particle orientation. Orientation showed no significant effect on internal bond (IB).

2. Boards formed by the electrostatic orientation at 4 kV/cm electrostatic field intensity level and by mechanical orientation method with 5 mm particle free fall distance showed better properties.

3. Wood raw materials with lower densities such as *Cryptomeria japonica* and *Shorea* spp. are more suitable for the production of low density particleboards than those with higher densities such as *Dryobalanops* spp. and *Dillenia* spp.

**Flammability of wood structures**, S. ISHIHARA: Woody age, **35**, 1–5 (1987) (in Japanese).

**Flammability of wood structures and its control**, S. ISHIHARA: Gohan Report, **No. 6**, 1–9 (1987) (in Japanese).

**Flame retardancy of wood. Burning process of wood and its control by flame retardants**, S. ISHIHARA: Mokuzai Hozon (Wood Preservation), **13**, 139–150 (1987) (in Japanese).

**Durable fire retardant treatment for wood and wood-based materials. I. Reducing flammability of filter paper and sliced veneers treated with phosphoric acid-containing dicyandiamide-formaldehyde condensation products**, S. ISHIHARA: Mokuzai Hozon (Wood Preservation), **13**, 151–166 (1987) (in Japanese with English summary)

Durable fire retardants based on phosphoric acid-containing dicyandiamide-formaldehyde condensation products (H<sub>3</sub>PO<sub>4</sub>•DFAC) were applied to filter paper and sliced veneers. The fire retardants give clear, acidic aqueous solutions. Upon aging, these aqueous solutions transform first to hydrophilic colloid, then to water dispersible gel and finally upon drying to a water-insoluble resin.

## ABSTRACTS

Fire retardant treatment is done by soaking samples in an aqueous solution of  $\text{H}_3\text{PO}_4 \cdot \text{DFC}$ , drying at  $105^\circ\text{C}$  for 24 hours, and curing at  $160^\circ\text{C}$  for 30 minutes.

In filter paper and sliced veneer test specimens treated with a solution of higher phosphoric acid molar ratio, fire retardance is attained at lower resin add-on level than with a mixture of phosphoric acid and dicyandiamide. Satisfactory fireproofing properties can be obtained in filter paper and sliced veneers at resin add-on levels as low as 5~10%, with a few exceptions.

**Durable fire retardant treatment of wood and wood-based materials.**  
**II. Fire retardant treatment of plywood, doubling as preservative treatment,** K. HAGIO, K. TSUNODA and S. ISHIHARA: Mokuzaï Hozon (Wood Preservation) **14**, 8-17 (1988) (in Japanese with English summary).

Fire retardancy and durability of chemically treated plywoods was investigated in the laboratory.

Plywood samples (<5 mm in thickness) were treated with fire retardant chemicals by soak-vacuum or surface-coating technique. Fire retardant chemicals used were phosphoric acid dicyanodiamide formaldehyde condensates, and boric acid or hydrobromic acid was additionally mixed with the formulation to reinforce preservative properties. The treated samples were then tested for their fire retardancy and resistance against fungal and termite attacks.

Fire retardancy of plywoods was determined on the basis of after flame, after glow, and char length according to JIS Standard A 1322 (1966). Test results indicated that all treated specimens did not show any after flame and after glow and that those were more effective in minimizing char length than untreated plywoods. Coating treatment was superior in fire retardancy to soak-vacuum treatment because of chemicals' intumescence. Addition of boric acid or hydrobromic acid had no beneficial influence on fire retardancy.

Decay test of the treated plywoods conducted according to JWPA Standard (3).

Decay resistance was apparently increased by the fire retardant treatments, although weight loss of untreated controls caused by *Coriolus versicolor* did not exceed 20% if they were not weathered. Addition of boric acid or hydrobromic acid seemed to increase decay resistance. Comparison of decay resistance against *Tyromyces palustris* could not be made as the fungus failed in attacking even untreated plywoods.

Similarity was perceived for termite resistance of the treated plywoods.

The result suggests that the present chemical formulation could bestow satisfactory fire retardancy upon the treated thin-assembly plywoods. Addition of preservatives such as boric acid and hydrobromic acid definitely is worthy to be considered for improving the resistance of the treated plywoods against biodegradation.

**Fire resistive low-density particleboard**, S. ISHIHARA: Proceedings of International Conference on Wood Burning, p128-135, May 11-13, Tatry, Czechoslovakia.

Fire resistive low-density particleboards bonded with polymeric isocyanate adhesive containing triethyl phosphite (TEP) were manufactured. The fire retardant polymeric isocyanate-TEP adhesive was formulated for low-density particleboards. The fire resistive low-density particleboards were tested in a laboratory scale vertical exposure furnace in accordance with the Japanese Industrial Standard (JIS) Fire Test of Building Constructions and Materials (A-1304). Fire resistive efficiency of the board was evaluated based on the times for the temperature at the unexposed surface of the board to reach a maximum value of 260°C. The fire resistive low-density particleboards showed 5 to 45 minutes improvement over control boards, i. e., boards bonded with isocyanate adhesive alone. Harmful effects of TEP addition to the adhesive on mechanical and physical properties of the low-density particleboards were not observed except for boards glued with adhesive containing high weight ratio of TEP.

**Fire endurance of carbon material overlaid particleboards**, S. ISHIHARA, S. KAWAI, Y. YOSHIDA and A. TAKAMATSU: Proceedings of s5.03-04 Sessions, IUFRO All Division 5 Conference, p1-9, May 18, 1988, Sao Paulo, Brazil.

Various types of overlays were used in the manufacture of fire resistive particleboards. Fire endurance of overlaid boards were tested by different methods and compared with those of boards without overlay and non-combustible commercial boards. Carbon material overlays such as graphite and charcoal from softwood sawdust and bark were found to be effective in increasing fire resistance of boards. Fire endurance of overlaid boards were improved by the time delay in temperature rise in carbon material overlaid boards due to low combustibility of carbon. Carbon material overlaid boards also performed well in other fire endurance test criteria such as absence of ignition and crack, short after flame time span, and strength retention.

**Amino-phosphonate wood fire retardant. II. Fire endurance of particleboard and plywood**, S. ISHIHARA and N. KOBAYASHI: Proceedings of s5.03-04 Sessions, IUFRO All Division 5 Conference, p21-30 May 18, 1988, Sao Paulo, Brazil.

A 60% aqueous formulation comprizing one part by weight of 3-(dimethylphosphono) propionamide (abbreviated as DMPPA), and two parts by weight of methylated hexamethylol melamine (abbreviated as MHMM) has been found suitable as a room-temperature curing, transparent fire-retardant for such wood-based materials as particleboard and plywood. The present paper describes the fire-re-

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sistance of various kinds of particleboard and plywood, coated either with the aforementioned formulation or with a commercially available fire-retardant chemical. It was found that the intumescent layer formed by the latter became damaged and peeled off under the very severe stream of heat in the JIS A-1304 test—this test being very similar to both the ASTM E-119 and DIN-4102. By contrast, the intumescent layer formed by present formulation, when tested in the same manner showed much greater resistance to damage. The commercially available product, with the greater coverage rate of 400 g/m<sup>2</sup>, endured for a fire exposure time of just under 30 minutes in the case of a 20 mm thick particleboard; the present formulation, with the lower coverage rate of 300 g/m<sup>2</sup>, survived over 40 minutes in the same test. Thus the essential difference between the performance of two retardants seems to lie in the physical strength of the intumescent layer, rather than in the amount of retardant applied to the wood surface.

**Halogen and their compounds as fire retardants for wood**, S. ISHIHARA: Mokuzaï Hozon (Wood Preservation) **14**, 49–54 (1988) (in Japanese)

**Fire retardant**, S. ISHIHARA: Mokuzaï Kogyo (Wood Industry), **43**, 140–141 (1988) (in Japanese)

**Wood-based composition board and their laminated composites**, S. KAWAI: “New High Performance Wood Composites”, Text of a lecture sponsored by the Society of Materials Science, Osaka, November, 1987, p1–41 (in Japanese)

New wood-based composition boards developed recently such as oriented strand board (OSB), waferboard, low-density particleboard, were evaluated and summarized in the global trend of research and development in this field.

Acetylated veneer-overlaid particleboard with high performances of mechanical strength, dimensional stability, and anti-fungus and termite attack were presented, and then carbon-material overlaid particleboard as an excellent fire resistive material was introduced.

**Production technology for low-density particleboard V. Influence of size and shape of chips fed into a knife ring flaker**, S. KAWAI, M. NAKAJI and H. SASAKI: Mokuzaï Gakkaishi, **33**, 702–707 (1987) (in Japanese with English summary)

Flakes of seraya (*Shorea* spp., density: 0.51 g/cm<sup>3</sup>) were prepared from raw chips with strictly controlled dimensions, using a knife-ring flaker (Pallmann PZ-8). Boards with a density range of 0.3–0.5 g/cm<sup>3</sup> were manufactured using an isocyanate compound resin adhesive, and the board properties were examined in relation to the raw chips and to the particle configurations. Results obtained were as follows:

1) The average length of flakes prepared was proportional to that of raw chips; flake lengths were 60–75 percent of chip lengths except for those from relatively large chips ( $70 \times 23 \times 10$  mm) compared with the effective knife length of the flaker. On the other hand, the average width of flakes was independent of chip size, which was in the range of 1.5–2.0 mm. The deviations of flake length and width increased with an increase of chip size.

2) Scanning electron-microscopy observation showed that the ring-flakes of this experiment were damaged more than disc- and drum-flakes, and that the damage seemed to increase with increasing chip size.

3) The bending properties, modulus of rupture (*MOR*) and modulus of elasticity (*MOE*), were not affected by raw-chip size when the boards were not compressed enough (compaction ratios 0.6 and 0.8). On the other hand, the *MOR* and the *MOE* increased gradually with increases of chip length from 20–50 mm when the compaction ratio was 1.0. The effect of chip length on the bending properties seemed to be offset partly by the damage to the particles occurring when they were prepared.

4) The internal bond strength increased with decreases in chip length and with increases in the compaction ratio. The dimensional stability in the thickness direction improved with decreasing chip length, and it was not affected by the compaction ratio in this experiment, perhaps because of the low compaction of particles and a short-term (24 hrs) water immersion.

**Aligning torque generated on wood particles in an electrostatic field I., Effects of various factors on the aligning torque, S. KAWAI, H. SASAKI and M. NORIMOTO: Mokuzaï Gakkaishi, 33, 872–878 (1987) (in Japanese with English summary)**

Aligning torque generated on wood particles in an electrostatic field was measured, and the effects of various factors on the aligning torque are discussed. The factors used were electric field intensity, shape, size, and moisture content of particles, relative humidity of atmosphere, and so forth. Furthermore, the aligning torque on alcohol-benzene extracted particles and on acetylated particles also was measured to clarify the generating mechanism of the aligning torque on wood particles. The results are summarized as follows:

1) The aligning torque is proportional to the sine of twice the initial angle  $\theta$  between particle length and electric field lines' directions, and to approximately 1.9th power of the field intensity. 2) In a range of aspect ratio,  $l/w > 2$  ( $l$  and  $w$ : length and width of particles, respectively), the aligning torque is approximately proportional to  $l^{2.6}$ , and is proportional to 0.35th power of the cross-sectional area of the particles,  $w \times d$  ( $d$ : thickness of particles). The moment inertia of particles

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changes especially with proportion to  $l^3$  and to  $w \times d$ . Therefore, better alignment can be obtained with smaller particles than with larger ones. 3) The aligning torque increases linearly with increases of moisture content below 20%, which is in the range of absorbed water. The torque seems to be saturated at about 20% m.c. and to keep a constant value or undergo a slight reduction at a moisture content above 20%. 4) The aligning torque on wood particles is supposed to be generated mainly by the electric dipoles in wood.

**Steam injection pressing**, S. KAWAI and T. HATA: Mokuzaï Kogyo (Wood Industry), **42**, 562–565 (1987) (in Japanese)

The outline of steam injection pressing, a newly developed hot-press technique for board production, is described. This pressing method enables to shorten the press time greatly, because saturated steam injected from hot-plates diffuses instantly through a particle mat bringing the thermal energy.

The distinctive features on production technology of steam injection pressing such as temperature changes of the core particle mat at steam injection, possibility of shortening the press time, etc., and on properties of boards produced with this pressing were summarized. A numerical analysis predicted that a board of 100 mm thick could be pressed within 2 minutes.

**A viewpoint for developing composite wood**, S. KAWAI: New Lumberman, Vol. 17, No. 65, 13–24 (1987) (in Japanese)

A viewpoint based on total system from production to waste disposal has become very important for future research and development of new materials. For developing composite wood materials, global changes of forest resources were described and then the trend of the recent development of composite wood is discussed. Finally, present state of wood waste disposal was considered, and the importance of establishing recycle system for utilizing used structural timber as a raw material for wood-based composition boards was emphasized.

**Studies on curing condition of particleboard adhesive I., Effect of environmental temperature and adhesive temperature on gelation time**, B. SUBIYANTO, S. KAWAI, H. SASAKI, N. KAHAR and S. ISHIHARA: Mokuzaï Gakkaishi, **34**, 333–336 (1988)

The influence of environmental (oil-bath) temperature and adhesive temperature of gelation time of several types of adhesives in test tubes dipped in an oil-bath is discussed. Adhesives used were urea formaldehyde (UF), urea melamine formaldehyde (UMF), phenol formaldehyde (PF), phenol melamine formaldehyde (PMF), and isocyanate (IC) resins. Target environmental temperatures varied from 80°C

to 200°C. Resin amount for all types of adhesives were based on the solid weight of resin, i. e., 2.35 gram solid. Adhesive temperature and environmental temperature were recorded, and the gelation of adhesives was detected through a viscotester connected to a stirrer.

The results obtained were as follows; The temperature of adhesive did not exceed 100°C mainly due to the evaporation of water contained within adhesive. UF and IC resins cured before adhesive temperature reached 100°C. The relationship between gelation rate of adhesive and environmental temperature for all the resins were found to obey Arrhenius equation at a rough estimate, while the gelation rate and average temperature of adhesive do not seem to show significant relationship. The gelation time ratio of IC: UF: UMF: PMF: PF above 140°C were estimated as 1:1.2:1.6:2.4:7.0.

**Aligning torque generated in wood particles by an electrostatic field**  
**II. Distribution and intensification method of aligning torque in the space surrounding electrodes,** Y. Yoshida, O.R. PULIDO, S. KAWAI and H. SASAKI: *Mokuzai Gakkaishi*, **34**, 401-407 (1988) (in Japanese with English summary)

An improved forming system for manufacturing oriented particleboards is presented. This system, based on the principle that aligning torque is generated in wood particle by an electrostatic field, is characterized by the setting of electrodes below the reverse side of the forming conveyor. This report describes fundamental concerning this improved system. When wood particles are exposed to the curved lines of an electrostatic-force field charged in the space surrounding the electrodes, they are activated and tend to align themselves parallel to this field. The aligning torque generated is divided into its horizontal and vertical components and is evaluated. The results are summarized as follows:

(1) The horizontal component of the aligning torque tended to decrease hyperbolically with increase  $h$ , where  $h$  is the height of the activated particles from the upper-edge level of the electrodes.

(2) The vertical component of the aligning torque had a greater value at a measurement point located near a positive electrode than at one near a negative electrode. It may be said that the activated particles were attracted strongly toward the positive electrode.

(3) When a plate interface, supported by the upper edges of both electrodes, was placed, an electrostatic field was generated through it. Therefore, the horizontal component of aligning torque was affected by the material of the interface plate. For example, the aligning torque was intensified 2.5 times by using a bakelite plate interface as compared to the maximum value without an interface.

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(4) The effect of a plate interface was verified with oriented mats formed by a pilot-sized test plant. Within the limits of this experiment, the orientation of particles was improved with the bakelite plate interface with an average alignment angle of 23.3 degrees.

**Present status of forest product industry and wood preservation in Korea**, M. TAKAHASHI: Mokuzai Hozon (Wood Preservation), **13**, 21 (1987) (in Japanese)

Current status of Korean forest product industry and wood preservation industry are described. Production and export of wooden furniture and musical instrument are increasing very rapidly, instead of the decline of plywood industry. Research activities, Forest Museum and Arboretum in Korean Forestry Research Institute are introduced briefly.

**Japanese standardized method for testing effectiveness of soil termiticides**, Shiroari M. TAKAHASHI: (Termite) No. **71**, 2 (1988) (in Japanese)

Japanese standardized method for testing effectiveness of soil termiticides are reviewed. The method was standardized by Japanese Examining Board of Wood Preservatives in 1987. The author is a member of Technical Committee under the board, and was in charge of the preparation of this method. This standard describes laboratory test, field test and qualitative standard for effectiveness of soil termiticides.

**Effectiveness of trihaloallyl based chemicals against wood-decaying fungi and termites**, D-h. LEE, M. TAKAHASHI and K. NISHIMOTO: Bokin Bobai Gakkaishi (J. Antibact. Antifung. Agents), **16**, 163 (1988) (in Japanese with English summary, tables and figures)

Preservative effectiveness of trihaloallyl-based chemicals for surface treatment was investigated by using the method prescribed by Japan Wood Preserving Association Standards No. 1 and No. 11. Thirty formulations containing two, three or four of the following compounds were prepared; EBIP 3-bromo-2, 3-diiodo-2propenyl ethyl carbonate (trihaloallyl compound), Phoxim {*O*, *O*-diethyl-*O* ( $\alpha$ -cyanobenzylideneamino) phosphorothioate, currently-prevailing termiticide}; Chlorpyrifos (*O*, *O*-diethyl-*O*-3, 5, 6-trichloro-2-pyridylphosphorothioate, currently-prevailing termiticide), S-421 (1, 1, 1, 2, 6, 7, 7, 7-octachloro-4-oxaheptane, synergic agent for Phoxim) and N-290•k (di-2-ethylhexyl sodium sulfosuccinate, stabilizer for chlorpyrifos). EBIP and its mixtures with S-421 and/or N-290•k were not effective to inhibit the decay by *Serpula lacrymans*, an important house-attacking fungus in Japan, even at 1.0% (w/v) of EBIP which was the highest concentration used in this ex-

periment. Effectiveness of EBIP against *S. lacrymans* was greatly enhanced by addition of a termiticide Chlorpyrifos, the concentration in the solution being 1.0% each. Amendment to 0.5% EBIP solution by addition of 1.0% Phoxim and 1.5% N-290•k was equally effective. Addition of more amount of N-290•k (2.0%) was necessary to reduce the concentrations of EBIP, Phoxim and Chlorpyrifos to 0.5–0.6%.

These formulations are considered to be the most promising preservatives for use in the high-hazard condition of biodeterioration, because of their higher anti-termitic performance.

**Evaluation of strength properties of composite-wood treated by incorporation of fungicides in the glue**, Y. IMAMURA and Y. NAKAMURA: *Mokuzai Hozon* (Wood Preservation), **14**, 178 (1988) (in Japanese)

Glue additive treatment is practically applied for plywoods and particleboards to impart decay and/or termite resistance. When compared regression curves between weight loss and bending strength in untreated and treated plywoods after exposure to fungi, it was shown that glue additive treatment permitted insignificant reduction in strength properties. When subjected to a bending-creep test under progressive fungal attack, treated particleboards showed a little deflection after a long period, while untreated particleboards failed within a short days. It was concluded that incorporation of fungicides in the glue was evidently more effective against fungal attack possibly because of better even distribution of toxicant forms on the particles' surfaces.

**Properties of wood-based board-materials (2) Decay and termite resistance of particleboard**, Y. IMAMURA: *Mokuzai Kogyo* (Wood Industry), **42**, 585 (1987) (in Japanese)

Biodeterioration of particleboards was reviewed. The amount of deterioration was affected by the species of wood used in the boards, the size and shape of the particles, the type of adhesive used as a binder, and the physical properties of the board such as density or composition. Among those factors, the type of adhesive and its content were shown to have large effects on resistance.

Possibilities and present knowledge of preservation against decay and termite attacks were briefly described.

**Characterization of incipient decay in wood and methods for its detection**, Y. IMAMURA: *Mokuzai Hozon* (Wood Preservation), **13**, 167 (1987) (in Japanese)

Wood decay as early as 5 percent weight loss or less cannot be reliably diagnosed on the basis of appearance alone. The strength properties, however, are most severely and rapidly diminished by the onset of decay.

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This article reviews the mechanical properties and the morphological characters of wood in the early stage of decay and summarized the method for detecting incipient rot. Of the methods, monitoring the acoustic emissions (AEs) is shown to be a sensitive indicator of early decay in specimens stressed in bending or compression.

**Internal bond strength of acetylated flakeboard exposed to decay hazards**, Y. IMAMURA, K. NISHIMOTO and R.M. ROWELL: *Mokuzai Gakkaishi*, **33**, 986 (1987)

Aspen flakeboards were made from untreated and acetylated flakes using phenol-formaldehyde or isocyanate adhesives. These boards were subjected to fungus cultures of *Tyromyces palustris* and to burial in moist unsterile soil. Strength losses, as measured by internal bond (IB), were determined after biological exposure to assess the potential performance in severe hazard usage. Acetylated flakeboards had a relatively great retention of **IB** strength after decay attacks, insuring continued strength in service.

**Strength tests on acetylated aspen flakeboards exposed to a brown-rot fungus**, R.M. ROWELL, J.A. YOUNGQUIST and Y. IMAMURA: *Wood and Fiber Science*, **20**, 266 (1988)

Aspen flakeboards made from control flakes and acetylated flakes at 18% acetyl weight gain using phenol-formaldehyde or isocyanate adhesives were subjected to bending creep test under progressive brown-rot fungal attack with *Tyromyces palustris*. Deflection of the boards was measured as a function of time until failure. Isocyanate-bonded control flakeboards failed in an average of 26 days, while isocyanate-bonded acetylated boards showed little deflection after 100 days in test. Average weight loss of isocyanate-bonded control boards at failure averaged 6.2%, while the acetylated boards showed about 1.0% weight loss at the end of 100 days. Phenol-formaldehyde-bonded control flakeboards failed in an average of 76 days, while acetylated boards showed little deflection after 100 days in test. Average weight loss of phenol-formaldehyde-bonded control boards at failure averaged 8.6%, while the acetylated boards showed no weight loss after 100 days.

**Review of wood preservative research in Asia**, \*K. TSUNODA: *Proc. A. W.P.A.*, **83**, 145-161 (1987)

Research trends and activities on wood preservation in Asian countries were outlined and highlighted along with the following subjects: biological problems, fundamentals of testing, preservatives and methods of treatment, and marine wood preservation, covering over 130 papers published in the recent years.

**Potential wood preservatives for glue-line treatment of plywood, \*K. TSUNODA, M. TAKAHASHI, Y. IMAMURA and K. NISHIMOTO:** Proc. IUFRO Wood Protection Subject Group, Canada, 219-237 (1987)

Three organic compounds which showed promising fungicidal performance in the laboratory decay tests were tested for their effectiveness in glue-line treatment of plywoods against decay fungi in relation to weathering severity.

Unweathered plywood specimens were successfully protected from a brown-rot fungus, *Tyromyces palustris* (Berk. et Curt.) Murr. by the following two chemicals: 4-chlorophenyl-3-iodopropargyl formal (IF-1000) and 3-ethoxycarbonyloxy-1-bromo-1, 2-diiidopropene (EBIP) at 0.6 kg/m<sup>3</sup> and 1.0 kg/m<sup>3</sup>, respectively. Higher retentions were required to control a white-rot fungus, *Coriolus versicolor* (Linn. ex Fries) Quéf. Unexpectedly, 2-(4-thiocyanomethylthio) benzothiazole (TCMTB) failed in protecting plywoods from decay fungi even at the highest retention of 2.4 kg/m<sup>3</sup>.

Specimens weathered at 60°C for 90 days often increased their decay resistance, while the longer weathering period adversely resulted in the lower preservative efficacy. When exposed to wet-dry cycles 90 times (specimens immersed in non-running water for 6 hours, dried at 60°C for 18 hours and the cycle repeated), the similar enhancement in effectiveness was noticed. The results indicated that weathering of specimens did not always lead to the decreased decay resistance of the treated plywoods, and suggested that movement of active ingredient(s) from the glue to adjacent veneers played an important role in efficient protection.

The two new chemicals are considered potential as glue-line additives for plywood based on the present results, although some further investigations are needed to ascertain the effectiveness against the white-rot fungus.

**Prevention of stain and mould on sawn softwoods-The Situation in Japan, \*K. TSUNODA:** Proc. IUFRO Wood Protection Subject Group, Canada, 340-344 (1987)

Approximately 7,000,000 m<sup>3</sup>/year of sawn timber is subjected to anti-sapstain treatment with chemicals at the sawmills in Japan today.

Chemicals which are widely used for the treatment are 2, 4, 6-trichlorophenol and its sodium salt, and organotin compounds. It is estimated that some 1,000 tons of chemicals is annually consumed for the prevention of mould and stain on sawn timber, although no statistical data are available on how much chemicals is used.

The search for alternatives to the chlorinated phenols is an important research target because toxicologically safer chemicals are required in the future treatment for diminishing a potential threat to human health and the environment.

**Recent termite research, K. TSUNODA:** Shiroari (Termite), 70, 3-12 (1987)

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(in Japanese)

Recent research activities on termites in Australia and USA are briefly introduced and documented with emphasis on termite control aspects-evaluation of termiticides for soil treatment, field survey of termite invasion in the urban area in Florida, etc.

**Japanese standardized method for evaluating effectiveness of anti-sapstain and anti-mold chemicals**, \*K. TSUNODA and K. NISHIMOTO: The Int. Res. Group on Wood Preserv. Document No.: IRG/WP/2299 (1988)

Japan Wood Preserving Association established a method for testing effectiveness of chemicals against sapstain and mold fungi on wood in 1979. The method is concerned with a laboratory technique using small timber specimens ( $2^{\circ} \times 50 \times 3$  mm), petri dish and 5 test fungi.

Effectiveness of each candidate chemical is evaluated on the basis of the relative resistance to sapstain and mold fungi which derives from visual rating of the fungal growth on the treated and untreated wood after 4-week incubation at  $26 \pm 2^{\circ}\text{C}$  and 70–80% R. H. Results of commercial trichlorophenol-base product indicated that relatively higher concentrations were required to protect timber satisfactorily from fungal attack in the test, as compared with practical treating concentrations at the sawmills.

**Evaluation and approval of wood preservatives in Japan**, \*K. TSUNODA: The Int. Res. Group on Wood Preserv. Document No. : IRG/WP/2303 (1988)

Japanese standardized decay test methods, performance requirements and approving system are briefly described. JIS (Japanese Industrial Standard) A 9302, which is related to a testing method for evaluating effectiveness of wood preservatives when applied to pressure treatment, is fundamentally a sand-block laboratory test method. According to performance requirements in JIS A 9201, mean percentage weight of treated wood specimens should be less than 10% and 20% of that of untreated specimens against *Tyromyces palustris* and *Coriolus versicolor*, respectively.

JWPA (Japan Wood Preserving Association) Standard 1 covers a testing method for assessing efficacy of wood preservatives for superficial treatment. Test procedure is basically the same as JIS A 9302, although some major modifications are adopted with regard to shape and size of wood specimens, weathering cycles and the length of forced decay. Qualitative standards require that a candidate chemical should inhibit decay keeping mean percentage weight loss of treated wood specimens less than 20% of that of untreated ones in any case as prescribed in JWPA Standard 7.

Results obtained by the above methods are well discussed together with other

information by Japanese Examining Board of Wood Preservatives to approve a candidate chemical as a wood preservative when an application form is submitted to the board. And then the final decision will be made by JWPA [or JTCA (Japan Termite Control Association)] if the applied chemical is acceptable for approval or not.

**New complex material, wood ceramics-their properties**, \*K. NISHIMOTO, K. TSUNODA and Y. IMAMURA: Proc. IUFRO Div. 5 Conference (S5.03-04), Brazil, 55-63 (1988)

New principle of double diffusion treatment system was developed to produce novel complex materials, wood ceramics, forming water-insoluble deposits within timber which are expected to improve performance of the treated timber.

Improvement of fire resistance has been the main research target through the double diffusion treatment with aqueous solutions of inorganic compounds such as barium chloride and ammonium phosphate.

Veneers (<5 mm in thickness) were treated, glued together and made into a plywood or a laminated veneer lumber (=new complex wood) for the later performance tests. New complex materials were tested for their incombustibility according to Japanese standardized testing methods as prescribed in JIS A 1321, and the results indicated that the complex materials met performance requirements for "very slow burning material" designated in Notification No. 1231 of the Ministry of Construction of Japan. In addition, the resistance against fungal and termite attacks also increased, as compared with untreated controls when tested in the laboratory.

As the double diffusion process was proved to work well with veneers, it seems worthy of considering applicability of the new treating system to solid timber (>5 mm in thickness).