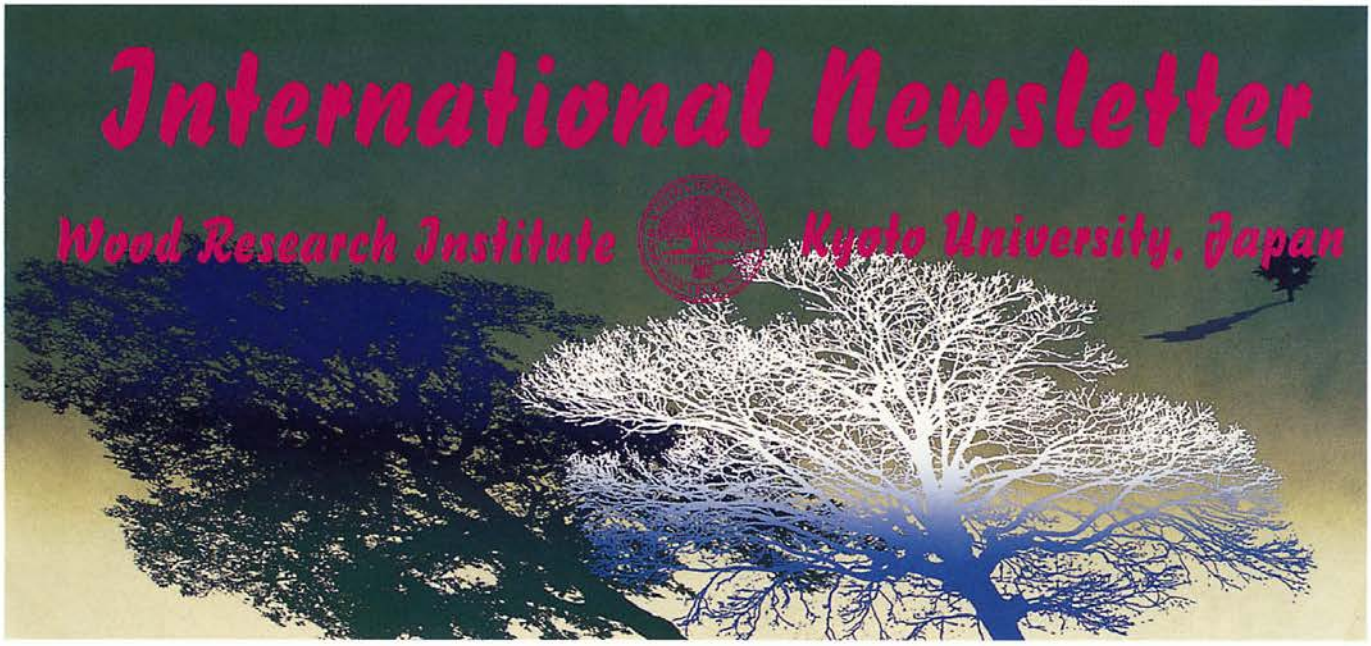
No. 12 March 2003

JSPS Core University Program in the Field of Wood Science



= Research Report =

Processing and Drying Properties of Timber Cut from Leaning Stem of Grown *Acacia mangium* and *Acacia auriculiformis*

Dr. Zaidon Ashaari and Prof. Mohd. Hamami Sahri

Faculty of Forestry, Universiti Putra Malaysia

We conducted a series of studies at Universiti Putra Malaysia (UPM) on the properties and utilization of timber cut from the leaning stem of grown *Acacia* species. The research work was divided into several major parts related to the evaluation of processing and drying properties, as well as utilization of these timbers for particleboard. However, only the processing and drying properties of the timber are reported in this newsletter.

Acacia mangium and *Acacia auriculiformis* are among the multi-purpose fast growing timber species introduced in Malaysia to augment the diminishing supply of timber from the natural forest. *Acacia* wood is suitable for making furniture, light structural timber, cabinet works, wood composites and pulp and paper. However, with the application of various sivilculture treatments to achieve optimum site productivity, fast grown *Acacia* trees may contain growth stresses, especially in leaning stems on flat terrain, or upright boles on hill slope. Stressed wood, which is also known as reaction wood, refers to the tissue of a living tree that is exposed to stresses during the maturation period. In hardwood, the reaction wood formed on the upper side of a leaning stem is known as tension wood. The presence of tension wood will reduce the quality of the timber during processing, thus limiting the end uses. The extent of defects in tension wood can be minimized if proper measures are taken during the processing and drying of the lumber.

Felled Acacia mangium at UPM's plantation

Acacia mangium and *Acacia auriculiformis* trees (17 and 15 yrs-old, respectively) with leaning stems were felled from a plantation field at UPM. For comparison purposes, trees with straight stems were also felled. Property evaluation was conducted on 40mm thick lumber. Defects of the boards were evaluated after drying using a low temperature dehumidifier kiln. The Quick Drying Test (QDT) was employed to determine the appropriate drying schedule for the boards.

On the machining properties, the boards that contained tension wood incurred burning marks, torn grain and fuzzy grain on the surface after sawing, planing, boring and sanding. Regarding mechanical properties, the tension wood was stronger and stiffer than normal wood. However, the tension wood was hard to coat and laminate. Regardless of species or type of wood, the time taken to dry the boards to about 11-18% MC using the low temperature dehumidifier kiln was 21 days. Casehardening was found on the boards containing tension wood. Boards with tension and normal wood of *A. mangium* were found to have similar cupping, bowing and slight to moderate end-checks and honeycombing, but the tension wood had a relatively higher degree of the defects. Tension wood of *A. auriculiformis* had more severe defects than normal wood. The two species had more or less the same defects except that the normal wood of *A. auriculiformis* was free from twisting. End-checks and honeycombing were found to be more severe

in *A. auriculiformis* boards than in *A. mangium* boards.

The drying schedules determined from QDT for 40 mm thick *A. mangium* was D34/W44 for normal wood and D33/W34 for boards consisting of tension wood. These schedules were similar to those of Schedule G recommended by the British Forest Product Research Laboratory (BFPRL), nonetheless the proposed schedules call for relatively harsher conditions (lower RHs). The schedules proposed for *A. auriculiformis* (D23/W24 for boards with normal wood and D23/W44 for boards with tension wood) were comparable to those of Schedule F of BFPRL. Compare to normal wood, tension wood of both species required milder conditions for kiln drying.

These finding may help in promoting the use of such material in sawmill processing plants, and increase the use of plantation timber. It is widely considered among Malaysian sawmillers that drying of *Acacia* timbers is one of its greatest limitations (due the presence of tension wood), since it dictates the overall yield in lumber production. A typical *Acacia* sawmill has a relatively low recovery rate of 25-40% due to heartrot. With the addition of potential drying defects, this number can be even smaller. It is thus undoubtedly important to further study the processing and drying techniques of these timbers, which will not only benefit Malaysia, but also the Indonesia, Thailand and other producing countries. In addition, it is crucial to carry out fundamental studies of the analysis and quantification of the morphological properties of tension wood and how they influence the processing and drying properties of the lumbers. An international collaborative research work on these studies will be proposed to the JSPS Core University Program in the next fiscal year.

Lumber cut from leaning stem of *Acaia mangium*

= Research Report =

Recent Research Topics in Wood Preservation

Mr. Yoshiyuki Yanase

Div. of Forest and Biomaterials Science, Kyoto Univ.

Recently, there have been many studies on preservation of wood against termite and fungal attack and weathering, with increasing needs for wooden structures and products. For optimum control of termites, it is important to approach the problem from several research fields, including the chemical control of termites, the evaluation of several wood species or treated wood against termite attack, taxonomy of the genus and ecological control, development of technology for detection of termite attack. I will introduce several topics of recent studies I reviewed while visiting Indonesia on 1-10 September, 2002, to participate in The Fourth International Wood Science Symposium held at Puspiptek Campus, Serpong, Indonesia, on 2-5 September, and to accompany the research on termite species and the damage to houses in Pontianak, Kalimantan Island, on 6-9 September.

Firstly, it is very important to comprehend the distribution of termite species in each area, because termite activity and ecology is different for each species and the most effective method to control termite should be selected. *Coptotermes* spp. is perhaps the most economically important termite species, distributed on the islands in Indonesia, and also in Japan. For the control of this species, not only the conventional chemical treatments but also less-chemical treatments and chemical-free treatments were researched, and we will be able to use them for the several situations in the future. There are many kinds of tropical wood species in Indonesia and their resistance to Indonesian termites was evaluated, as many Japanese and imported woods were examined for Japanese termites in Japan, showing the importance of using appropriate wood species for wood products to prevent termite attack. Furthermore, damage by dry-wood termites has been extending in Japan, and it is also a serious problem in Indonesia, because it is difficult to detect dry-wood termites and

Termite mount net of M. gilvus

to control them, and dry-wood termites attack not only wooden constructions but also wall materials and furniture inside buildings and bamboo. The "Acoustic Emission (AE)" method is one of the non-destructive methods applied to detection of dry-wood termites. In Japan, the application of AE monitoring for dry-wood termites in wooden houses was useful, and it may be possible to detect Indonesian dry-wood termites, similarly.

After the symposium, I visited Pontianak, Kalimantan Island on 6-9 September to accompany 4 Japanese and 2 Indonesian members in research on the termite species and the damage to houses. The distribution and identification of Indonesian termite species have been examined through field investigations in tropical forests. For research of taxonomy of *Coptotermes* spp. in urban areas and in tropical rain forests, using cuticular hydrocarbon analysis and DNA analysis as well as the morphology of termite body, we visited the campus of Fakultas Kehutanan, Universitas Tanjungpura (Faculty of Forestry, University of Tanjungpura), houses in urban areas, and a tropical rain forest. We have observed the damage by termites in houses, and collected *Coptotermes* spp. of urban areas. In Indonesia, the damage by termites was concentrated in wooden walls and furniture in houses because the construction framework houses were not made of wood, unlike houses in Japan.

As a side topic, there were many termites on a living tree near the Guest House, and I observed them with interest. After the symposium, Dr. Yoshihisa Fujii, Dr. Yoko Takematsu, Mr. Kohei Kanbara and I have found a mound nest of *Macrotermes gilvus* near the path from the Guest House to the symposium site, broke in half the mound nest well, and observed the structure of the mound nest keenly. I observed the structure of a nest and a living queen termite of *M. gilvus* for the first time, and I was very surprised that *M. gilvus* made the functional mound nest using soil and excrement, and many worker termites carried the queen termite rapidly away.

= New Project =

Tissue Culture and Molecular Breeding of Tropical Trees

Dr. Takahisa Hayashi

WRI, Kyoto Univ.

An ongoing goal in the field of forest-tree biotechnology is to induce woody plants to grow faster and to increase cellulose deposition. Since woody plants have a long generation time, it is difficult to apply traditional breeding methods for their improvement. The improvements mentioned above are required not only to increase the production of timber, paper materials and energy but also to ameliorate problems from rising atmospheric carbon dioxide levels by virtue of the large carbon sink offered by trees.

N. Sumiasri and D. Priadi (LIPI) are going to focus on developing propagation and E. Sudarmonowati and N. Sri (LIPI) plan to work on genetic engineering on tropical trees, *Acacia mangium*, *Paraserian falcataria* and *Palaquium hexandrum*. N. Yoshizawa and S. Yokota (Utsunomiya Univ.) expect to work for tissue culturing of tropical trees, T. Hayashi (Kyoto Univ.) for their genetic engineering, K. Baba (Kyoto Univ.) for tension wood formation on transgenic tropical trees, and T. Okuyama and H. Yamamoto (Nagoya Univ.) for the characterization of growth between the wild-type and transgenic tropical plants. T. Furuno and S. Katoh (Shimane Univ.) expect to analyze the genes involved in the formation of monoterpenes and T. Umezawa (Kyoto Univ.) will study the formation of wood on tropical trees. We hope future forestry efforts are greatly improved by such trees, beginning a new era of wood production and quality.

Production forest in Indonesia

Transportation of the seedlings by truck to the field for planting

= New Project =

Production of Cellulosic Materials and Biomass Chemicals from Unutilized Plant Resources

Prof. Takashi Watanabe

WRI, Kyoto Univ.

Production of baggasse from sugarcane industry

Continued use of fossil fuels has caused serious environmental problems such as production of undegradable toxic compounds and emission of carbon dioxide. Therefore, it is necessary to emphasize that utilization of biomass as chemical and energy resources in harmony with environmental safeguards is urgently needed for ensuring human activities for the next generation. The JSPS project, "Production of cellulosic materials and biomass chemicals from unutilized plant resources", will start from FY2003 to produce chemicals, cellulosic hydrogel and lignin-based functional polymers from unutilized bioresources, bagasse and basil plants. The sugarcane industry produces large volumes of bagasse (sugar cane fibre) each year. Bagasse is used for cattle feed and boiler energy to generate process heat and electricity for the industry. However, utilization of bagasse for other purposes is still limited. To expand the potentials of this biomass, a new program will be launched aimed at producing chemicals, lignin-derived adhesives and fuel ethanol by biological and chemical processes. In addition to the conversion of bagasse, we will investigate production and modification of cellulosic hydrogel from basil plants. In the project, a novel natural hydrogel from basil plants is explored and characterized. A genetic approach for the biosynthesis and biodegradation of hydrogel is included in this program. In the biodegradation of cellulosic hydrogel, special emphasis is placed on the usage of cellulolytic enzymes from termites. We do hope that the new technologies developed in this program will lead to a better future for everyone.

(Japanese side)
Takashi Watanabe* (Kyoto Univ.)
Jun-ichi Azuma (Kyoto Univ.)
Masaaki Kuwahara (Akita Pref. Univ.)
Yoichi Honda (Kyoto Univ.)
Masahiro Sakamoto (Kyoto Univ.)

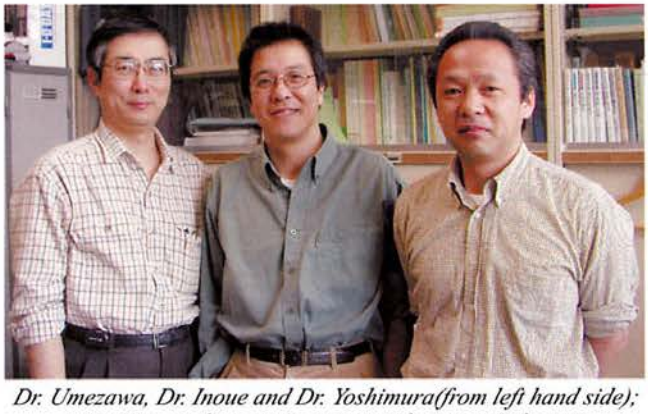
(Indonesian side)
Bambang Prasetya** (LIPI)
Euis Hermiati (LIPI)
Faizathul Fallah (LIPI)
Myrtha Karina (LIPI)
Tami Idiyanti (LIPI)
Lucia Indrati (LIPI)
Rike Yudianti (LIPI)
(*: Project leader, **: Vice Project Leader)

= New Project =

Sustainable Production and Utilization of Tropical Forest Resources for Establishment of a Recycling-based Society

Dr. Toshiaki Umezawa

WRI, Kyoto Univ.



Dr. Umezawa, Dr. Inoue and Dr. Yoshimura(from left hand side): a meeting on this year's project and visiting Indonesia

Fossil resource-based industry has provided prosperity to developed countries. However it also has brought the serious negative impact on the global environment due to the increase in the atmospheric concentration of carbon dioxide, accompanied by a number of pollution problems. Therefore, it is becoming more and more important to establish a sustainable and recycling-based society which depends on renewable resources, otherwise man can not survive.

Wood biomass is the most abundant and potentially renewable resource. However, utilization of wood biomass has been based on the paradigm of a fossil resource-based society. Therefore, it is critically important to establish the sustainable production and utilization of forest resources, so that a sustainable, recycling-based society can be established. This is our most important mission in WRI, Kyoto University, and the final goal in the JSPS-LIPI core university program.

The core university program started 7 years ago, and now is a good time to review the previously conducted projects. In this project, we will review the previous projects, and discuss about the outline of future research projects to approach the establishment of a recycling-based society. The Japanese members are T. Umezawa (Principal investigator, WRI, Kyoto Univ.), M. Inoue, T. Mori, T. Morooka, J. Sugiyama, H. Yano, K.

Yazaki, T. Yoshimura, and T. Watanabe (WRI, Kyoto Univ.). The Indonesian members are Bambang Subiyanto (Principal Investigator, R & D Unit for Biomaterials, LIPI), Mirtha Karina (Res. Center for Physics, LIPI), Yusuf Sudo Hadi (Bogor Agricultural Univ.), Erman Munir (Univ. North Sumatera), and Pipin Permadi (Forest Products Inst). From Malaysia, Mohd. Hamami Sahri (Univ. Putra Malaysia) is joined.

= Project Report =

Behavior of Extractives during Pulping and Bleaching of Tropical Plantation Woods

Prof. Gyosuke Meshitsuka, The University of Tokyo

Prof. Wasrin Syafii, Bogor Agr. Univ.

Autoclave adjustment

Some tropical wood species are known to contain a high amount of extractives. Such extractives can't completely be removed by organic solvent extraction and thus interfere in the lignin determination of those species. During the initial stage of cooking the extracts dissolve into the cooking liquor and consume the alkali. It may thus be necessary to distinguish the real delignification from the dissolution of those extracts during the mild alkali treatment.

Three species of tropical plantation woods, namely *Gmelina arborea, Eucalyptus deglupta* and *Paraserianthes falcataria* were subjected to alkali extraction under two conditions, room temperature and boiling temperature. Gravimetric determination, measurement of permanganate consumption and TOC (total organic carbon) determination were conducted for the extracts. Permanganate consumption of the extracts was expressed as the assumed lignin content in the extracts. Ozonation and alkaline nitrobenzene oxidation analysis, Klason lignin determination, methoxyl determination and neutral sugar analysis were conducted for the extraction residue.

We found that the alkali extracts of sapwood was slightly higher than those of heartwood. Although the assumed lignin content of the extracts was quite high, its low TOC content indicates the dissolution of carbohydrate proceeded during the alkali extraction at both room temperature and boiling temperature.

Methoxyl determination of the extraction residue suggested that purity of lignin (real lignin / Klason lignin) increased to some extent by alkali extraction at both room and boiling temperature. However, both the *erythro* / *threo* ratio of b-O-4 structure and S / V ratio of nitrobenzene oxidation products changed during the alkali extraction even at room temperature. These findings demonstrated that at least part of lignin in these species is quite reactive toward alkali and is dissolved into the alkali liquor. Therefore, apparent "delignification" calculated based on the changes in Klason lignin content before and after the alkali extraction is partly a result of real delignification.

Below photo displays the preparation of wood-disc samples for the alkali cooking. The wood discs were fitted with a metal rim to avoid defibration during cooking. Left photo shows a small laboratory autoclave used for the alkali cooking.

Preparation of wood disc samples for alcali cooking

= Project Report =

Biochemical Analysis of Organic Acid Metabolism of Symbiotic and Saprophytic Basidiomycetes Occurring in Forest Ecosystems

Prof. Mikio Shimada

WRI, Kyoto Univ.

Time flies like a bullet these days! Three years have already passed very quickly since we started our collaborative research work in April 2000, led by Prof. Yadi Setiadi and myself on the Indonesian and Japanese sides, respectively. Although it is a pity not to continue this project further, I am very much satisfied to learn many important functions of fungi in forest ecosystems of tropical countries throughout the course of this joint research. Furthermore, I am very happy to see that our group has discovered a novel metabolic feature of the copper-tolerant wood rotting fungi, which has been reported in Proceedings of the National Academy of Sciences of USA (*PNAS*: Erman Munir, *et al*. **98**, 11126, 2001), comparable to *Nature* and *Science*, followed by other international journals reported elsewhere.

The primary objective of our research project was to investigate metabolic mechanisms for biosynthesis of organic acids, including oxalic acid, in forest fungi, because production of organic acids by fungi is relevant to many important metabolic features of basidiomycetous fungi. Firstly, it is known that some symbiotic mycorrhizal fungi enhance tree growth by secreting organic acids into the rhizosphere to make fixed phosphate available to plants. Secondly, wood rotting fungi attack wood in service in our housings and other structures. Thirdly, both symbiotic and saprophytic fungi produce edible fruit bodies (mushrooms) whose formation may be related to en-

Staffs of Prof. Yadi Setiadi (2nd from the right) and the author (front) at IPB, Bogor

ergy acquiring metabolism with organic acids in TCA and the glyoxylate cycles. Thus, if we succeed in elucidating biochemical mechanisms for their strategies to attack woods or promote tree growth, we can learn how to control them for the benefits of human life; the protection of wood resources against fungal attack increases the service life of woods on one hand, and activates reforestation of economically important timbers with aid of the symbiotic fungi on the other. Also, mushroom cultivation will be more important socio-economically in financially supporting long-range reforestation and timber production.

For our collaboration work, we Japanese researchers decided to concentrate on biochemical work on symbiotic and saprophytic fungi in the laboratory and Indonesian researchers were encouraged to give us much information on biological interactions plants and fungi, carrying out the field work led by Prof. Setiadi (IPB) and Prof. Madame Asmarlaili (USU). We enjoyed exchanging lot of academic information from different aspects throughout the collaboration work. In practice, however, the Ph.D. candidate graduate student Erman Munir from USU could come to us taking advantage of the JSPS program to conduct biochemical analysis with enzymes of a very important brown-rot copper-tolerant fungus (*Fomitopsis palustris*) in our laboratory (WRI, Kyoto).

During the course of this work, We enjoyed visiting many different places including, Serpong (PUSPIP-TEK, LIPI), Bogor (IPB, the university forest Biotechconological. Res. Institute for Estate Crops, and Biological Research Center, LIPI), Medan (USU and the Toba Lake), and Bandung (PP-FISIKA, LIPI), to give lectures and seminars discussing interesting related research subjects with many people in these research organizations. Here again, I appreciate their kind guidance and hospitality. Also, we had a wonderful time with our research collaborators in and out of Japan, although it was a pity that we could not receive all of them at our laboratory.

At the end of this period of collaborative work, I would like to state again that our fruitful results have been obtained principally by the Indonesian student (E.M.), who was conferred the degree of Doctor of Agricultural Science from Kyoto University in due course. So, I believe that teaching young foreign students at universities in Japan is just like planting human-plantlets in the fields of the developing Asian countries. In the long run, I acknowledge that the JSPS Core University Program for Wood Science will certainly contribute not only to the achievement of the sustainable utilization of forest resources in the tropics but also to raising the socio-economic leaders of wood science and technology in future. In this context, global reforestation is urgent for sustainable industrial society, because, "The forest is the mother of the earth", although people usually say, "Hutan adalah ibu dari laut.", "El bosque es la mama del mar.", "La foret est la mere de la mer." , "The forest is the mother of the sea." and "Mori wa umi no haha."

Researchers Involved in This Collaboration Work:

Mikio SHIMADA	(WRI, Kyoto Univ.)
Takefumi HATTORI	(WRI, Kyoto Univ.)
Fukumi SAKAI	(WRI, Kyoto Univ.)
Hiroyuki KURODA	(WRI, Kyoto Univ.)
Yadi SETIADI	(Bogor Agr. Univ.)
Iridika MANSUR	(Bogor Agr. Univ.)
Ricksy PRIMATURI	(Bogor Agr. Univ.)
Asmarlaili S. HANAFIAH	(USU)
Erman MUNIR	(USU)
Ir. Sabrina TENGKU	(USU)
Didiek H.GOENADI	(Biotech. Res. Inst. for Estate Crops)
Darmono TANIWIRIYONO	(Biotech. Res. Inst. for Estate Crops)
Happy WIDIASTUDI	(Biotech. Res. Inst. for Estate Crops)

Mme. Sabrina Tengku, Erman Munir, M. Shimada, Prof. Asmarlaili Shar-Hanafia, and Prof. S. Doi (From left to right) at USU, Medan

= Dr. degree from Kyoto Univ., 2003 =

Characterization of Untreated and Chemically Modified Wood after Outdoor Exposure

Dr. Yanni Sudiyani

Research and Development Unit for Biomaterial, LIPI

Deterioration of wood exposed to outdoor (weathering) is mainly attributed to the decomposition of lignin in the cell walls. Water such as rainfall is thought to play important role, causing the formation of checks, cracks and new surfaces, which are then exposed to UV irradiation during shrinking and swelling. Consequently, the decomposed lignin component are easily leached out from the cell walls accompanied by erosion and discoloration. On the other hand, the degradation of wood components by weathering is assumed to influence the growth rate of molds and fungi, because their growth is possibly affected by the chemical and physical properties of the wood and climatic conditions.

The need to maintain the surface characteristics of wood and other exterior applications alternatively exposed to sunshine and rainfall is increasing yearly and worldwide, to improve the amenity characteristics and environmental friendliness of the materials.

Sugi (*Cryptomeria japonica*) and five tropical wood species were exposed to natural weathering in Indonesian climates for various periods.

The factors causing chemical, physical, biological, and weathering related deterioration were characterized at first, then methods to enhance weathering resistance by chemical treatment were considered.

Chemical analyses showed that the presence of water during weathering promoted the deterioration of wood under UV irradiation, resulting in the destruction of the lignin- hemicellulose matrix in the cell walls. The photo acoustic spectra exhibited rapid decomposition and elusion of wood constituents containing benzene rings in the region of wood specimens closest to the exposed surfaces. The change in these properties after outdoor exposure varied significantly by the wood species. The mold population count differed by exposure period and wood species, but there was no significant effect of climate conditions. In the mold gen-

Dr. Yanni, observing decay of weathered wood specimens

era identification, *Aureobasidium, Cladosporium,* and *Penicillium* were dominant molds on the exposed wood surfaces. Enhancement of decay resistance and persistence against weathering were recognized in all chemical modification treatments employed. Acetylation and PF-resin treatments again ranked higher than other treatments in weathering resistance of the surface characteristics.

Fast growing and low density albizia wood was considered to be promising for outdoor uses following acetylation or PF-resin impregnation.

= Dr. degree from Kyoto Univ., 2003 =

Alternative Approach to the Preservative Treatment of Wood-Based Composites Using Supercritical Carbon Dioxide

Dr. Musrizal Muin

Forestry Dept., Hasanuddin Univ.

Dr. Muin, setting up the SC-CO_2 treatment apparatus

Since wood-based composites have been increasingly used under conditions inducing biological degradation, considerable attention should be paid to the preservative treatment of the products when used as building or structural materials. Current methods for preservative treatment of wood-based composites have drawbacks such as environmental problems, reduction in strength properties, and the need for additional handling. Because of these limitations, we evaluated an alternative approach using supercritical carbon dioxide (SC-CO_2) as a carrier solvent for biocides. SC-CO_2 is created by heating and compressing carbon dioxide above its critical point (30.84ºC and 7.40 MPa).

Any wood-based composite is treatable with SC-CO_2. Although treatment parameters (temperature and pressure) greatly affect the treatability of wood-based composites, SC-CO_2 impregnation slightly above critical point was able to carry and transport biocide(s) into the wood-based composites without any unfavorable effects. The biological resistance of wood-based composites was significantly enhanced by treatment with biocide(s) under conditions slightly above critical point. This finding was supported by chemical analyses, which showed sufficient retention of the biocide in the core of the treated materials.

In addition to the type of wood-based composite treated, the amount of biocide introduced and the solubility of the biocide in SC-CO_2 as well as the treatment temperature and pressure seem to be combined factors affecting the success of the new preservative treatment method. Treatment with fungicide-termiticide mixtures with an identical ratios of each constituent as in the commercial formulation for superficial treatment improved the resistance of wood-based composites against fungal and termite attacks. However, it seems necessary to modify the ratios of the constituents of mixtures to attain satisfactory performance against both major biodegrading agents. Development of the current SC-CO_2 treatment process toward a closed treatment system with the efficient recovery and reuse of carbon dioxide as well as active ingredients should be investigated to ensure that economical and environmental benefits are realized.

= Dr. degree from Kyoto Univ., 2002 =

Improvement of Fire Retardance of Wood Based Materials Using Chemical Coating and Carbon Overlaying

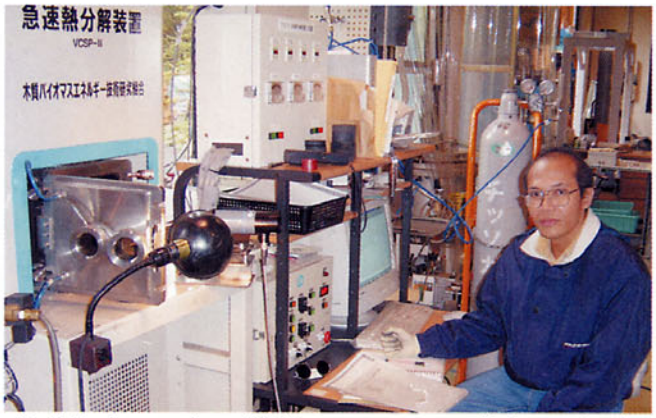
Dr. Subyakto

Research and Development Unit for Biomaterial, LIPI

We developed a fire retardant fast-growing wood product was developed by coating with trimethylol melamine formaldehyde resin mixed with phosphoric acid and densifying the surface of sugi and albizia woods. The results showed that the treatments improved the fire retardancy of lumber without reduction in the bending strength. Evaluation of the fire retardant performance of edge-jointed lumber made from fast growing woods (albizia, gmelina, hinoki) was performed using the standard fire test (JIS A 1304) and the cone calorimeter test (ISO 5660). Lumber coated with trimethylol melamine phosphoric acid, performed similarly, but the fire retardant properties of the lumber in the cone calorimeter test were inferior compared with those of the standard fire test.

The anisotropic thermal properties of molded carbon phenolic spheres (CPS), a mixture of sugi wood charcoal powder and phenol formaldehyde resin molded with a hot press, were investigated. Anisotropy of the thermal properties in horizontal to vertical directions was much higher in the molded CPS than in the

uncarbonized wood. The thermal properties were affected by carbonizing temperature, density, and particle size. An LVL butt joint made with metal plate connectors was covered with graphite phenolic sphere (GPS) sheeting and tested for creep under fire. GPS sheeting was overlaid on the joint in different sizes and locations. The fire resistance of the joint was significantly improved by the *GPS* sheet. The same experiment using carbon phenolic spheres (CPS) sheeting was then conducted. We discuss the effects of carbonizing temperature of charcoal, thickness and location of the sheet on the joint on the fire performance of the joint. A very highly fire-resistant LVL joint was obtained using CPS sheet carbonized at 1600°C. A 3mm sheet covering 3 sides of the joint prolonged the time to rupture more than 16 times compared to an unprotected joint.



Dr. Subyakto, conducted CPS treatment process for improving fire retardancy of wood joint

= Dr. degree from Kyoto Univ., 2002 =

A Novel Mechanism for Oxalic Acid Biosynthesis Related to Energy Generating Systems in the Wood-Rotting Basidiomycete *Fomitopsis palustris*

Dr. Erman Munir

Faculty of Mathematics and Natural Sciences,

The University of North Sumatera

Dr. Erman Munir and Dr. Shirou Suzuki, raising a pine plant let at WRI, Kyoto Univ.

I propose a new metabolic mechanism for oxalic acid biosynthesis in the wood-rotting basidiomycete *Fomitopsis palustris* on the basis of biochemical analyses of glucose metabolism. I found a strong correlation between glucose consumption and oxalate production. Oxalic acid was found to accumulate in the culture fluid in about 80% of the theoretical yield, or about 5-fold on the basis of the fungal biomass harvested. The results clearly indicated that glucose was not completely oxidized to CO_2 by the tricarboxylic acid (TCA) cycle but converted mainly to oxalate, because the decarboxylation steps catalyzed by isocitrate dehydrogenase and oxoglutarate dehydrogenase were found to be ineffecteive. The determination of enzymes concerned revealed the unprecedented occurrence of metabolic coupling of the TCA and glyoxylate (GLOX) cycles that support oxalate biosynthesis. In the metabolic system, isocitrate lyase (ICL), together with oxaloacetase, was found to play a pivotal role in yielding oxalate from oxaloacetate via the acetate-recycling routes. Moreover, malate dehydrogenase with an extraordinarily high activity among the enzymes tested was shown to play an important role in generating NADH by oxidation of malate to oxaloacetate. Thus, I propose as a new concept that the wood-rotting basidiomycete acquires biochemical energy by oxidizing glucose to oxalate, which may be a general feature of both brown- and white-rot fungi during the wood decay process. Furthermore, ICL and malate synthase (MS), known as the key enzymes in the Kornberg's GLOX cycle, play an important role in the metabolic system; ICL functions in both TCA and GLOX cycles, while MS is active in GLOX cycle and acetate-recycling routes, which prevent leaking of acetate to the extracellular site. The enzymes were successfully purified and characterized for the first time for the class of basidiomycetes in the course of this investigation. Importantly, ICL and MS activities were strongly inhibited by oxalate, which is also the major organic acid produced by this fungus. A slight increase in the level of oxalate within the cell may be enough to inhibit the metabolic systems that are important energy-generating devices for fungal growth. Thus, I hypothesize that oxalate-producing fungus has an elaborate system to transport oxalate from intracellular sites to extracellular sites.

The Committee of International Academic Exchange
Y.Imamura(Chairman),
T.Hayashi, T.Umezawa, F.Tanaka,
T.Nomura and T.Hata

Wood Research Institute (WRI)
Kyoto University
Gokasho, Uji, Kyoto 611-0011,Japan
Tel: +81-774-38-3603
Fax: +81-774-38-3600
E-mail :
wri-adm@kuwri.Kyoto-u.ac.jp

Illustrated by
Tadayoshi Yamamoto
Member of Japan Contemporary Arts and Crafts Association

目次にもどる