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Investigation of exquisite, powerful, and aesthetic nature of materials of plants origin

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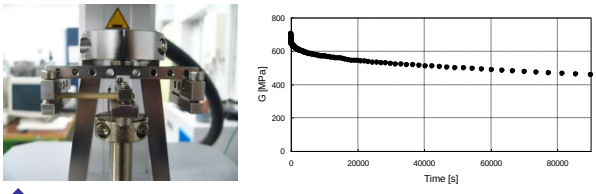
- Biomaterials of plants origin such as wood, bamboo, and so on, have been organized in the present time through the natural selection for a long time. Physiological activity and anatomical features of these plants have the sufficient rationality to survive on the earth.
- Though wood is a death material, it succeeds to the rationality of the biomaterials. Mechanism of the physical properties of wood is very ingenious. The unknowns about this mechanism exist in front of us widely and deeply, and many of them are very interesting but untouched topics.
- To make clear the useful physical properties of wood, and then, to accomplish the high utilization of wood for various purposes, our laboratory promotes the study on wood technology theoretically and experimentally.

Wood is one of the biomaterials which passed through the selection for a long time. Wood succeeds to the rational structure and function of trees; they have been exposed to the force of gravity and the weathering, but survived in the global environment. To make clear the useful physical properties of wood, and then, to accomplish the high utilization of wood in human activities, we promote following studies on wood technology theoretically and experimentally.

Physical properties of wood

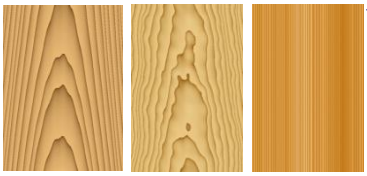
Experimental and theoretical analyses to explain physical properties of the biomaterials of plants origin (for example, mechanical and dielectric relaxation, fatigue and fracture mechanics, adsorption, and so on) are promoted. To approach the above research subjects, interaction between water and higher-order structure of the biomaterials and relations between the interaction and various physical properties of them are studied using model-analyses and thermodynamic descriptions.



Measurement of mechanical relaxation of wood
Mechanical relaxation of a small wood specimen with a given moisture content is measured in a thermo-hygrostat chamber. Relation between higher-order structure of wood and water molecules is analyzed theoretically.

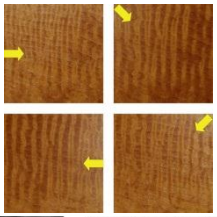
Wood and human relations

Various visual features of wood (color, grain pattern, gloss, etc...) are characterized numerically by using the image technology. Psychological and physiological responses of human who evaluates these features are also examined based on sensory evaluation, computer simulations, and so on. This research is connected with the science of visual design, and the results of the study will be used widely for the manufacturing or designing of wood-based materials, furniture, wooden interior, and so on.



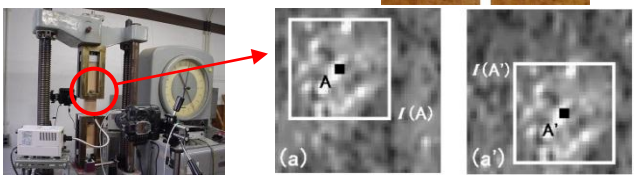
CG wood grain patterns
To investigate relations between visual features of lumber and human impressions quantitatively, various wood grain patterns are simulated systematically.

Extraction of wood gloss
Wood gloss changes dynamically by a geometrical relation of a lamp, a specimen and an observer. This change is extracted by an advanced image analysis.



Analyses of fracture and fatigue behavior

Wood shows complicated strain distribution for the external force and the fracture mechanism of it is also complex, because wood is an anisotropic material. Using the special imaging technique for the strain analysis and the computer simulations, mechanical properties, deformation, and fracture mechanism of wood and wood-based materials are studied theoretically and experimentally.



Deformation analysis by using the digital image correlation (DIC)
The unique imaging technology has made the accurate analysis of strain on wood possible. Various deformation behavior of wood is visualized in multi-scale from a cell to a full-size member.

Keywords

Wood, mechanical relaxation, adsorption, swelling, shrinkage, digital image correlation method, image analysis, image processing, strain analysis, fracture mechanics, strength, wood constructions, wooden interior, color, wood grain pattern, gloss, living comfort, cognitive response

Recent Publications (2007 ~ 2011)

H. Nagai, K. Murata, T. Nakano: Strain analysis of lumber containing a knot during tensile failure, J. Wood Sci., 57, 114-118 (2011)

K. Murata, H. Nagai, T. Nakano: Estimation of width of fracture process zone in spruce wood by radial tension test , Mechanics of Materials, DOI 10.1016/j.mechmat.2011.04.005 (2011)

S. Nakao, T. Nakano: Analysis of molecular dynamics of moist wood components by applying the stretched exponential function, J. Mater. Sci., DOI 10.1007/s10853-011-5385-z (2011)

E. Kanzawa, S. Aoyagi, T. Nakano: Vascular bundle shape in cross-section and relaxation properties of Moso bamboo (Phyllostachys pubescens), Mater. Sci. & Technol., doi: 10.1016/j.msec.2011.03.004

A. Taguchi, K.Murata, M. Nakamura, T. Nakanao: Scale effect in the anisotropic deformation change of tracheid cells during water adsorption, Holzforschung, 65, 253-256 (2011)

M. Sato, M. Nakamura: Gloss property of radial surface of Japanese Cypress (Chamaecyparis obtusa): Relationship between goniometrical gloss measurement and image analyses, Zairyo (Journal of the Society of Materials Science, Japan), 60 (4), 282-287 (2011)

A. Taguchi, K. Murata, T. Nakano: Observation of cell shapes in wood cross-sections during water adsorption by confocal laser-scanning microscope (CLSM). Holzforschung, 64, 627-631 (2010)

T. Nakano: Mechanism of microfibril contraction and anisotropic dimensional changes for cells in wood treated with aqueous NaOH solution, Cellulose, 17, 711-719 (2010)

T. Tsubaki, T. Nakano: Creep behavior of bamboo under various desorption conditions, Holzforschung, 64, 489-493 (2010)

M. Nakamura, M. Matsuo, T. Nakano: Determination of the change in appearance of lumber surfaces illuminated from various directions, Holzforschung, 64 (2), 251-257 (2010)

K. Murata: Properties of eucalypt wood in China, Zairyo (Journal of the Society of Materials Science, Japan), 59 (4), 268-272 (2010)

K. Murata, H. Tanahashi: Measurement of Young's modulus and Poisson's ratio of wood specimens in compression test , Zairyo (Journal of the Society of Materials Science, Japan), 59 (4), 285-290 (2010)

Y. Ohmae, Y. Saito, M. Inoue, T. Nakano: Water adsorption process of bamboo heated at low temperature, J Wood Sci, 55, 13-17 (2009).

Y. Ohmae, Y. Saito, M. Inoue, T. Nakano: Mechanism of water adsorption capacity change of bamboo by heating, Holz als Roh- und Werkstoff, 67, 13-18 (2009)

Y Ohmae and T. Nakano: Water adsorption properties of bamboo in the longitudinal direction, Wood Sci. & Technol, 43, 415-422 (2009)

M. Shiga, T. Nakano: Effects of heating at lower temperature on water adsorption behavior for wood, Zairyo (Journal of the Society of Materials Science, Japan), 58 (2) 175-179 (2009)

K. Bessho, T. Nakano: Analysis of adsorption and desorption processes for heated wood, Zairyo (Journal of the Society of Materials Science, Japan), 58 (1) 53-59 (2009)

S. Aoyagi, T. Nakano: Effect of longitudinal and radial position on creep for bamboo, Zairyo (Journal of the Society of Materials Science, Japan), 58 (1) 57-61 (2009)

Nagai, H, Murata, K, Nakano, T, Journal of Wood Science, Defect detection in lumber including knots using bending deflection curve: comparison between experimental analysis and finite element modeling 55(3) 69-174 (2009)

S. Kawamura, H. Ohata, K. Murata: Panel shear performance of bearing wall made of diagonal plywood, Zairyo (Journal of the Society of Materials Science, Japan), 58 (4) 280-285 (2009)

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Recent Publications (2007 ~ 2011)

Y. Ishikura and T. Nakano: Compressive stress-strain properties of natural materials treated with NaOH, Holzforschung, 62, 448-452 (2008)

T. Nakano: Analysis of cell wall swelling on the basis of a cylindrical model, Holzforschung, 62, 352-356 (2008)

J. Miyazaki, T. Nakano: Fracture Behavior of Laminated Wood Bonded with Aqueous Vinyl Polymer-Isocyanate Resin and Resorcinol-Formaldehyde Resin under Impact Fatigue, J. Appl. Polym. Sci., 109, 276-281 (2008)

Nakamura, M, Kondo, T: Quantification of visual inducement of knots by eye-tracking, Journal of Wood Science, 54 (1), 22-27 (2008)

S. Ukyo, M. Karube, M. Harada, T. Hayashi, K. Murata: Determination of the shear modulus of wood with standard shear block specimen, Zairyo (Journal of the Society of Materials Science, Japan), 57 (4) 317-321 (2008)

K. Murta, H. Koyabu, T. Nakano: Effect of interlocked laminates on fracture of laminated veneer lumber in dowel-bearing strength test, Zairyo (Journal of the Society of Materials Science, Japan), 57 (4) 322-327 (2008)

Y. Ishikura and T. Nakano: Contraction of the microfibrils of wood treated with aqueous NaOH, J. Wood Sci., online fast (2007)

Nakamura, M, T. Fuwa, K. Inoue, F. Iwasaki, S. Kudo, H. Sako, M. Sato, Y. Shimomura: Prospect of Manufacturing and Designing Based on Physiological Polymorphism, Journal of Physiological Anthropology, 26, 507-511 (2007)

Nakamura, M, Kondo, T: Characterization of Distribution Pattern of Eye Fixation Pauses in Observation of Knotty Wood Panel Images, Journal of Physiological Anthropology, 26, 129-133 (2007)

Miyauchi, K.,Murata, K.,"Strain-softening behavior of wood under tension perpendicular to the grain", Journal of Wood Science, 48 (4), 463-469 (2007)

Murata, K., Kanazawa, T: Determination of Young's modulus and shear modulus by means of deflection curves for wood beams obtained in static bending tests, Holzforschung, 61 (5), 589-594 (2007)

K. Murata, S. Nakao: Transverse compression behavior of softwood and alternately laminated lumber of rubberwood veneer and falcata veneer, Zairyo (Journal of the Society of Materials Science, Japan), 56 (4) 316-320 (2007)

H. Nagai, K. Murata, M. Nakamura: Defect detection of lumber including knots using bending deflection curve, Zairyo (Journal of the Society of Materials Science, Japan), 56 (4) 326-331 (2007)