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

Lab. Biomaterials Design  Professor: Nakano, T., Assoc. Prof.: Nakamura, M., Assist. Prof.: Murata, K

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.

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.

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.

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.

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.

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)

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)
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)