

# Learning from Biomaterials

The Chemistry of Biomaterials

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“Biomaterials” is a general term for natural organic materials produced by an organism for itself. The elucidation of their chemical structures and purpose of their production in nature gives a new basic idea for the development of new functional materials. We are studying their chemical structures and functions based on organic synthetic technique from the standpoint of “Learning from biomaterials!” .



## Structure analysis of biomaterials

Lignin is one of the main components of wood and represents, after cellulose, the most abundant polymer in nature. Unfortunately, the elucidation of its chemical structure has not been finished. We are studying to develop a new isolation method, and a new chemical analysis technique. Recently, our research also addresses unknown compounds extracted from tropical forest products, particularly in Kalimantan, Indonesia.



Modern analytical instrument



## Chemical synthesis of biomaterials

Design and synthesis of cellulose derivatives

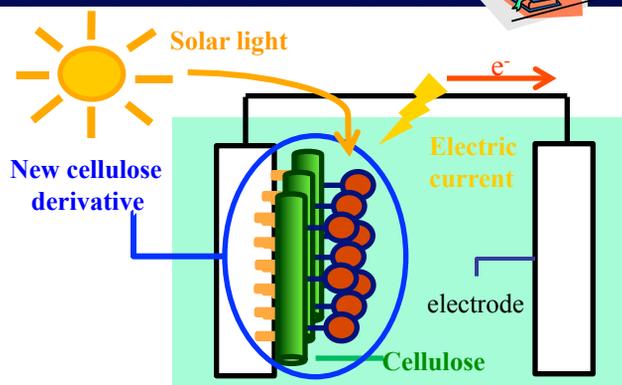


Cellulose accounts for approximately 50% of wood, and is the most abundant polymer in nature. In 1996, we succeeded in the first chemical synthesis of cellulose. Currently we have particular interest in the synthesis of cellulose derivatives with regioselective and blocky functionalization patterns to explore their structure-property relationships.

## Functionalization of biomaterials



We are actively engaged in developing an LB film of a new cellulose derivative and a new artificial photosynthesis system with the aim of application of cellulose at a nano-level. Our research focuses on the synthesis of polysaccharide derivatives with fascinating functions from sustainable biomaterials.



## Key words

*Biomaterials, Wood components, Cellulose, Lignin, Extractives, Tannin, Chemical analysis, Chemical modification wood, Organic synthesis, LB film, Artificial photosynthesis system, Wood chemistry*

## Recent publications

**Studies on electrooxidation of lignin and lignin model compounds. Part 1: Direct electrooxidation of non-phenolic lignin model compounds**

T. Shiraishi, T. Takano, H. Kamitakahara, F. Nakatsubo (2012)  
*Holzforschung* 66, 303-309.

**Studies on electrooxidation of lignin and lignin model compounds. Part 2: N-Hydroxyphthalimide (NHPI)-mediated indirect electro-oxidation of non-phenolic lignin model compounds**

T. Shiraishi, T. Takano, H. Kamitakahara, F. Nakatsubo (2012)  
*Holzforschung* 66, 311-315.

**Fractionation and characterization of lignin carbohydrate complexes (LCCs) of *Eucalyptus globulus* residues left after MWL isolation. Part I: Analyses of hemicellulose-lignin fraction (HC-L)**

Y. Miyagawa, O. Takemoto, T. Takano, H. Kamitakahara, F. Nakatsubo (2012)  
*Holzforschung* 66, 459-465.

**Comb-shaped graft copolymers with cellulose side-chains prepared via click chemistry**

Y. Enomoto-Rogers, H. Kamitakahara, A. Yoshinaga, T. Takano (2012)  
*Carbohydrate Polymers* 87 (3), 2237-2245.

**Synthesis of blockwise alkylated tetrasaccharide-quantum dot complexes and their utilization for live cell labeling with low cytotoxicity**

Kamitakahara H., K. Murata-Hirai, Y. Tanaka (2012)  
*Cellulose*, 19(1), 171-187

**Preparation of 6-azafulleroid-6-deoxy-2,3-di-O-myristoylcellulose**

Ichihara, N; Takano, T; Sakakibara, K; Kamitakahara, H; Nakatsubo (2011)  
*Carbohydr. Res.* 346, 2515-2518.

**Synthesis of diblock methylcellulose derivatives with regioselective functionalization patterns**

Nakagawa, A.; Fenn, D.; Koschella, A.; Heinze, T.; Kamitakahara, H (2011)  
*Journal of Polymer Science Part A: Polymer Chemistry* 49 (23), 4964-4976.

**Physical properties of diblock methylcellulose derivatives with regioselective functionalization patterns: first direct evidence that a sequence of 2,3,6-tri-O-methyl-glucoopyranosyl units causes thermoreversible gelation of methylcellulose**

Nakagawa, A.; Fenn, D.; Koschella, A.; Heinze, T.; Kamitakahara, H (2011)  
*Journal of Polymer Science Part B: Polymer Physics* 49 (21), 1539-1546.

**Synthesis of blockwise alkylated (1→4)-linked trisaccharides as surfactants: Influence of configuration of anomeric position on their surface activities**

A. Nakagawa, H. Kamitakahara, T. Takano (2011)  
*Carbohydrate Research* 346, 1671-1683.

**Synthesis of diblock copolymers with cellulose derivatives 4. Self-assembled nanoparticles of amphiphilic cellulose derivatives carrying a single pyrene group at the reducing-end**

Y. Enomoto-Rogers, H. Kamitakahara, A. Yoshinaga, T. Takano (2011)  
*Cellulose* 18(4), 1005-1014.

**Water-soluble low-molecular-weight cellulose chains radially oriented on gold nanoparticles**

Y. Enomoto-Rogers, H. Kamitakahara, A. Yoshinaga, T. Takano (2011)  
*Cellulose* 18(4), 929-936.