Chair Biomaterials Function

2.2.11 Laboratory : Chemistry of Composite Materials

Member :	Professor	Nishio, Yoshiyuki, Dr. Eng. Sci.
	Senior Lecturer	Yoshioka, Mariko, Dr. Agric. Sci.
	Assistant Professor	Teramoto, Yoshikuni, Dr. Agric. Sci.
	Doctor's program	2
	Master's Program	8
	Undergraduate	2
	Researcher	1

A. Research Activities (2010.4-2011.3)

A-1. Main Subjects

a) New Functionalization of Polysaccharides and Related Natural Resources

Naturally occurring polysaccharides represented by cellulose and chitin, and a polyphenol lignin have been re-evaluated recently as renewable organic resources. They are environmentally benign substances and possess a high potential to be newly developed for industrial and medical applications in themselves or in combination with various synthetic compounds. Our current research is concerned with utilization of the inexhaustible natural polymers as new functional chemicals or high-performance materials. Efforts are also devoted to elucidating several fundamental problems on the molecular and supramolecular structures and physical properties of carbohydrate polymers and related natural compounds. Of particular interest are (1) the microscopic incorporation (including graft-copolymerization) of cellulose and chitin with other polymers or inorganic substances, (2) the liquid crystallinity and chiroptical properties of cellulose and chitin derivatives, (3) the complex formation and crosslinking or gelation behavior of carbohydrate polymers and lignin derivatives, and (4) the molecular assembly of cholesterol-based lipids, each directed toward the design and fabrication of new, useful functional materials. Concretely, the material functionalities arousing interest include highly controllable biodegradability coupled with easiness of processing, and further extensions for special uses demanding dynamic controls, e.g., in shape memory-recovery performance or in novel optical, electro-optical, and magnetic functions.

b) Thermoplasticization and Liquefaction of Plant Biomass, Nanocomposite of Polymer / Biomass, and their Applications to High- performance, High-functional Materials

Wood can be converted to a thermally flowable material directly by chemical modifications in various structural levels, which may be termed “internal plasticization” of wood. In some cases, the thermoplastic property can be attained by blending the modified wood with supplementary plasticizers. By virtue of such plasticizing techniques, we can design and fabricate a variety of wood-based, melt-moldable composites, applicable to many articles of daily use, housing materials, and so on. Wood can also be liquefied through reaction and solvolysis in phenols or polyhydric alcohols. In addition to fundamental studies to elucidate the liquefaction mechanism, we are making efforts to apply the high reactivity of the liquefied wood and ingredients, e.g., to preparations of composites for adhesives, molding materials, foams, and coatings which are desirable to be environmentally friendly or biodegradable in view of practical uses. It has also been studying that clay (layerd silicate), silica and cellulose nanofiber are combined with the synthesized plastics, wood plastics or liquefied wood to get high performance and/or high functional nanocomposite materials. As well, studies directed towards utilization of other biomasses along the above-mentioned line are in progress.

A-2.Publications and presentations

a) Publications

Books

- Yoshiyuki Nishio and Yoshikuni Teramoto: “Synthesis and Function of Polysaccharide Esters”, In “Base and Practical Use of Glycochemistry” (Kazukiyo Kobayashi and Shin-ichiro Shoda, Eds.), Part 2. Chap. 1, Sec. 2, CMC Pub., Tokyo, pp. 133-143 (2010).

- Yoshioka, M., Sakaguchi, K., Ohno, T., Nishio, Y., Shiraishi, N.: "An Approach for Fabricating Pulverized Cellulosics by Ultra High-Pressure Water Jet Treatment and Successive Usages for Polymer Nano-Composites and Graft Copolymerization", In "Biocompatible Nanomaterials: Synthesis, Characterization and Applications", Chapter 13, Nova Science Publishers, pp. 317-335 (2010)

- Yoshioka M., Tsuneoka K., Terasawa I., Shiraishi N.: "Fabrication of resin from liquefied unused biomass", In "Application Technologies of Unused Biomass and Evaluation of Business Potential ", Chapter 2, Section 4, Science & technology Co.,Ltd., pp. 138-143 (2010)

Original Papers(including book-reviews)

- Lee, S. H., Y. Teramoto, T. Endo: Cellulose nanofiber-reinforced polycaprolactone/polypropylene hybrid nanocomposite（査読有り）. Composites Part A: Applied Science and Manufacturing 42 (2); 151-156, 2011

- Ito, H., H. Hattri, T. Okamoto, T. Endo, S. H. Lee, M. Fuji, Y. Teramoto, M. Ago, Y. Imanishi, M. Takatani: Effect of Fibrillation on the Performance of Wood-Plastic Composites with High Filler Content（査読有り）. Sen'I Gakkaishi 67 (1); 1-7, 2011

- Teramoto, Y., S. H. Lee, T. Endo, Y. Nishio: Scale of homogeneous mixing in miscible blends of organosolv lignin esters with poly(ε-caprolactone)（査読有り）. Journal of Wood Chemistry and Technology 30 (4); 360-372, 2010

- Matsumoto, Y., Y. Teramoto, Y. Nishio: Preparation of Thermoplastic Magnetic Wood via Etherification and In-situ Synthesis of Iron Oxide（査読有り）. Journal of Wood Chemistry and Technology 30 (4); 373-381, 2010

- Lee, S. H., S. Inoue, Y. Teramoto, T. Endo: Enzymatic saccharification of woody biomass micro/nanofibrillated by continuous extrusion process II: Effect of hot-compressed water treatment（査読有り）. Bioresource Technology 101 (24); 9645-9649, 2010

- Yoshida, T., S. Tsubaki, Y. Teramoto, J. Azuma: Optimization of microwave-assisted extraction of carbohydrates from industrial waste of corn starch production using response surface methodology（査読有り）. Bioresource Technology 101 (20); 7820-7826, 2010

- Lee, S.-H., Y. Teramoto, T. Endo: Enhancement of enzymatic accessibility by fibrillation of woody biomass using batch-type kneader with twin-screw elements（査読有り）. Bioresource Technology 101 (2); 769-774, 2010

- Ikeuchi, Y., F. Z. Khan, N. Onishi, M. Shiotsuki, T. Masuda, Y. Nishio, F. Sanda: Amino Acid-Functionalized Ethyl Cellulose: Synthesis, Characterization, and Gas Permeation Properties（査読有り）. Journal of Polymer Science Part A: Polymer Chemistry 48 (18); 3986-3993, 2010

- Aoki, D., Y. Nishio: Phosphorylated cellulose propionate derivatives as thermoplastic flame resistant/retardant materials: influence of regioselective phosphorylation on their thermal degradation behaviour（査読有り）. Cellulose 17 (5); 963-976, 2010

- Yoshioka M., Katsura H., Shiraishi N.: Fabrication and Characterization of Carbon Fiber Derived from Woody Biomass (refereed), Journal of The society of materials science, Japan, 60(1), 35-40, 2011

Reviews

- Lee, S. H., Y. Teramoto, T. Endo: Cellulose nanofiber production by hot-compressed water or ozone treatment/mechanical fibrillation and its enzymatic saccharification and application for nanocomposite. Cellulose Communications 18 (1); 12-17, 2011

- Teramoto, Y., R. Kusumi, Y. Nishio: Elaborate designing and material characterization of biomass polymer/aliphatic polyester microcomposites. Cellulose Communications 17 (2); 67-73, 2010

Patents

- JP No. 2010-115089, “Optical composite filmls and manufacturing method for liquid-crystal display devices” M. Ichihara, H. Hayashi, Y. Matsuoka, Y. Nishio

- JP No. 2010-281349, "Liquefied biomass, its fabrication methods and thermo-setting resin", M. Yoshioka, N. Shiraishi

b) Conference and seminar papers presented

- The 4th International Conference on Bio-Composites (Seoul, South Korea): 2 papers（invited）

- The 59h Annual Meeting of the Society of Polymer Science, Japan, 3 papers

- 2010 Annual Meeting of the Society of Fiber Science and Technology, Japan, 1 paper (invited)

- Research Seminar of Research Group on Basic Properties of Polymersof the Society of Polymer Science, Japan, 1 paper (invited)

- The 17th Annual Meeting of the Cellulose Society of Japan, 4 papers

- The 42nd workshop of Kansai Biopolymer Study Group, 1 paper (invited)

- The 6th Seminar of Kansai Affilate of the Cellulose Society of Japan, 1 paper (invited)

- The 55th Lignin Symposium, 1 paper

- Pacifichem 2010：2 papers (invited)

- The 16th Micro-Symposium of the Cellulose Society of Japan, 1 paper (invited)

- The 61st Annual Meeting of the Japan Wood Research Society, 4 papers

Membership in Science Council of Japan, etc.

A-3.Off-campus activities 1

Membership in academic societies

- Nishio, Yoshiyuki, Dr. Eng. Sci. : The Japan Wood Research Society (Editor-in-Chief), The Cellulose Society of Japan (Vice-President), The Society of Fiber Science and Technology, Japan (Councilor), Wood Technological Association of Japan; Wood-Plastic Composite Materials Committee (Trustee of Kansai Branch; Academic Advisory Panel of Wood-Plastic Composite Materials Committee)

- Yoshioka, Mariko, Dr. Agric. Sci. : The Japan Wood Research Society (Member of Committee for Strengthening and Setting up the Studies of The Japan Wood Research Society, Member of Working Group for Formulation of Educational Contents), The Society of Materials Science, Japan (Councilor, Referee commissioner, Organizer and Planning commissioner of Polymer Materials Section Committee), Wood Technological Association of Japan (Academic Advisory Panel of the Wood-Plastic Composite Materials Committee, Organizer of the Plywood Committee), The Society of Polymer Science, Japan (Member of Steering Committee for Research Group of Ecological Materials)

- Teramoto, Yoshikuni, Dr. Agric. Sci. : The Japan Wood Research Society (Member of Editorial Board), Wood Technological Association of Japan (Academic Advisory Panel of the Wood-Plastic Composite Materials Committee)

A-3.Off-campus activities 2

Research grants

1. Grants-in-aid for Scientific Research(KAKENHI)

- Scientific Research (A) : Nishio, Yoshiyuki, Dr. Eng. Sci. : Novel Nano-to-meso Structural Control and Modern Functionalization of Cellulosic Polysaccharides

- Scientific Research (C) : Yoshioka, Mariko, Dr. Agric. Sci. : Creations of New Biomass-containing Polymer-based Nanocomposites and Schematization of their Functional Properties

- Grant-in-Aid for Young Scientists (B) : Teramoto, Yoshikuni, Dr. Agric. Sci. : Material Functionalization of Lignosulfonate by Effective Use of Functional Groups

2.Other Research Grants

- "8th Research Fund for Development of Technologies from Nature" from Sekisui Chemical Co., Ltd.：Teramoto, Yoshikuni, Dr. Agric. Sci.：Preparation of Thermoplastic Magnetic Wood via Etherification and in situ Synthesis of Iron Oxide

- "Feasibility Study Stage, Search Type" in "Adaptable and Seamless Technology Transfer Program through Target-Driven R&D", Japan Science and Technology Agency：Yoshioka, Mariko, Dr. Agric. Sci.：Study for application of polyolefin combined with cellulose nanofiber to lithium-ion battery separator

A-4.International cooperation and overseas activities 1

Membership in academic societies

- Nishio, Yoshiyuki, Dr. Eng. Sci.: Member of Editorial Board of the Journal "Cellulose", International Academy of Wood Science（Fellow）

B.Educational Activities(2010.4-2011.3)

B-1.On-campus teaching

a) Courses given

- Undergraduate level： Basic Forest and Biomaterials Science A (in part; Nishio), Forest and Biomaterials Science II (in part; Nishio), Polymer Synthetic Chemistry (Nishio), Physical Properties of Polymers (Nishio), Materials Chemistry of Biomass Composites (Yoshioka), Laboratory Course in Forest and Biomaterials Science II (in part; Nishio, Yoshioka, Teramoto), Laboratory Course in the Basic Forest and Biomaterial Chemistry (in part; Nishio, Yoshioka, Teramoto), Laboratory Course in the Biomaterials Chemistry II (in Part; Nishio, Yoshioka, Teramoto)

- Graduate level : Chemistry of Composite Materials I (Yoshioka), Laboratory Course in Chemistry of Composite Materials (Nishio, Yoshioka, Teramoto), Seminar in Chemistry of Composite Materials (Nishio, Yoshioka, Teramoto),

B-2.Off-campus teaching etc.

Open lectures, etc.

- Yoshioka, Mariko: Lecturer, "The development of network polymer (thermosetting resin) from liquefied biomass molding and its application into motorcar components", In "The seminar for researchers and engineers" titled "Designing and technological direction of biomass plastics and bio-resin toward motorcar use", Science & technology Co.,Ltd.

C.Other Remarks

- Nishio, Yoshiyuki, Dr. Eng. Sci. : Vice Dean of Graduate School of Agriculture

- Mariko Yoshioka, Dr. Agr. : Committee of Science and Technology Promotion Adjusting Cost Assessment Working Group (International Collaborative Investigation Promotion Assessment Working Group) (Japan Science and Technology Agency, August 2010-January 2011)

- Yoshikuni Teramoto, Dr. Agr. : Committee Member of Creation of Biomass Inovation, Okayama Prefecture