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	3
	Master's Program	8
	Undergraduate	4

A. Research Activities (2009.4-2010.3)

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

- Yoshioka, M., Sakaguchi, K., Ohno, T., Nishio, Y., Shiraishi, N.:
Fabrication of pulverized cellulosics by ultra high-pressure water jet treatment and usage in polymer nano-composites and graft copolymerization, "Biocompatible Nanomaterials: Synthesis, Characterization and Applications", Chapter 13, S. Ashok Kumar, Soundappan Thiagarajan and Sea-Fue Wang eds., Nova Science Publishers, in press (2010)

Original Papers

- Sugimoto, M., M. Kawahara, Y. Teramoto and Y Nishio:
Synthesis of acyl chitin derivatives and miscibility characterization of their blends with poly(ε-caprolactone). Carbohydrate Polymers 79 (4); 948-954, 2010
- Chiba, R., M. Ito and Y Nishio:
Addition effects of imidazolium salts on mesophase structure and optical properties of concentrated hydroxypropyl cellulose aqueous solutions. Polymer Journal 42 (3); 232-241, 2010
- Matsubara, T., Y. Miyashita, Y. Nishio:
Synthesis and structural characterization of phenylcarbamate derivatives of chitin and chitosan. Kobunshi Ronbunshu 67 (2); 135-142, 2010

- Teramoto, Y., S. H. Lee and T. Endo:
Cost reduction and feedstock diversity for sulfuric acid-free ethanol cooking of lignocellulosic biomass as a pretreatment to enzymatic saccharification. Bioresource Technology 100 (20); 4783-4789, 2009
- Yoshioka, M., Sakaguchi, K., Ohno, T., Nishio, Y., Shiraishi, N.:
Fabrication of pulverized cellulosics by ultra high-pressure water jet treatment and usage in polymer nano-composites and graft copolymerization. Journal of Wood Science, 55 (5), 335-343, 2009
- Kusumi, R., S. H. Lee, Y. Teramoto and Y. Nishio:
Cellulose ester-graft-poly(ε-caprolactone): Effects of copolymer composition and intercomponent miscibility on the enzymatic hydrolysis behavior. Biomacromolecules 10 (10); 2830-2838, 2009
- Higeshiro, T., Y. Teramoto and Y. Nishio:
Poly(vinyl pyrrolidone-co-vinyl acetate)-graft-poly(ε-caprolactone) as a compatibilizer for cellulose acetate/poly(ε-caprolactone) blends. Journal of Applied Polymer Science 113 (5); 2945-2954, 2009

Reviews

- Teramoto, Y., Y. Nishio:
Chemical modification and functionalization of wood and its components, and related bioresources. Journal of The Adhesion Society of Japan 45 (12); 493-499, 2009
- Yoshioka, M.:
Fabrication and application of liquefied biomass and cellulose nanofiber, Abstract of the workshop for development and application of bio-based materials, The society of materials science, Japan, 17-23, 2009

Patents

- JP 2010-31229 A (Kokai Tokkyo 2010-31229), “Flame-resistant polymer resins and moled composite materials” Y. Yamanaka, T. Harada, H. Yaginuma, Y. Nishio, D. Aoki
- JP 2010-31230 A (Kokai Tokkyo 2010-31230), “Flame-resistant polymer resins and moled composite materials” T. Harada, Y. Yamanaka, H. Yaginuma, Y. Nishio, D. Aoki
- Patent no. 2010－004814 ‘Liquefied biomass, its fabrication methods and thermo-setting resin’ , inventors: Yoshioka, M., Shiraishi N., patentees: Yoshioka, M., Shiraishi, N., application date: Jan. 13, 2010

b) Conference and seminar papers presented

- The 58th Annual Meeting of the Society of Polymer Science, Japan, 4 papers
- The 16th Annual Meeting of the Cellulose Society of Japan (Sapporo), 4 papers
- ASEAN 2nd Regional Conference of the Interdisciplinary Research on Natural Resources and Materials (Yogyakarta, Indonesia): 1 paper (invited)
- 58th Symposium on Macromolecules (Kumamoto), 2 papers
- Japanese-European Workshop on Cellulose and Functional Polysaccharides (Hamburg, Germany), 1 paper (invited)
- International Conference on Polysaccharides as a Source of Advanced Materials, EPNOE 2009 (Truku, Finland), 2 papers (including 1invited paper)
- 1st Bioplastic Symposium (Osaka), 1 paper
- The 54th Lignin Symposium (Shizuoka), 1 paper
- The Society of Fiber Science and Technology, Japan; Hokkaido Paper & Pulp Round-table Meeting (Sapporo), 1 paper (invited)
- The Society of Mining and Materials, Japan; Hokkaido Mining and Materials Forum 2009 (Sapporo), 1 paper (invited)
- The 60th Annual Meeting of the Japan Wood Research Society (Miyazaki), 3 papers

A-3.Off-campus activities

Membership in academic societies

- Nishio, Yoshiyuki, Dr. Eng. Sci. : The Japan Wood Research Society (Member of Editorial Board), 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. : Wood Technological Association of Japan

(Academic Advisory Panel of the Wood-Plastic Composite Materials Committee)

Membership in Science Council of Japan, etc.

- Nishio, Yoshiyuki, Dr. Eng. Sci. : The Society of Mining and Materials, Japan; Hokkaido Mining and Materials Forum 2009 (Sapporo), 1 paper (invited)
- Yoshioka, Mariko, Dr. Agric. Sci. : The society of materials science, Japan, the workshop for development and application of bio-based materials (Tokyo), 1 paper (invited)
- Teramoto, Yoshikuni, Dr. Agric. Sci. : The Society of Fiber Science and Technology, Japan; Hokkaido Paper & Pulp Round-table Meeting (Sapporo), 1 paper (invited)

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

A-4.International cooperation and overseas activities

Membership in academic societies

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

International meetings(country,roles)

- Nishio, Yoshiyuki, Dr. Eng. Sci.：ASEAN 2nd Regional Conference of the Interdisciplinary Research on Natural Resources and Materials (Indonesia, visiting professor of ASEAN legation, invited speaker), Japanese-European Workshop on Cellulose and Functional Polysaccharides (Germany, member of organizing committee, invited speaker), International Conference on Polysaccharides as a Source of Advanced Materials, EPNOE 2009 (Finland, member of scientific committee)
- Teramoto, Yoshikuni, Dr. Agric. Sci.：International Conference on Polysaccharides as a Source of Advanced Materials, EPNOE 2009 (Finland, invited speaker)

B.Educational Activities(2009.4-2010.3)

B-1.On-campus teaching

a) Courses given

- Undergraduate level : Forest and Biomaterials Science II (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 II (Nishio), 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.

- Mariko Yoshioka: Public program name: Kansai Science School 2010 for Girl Students (Japan Science and Technology Agency Project of support for girl students to choose the science course)
Organizer: Kwasan and Hida Obsevatories, Graduate School of Science, Kyoto University, September, 2009
Role: Lecturer
Lecture theme: Fabrication of polymeric materials with low environmental load －Let's study "Biodegradable plastics and Biomass Plastics"－
- Teramoto, Yoshikuni, Dr. Agric. Sci.: Kyoto University Open Seminar of Forest Science (Committee)

C.Other Remarks

- Nishio, Yoshiyuki, Dr. Eng. Sci. : Vice Dean of Graduate School of Agriculture
- Mariko Yoshioka : Committee of Science and Technology Promotion Adjusting Cost

Assessment Working Group (International Collaborative Investigation Promotion Assessment Working Group) (Japan Science and Technology Agency, August 2009-January 2010)