

2.2.9 Laboratory : Fibrous Biomaterials

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	Doctor's program	1
	Master's Program	5
	Undergraduate	4
	Researcher	1

A. Research Activities (2009.4-2010.3)

A-1. Main Subjects

a) Processing of Cellulosic Materials Using Magnetic Fields (I)

Filler-in-cellulosic matrix: we prepare 2-dimensional composite materials in which organic, inorganic, and metal particles are precisely aligned and patterned magnetically in cellulosic materials such as paper, cellophane, and films of cellulose derivatives. These composites are expected to exhibit anisotropic mechanical, optical, thermal, and electrical properties.

b) Processing of Cellulosic Materials Using Magnetic Fields (II)

Cellulose-as-filler: the sizes of cellulose fibers are controlled from millimeter to nanometer sizes. Depending on their size, they exhibit various physical properties. In addition, by introducing nano particles onto the fiber, further functionalization of fibers can be achieved. By alignment of these fibers using magnetic field, we believe that 2-dimensional functional composites will be created.

c) Development of the technique of pseudo-single crystals and its application to diffraction method.

A magnetic method that we have developed enables to fabricate a pseudo-single crystal (PSC) from a powder sample. The obtained PSC gives rise to XRD equivalent to that obtained from a real single crystal. This method (PSC method) will provide the third way, coming after the powder method and the single crystal method in the diffraction methods including X-ray and neutron method. Since the protein structure analysis is becoming important, encouraged by a current trend of biorefinery, we expect an increasing demand to our PSC technique.

d) Paper friction—the real contact area—

The estimation of the contact area under different conditions including the applied pressure should be very important for examination of paper friction. In this report, an optical interference method using scanning laser microscope was adopted to measure the real contact area with plane smooth glass surface. The estimated contact area of paper at 1 KPa was around 1% of nominal area for common non-coated paper. The contact area of non-coated paper generally increases by two third power of the apparent pressure over wide range of pressure. It suggested that contact of paper was generally elastic contact and it was one reason describing the decrease in the coefficient with increasing apparent pressure. On the other hand the contact of coated paper was somewhat plastic and the pressure dependence of the friction coefficient was smaller than that of non-coated paper.

e) Role of the additives for new function development in paper materials

Laboratory handsheets made from lightly beaten hardwood kraft pulp containing various amounts of amphoteric or cationic polyacrylamide (PAM) dry strength resin were prepared by both the internal and external application methods. The internal application was performed by adding a dilute aqueous PAM solution to pulp fiber suspension, while the external application was performed by dipping a dry paper (handsheet) into an aqueous PAM solution and further squeezing it out with/without the standard wet press. Dynamic mechanical properties of them were measured to clarify a difference in mechanism of strength increasing between them. In the case of internal application both amphoteric and cationic PAMs were distributed in molecularly dispersed state within a fiber wall and no characteristic viscoelasticity of PAM appeared. On the other hand, external application caused the PAM distribution within a fiber wall, forming a PAM domain and the viscoelasticity of PAM appeared.

f) Characterization of recycled paper

In order to examine the sheet strength reduction and the net effect of simple dry-rewetting cycles, cellulose film, instead of wood fiber, was repeated to drying-and-rewetting cycle up to 30 times. No change in its mechanical properties was found and suggested that the strength decrease was caused by the lowering of fiber-to-fiber bonding..

g) Chinese Ink Blurring on Paper

Chinese ink blurring on various papers for calligraphy was examined by the use of non-diluted or diluted inks. The blurring indices based on Klemm Method, the ink absorption, the unevenness of the outlines at the blurring heads, represented well the changing of the blurring. The blurring evaluation based on human's feeling also corresponded to the changing of the blurring indices. Specially, the blurring index based on the unevenness of the outlines

at the blurring heads, as show in Fractal dimension, was preferable to represent the blurring evaluation based on human's feeling

h) Roles of paper and starch in restoration of paper based culture heritage

In case of starch application by blade coating, little starch penetrated, forming a sandwich structure and an increase in the tensile strength caused by starch application was little. On the other hand, in case of starch application by the impregnation, starch penetrated well in the paper layer, forming a starch-fiber composite, and the tensile strength increased with increasing in the amount of applied starch. Starch application by blushing at low solid content of starch was similar to the application by the impregnation. The blushing application at high solid content of starch was similar to the application by the blade coating Furthermore a plane variation in amount of applied starch by blushing increased with an increase in solid concentration of the starch..

A-2.Publications and presentations

a) Publications

Original Papers

- T. Kimura, Orientation of Feeble Magnetic Particles in Dynamic Magnetic Fields, Jpn. J. Appl. Phys. 48 020217 (3 pages) (2009).
- M. Yamato, T. Kimura, K. Takahashi, and K. Watanabe, Magnetic Alignment of Poly(ethylene terephthalate) in Molten State, Journal of Physics: Conference Series 156, 012001 (2009).
- F. Kimura and T. Kimura, Three-dimensional orientation of cellulose crystals under dynamic elliptic magnetic field, Journal of Physics: Conference Series 156, 012002 (2009).
- T. Kimura, C. Chang, F. Kimura, M. Maeyama, The pseudo-single-crystal method: a third approach to crystal structure determination. J. Appl. Crystallogr. 42, 535-537 (2009).
- H. Enozawa, M. Hasegawa, E. Isomura, T. Nishinaga, T. Kato, M. Yamato, T. Kimura, and M. Iyodam Magnetic Alignment in Solid State and Temperature Hysteresis in Aqueous Tetrahydrofuran Solution for Tetrathiafulvaleno[18]annulenes, ChemPhysChem 10, 2607-2611 (2009).
- F. Kimura, T. Kimura, K. Matsumoto, and N. Metoki, Single-Crystal Neutron Diffraction Study of Pseudo Single Crystal Prepared from Microcrystalline Powder, Cryst. Growth Des 10(1) 48-51 (2010).

- F. Kimura, T. Kimura, W. Oshima, M. Maeyama, and K. Aburaya, X-ray diffraction study on pseudo single crystal prepared from crystal belonging to point group 2. J. Appl. Crystallogr. 43 151-153 (2010).
- Sakaemura, T., Mihara, I., and Yamauchi, T.: Microscopic Attenuated Total Reflection/Fourier Transform Infrared Imaging of Paper Containing a Polyacrylamide Dry Strength Resin 繊維誌 65(9) 252-255(2009)
- Sakaemura, T., and Yamauchi, T.: Dynamic Mechanical Properties of Paper Containing a Polyacrylamide Dry Strength Resin -Effects of type of the resin and the application method-紙パ技協誌 63(11) 1349-1357(2009)
- Uchiyama, T., and Yamauchi, T.: Chinese Ink Blurring on Paper and a Proposal of the Evaluation Based on Klemm Method Seni Gakkaishi 66(3) 82-85(2010) (in Japanese)
- Sakaemura, T., and Yamauchi, T.: Strength restoration of paper from recycled pulp by an addition of a polyacrylamide dry strength resin and its distribution within a fiber wall 紙パ技協誌 64(6) 1349-1357(2010)
- Sakaemura, T., Inokuchi, F and Yamauchi, T.: Imaging with ESCA of Paper Containing a Polyacrylamide Dry Strength Resin Seni Gakkaishi 66(6) 160-162(2010)

Reviews

- T. Kimura, Magnetic Processing of Feeble Magnetic Materials under High Magnetic Fields. Magnetics Jpn., 4(11), 516-523 (2009) in Japanese
- T. Kimura, Magnetic Processing and its Application to Functional Papers and Printing, J. Printing Science and Technology, 46(4), 176-178 (2009) in Japanese

b) Conference and seminar papers presented

- The Cellulose Society of Japan 1 paper
- Japna-European Workshop on Cellulose and Functional Polysaccharides, Hamburg, T. Kimura, invited
- International Conference on Magneto-Science, Nijmegen, T. Kimura, invited
- The Magneto-Science Society of Japan, 6 papers
- The Crystallographic Society of Japan, 1 paper
- 14th Pulp and Paper Fundamental Research Symposium Oxford UK, T. Yamauchi
- The 76th Pulp and Paper Research Conference, 2 papers

A-3.Off-campus activities

Membership in academic societies

- Kimura, Tsunehisa, D.Eng. : The Magneto-Science Society of Japan (Vice President), The Cellulose Society of Japan (Board member)
- Yamauchi, Tatsuo : The Japan Technical Association of Pulp and Paper Industry (committee member for wood science and technology), , The society of Japan Packaging Science and Technology (councilor, Journal editorial board member)

Research grants

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

- B : T. Kimura : Creation of novel anisotropic composites from renewable materials

A-4.International cooperation and overseas activities

International meetings(country,roles)

- Kimura, Tsunehisa : International Conference on Magneto-Science (International Advisory Board , Programm Committee)

Visiting Research Scholars

- Invited Scholar 1 (China)

B.Educational Activities(2009.4-2010.3)

B-1.On-campus teaching

a) Courses given

- Undergraduate level: Forest Science II (Kimura) Physical Chemistry in Bio-materials(Kimura), Pulp and Paper (Yamauchi), Laboratory Course in Forest and Biomaterials Science II (Yamauchi, Kusumi), Laboratory Course in the Basic Forest and Biomaterials Chemistry (Yamauchi, Kusumi), Laboratory Course in the Biomaterials Chemistry II (Kimura, Yamauchi, Kusumi), Seminar in Forest and Biomaterials Science (Kimura, Yamauchi, Kusumi)
- Graduate level: Fibrous Biomaterials I (Kimura), Seminars in Fibrous Biomaterials (Kimura, Yamauchi, Kusumi), Laboratory Course in Fibrous Biomaterials (Kimura, Yamauchi, Kusumi)

C.Other Remarks

- Yamauchi, Tatsuo: “Paper Science Forum” (representative)