Toshikazu TAKATA, Prof.
Department of Organic and Polymeric Materials

1. Main Research Results

Creation of new devices and materials was achieved in the developments of novel polymers exploiting modified *cardo* structure, novel rotaxane elements and catalysts, and new chemical ligation tools as follows:

1) Development of novel polymers for optical use

Design and synthesis of high performance polymers having a spirobifluorene moiety with rectangular π-electronic system were studied, and novel optical use-oriented polymers with thermal stability as well as high refractive index and low birefringence were created.

2) Development of novel rotaxane switching system

The unprecedent neutralization reaction of crown ether–*sec*-ammonium-type rotaxane was achieved through (i) tertiarization of *sec*-ammonium moiety and (ii) counter anion exchange reaction by using tetrabutylammonium fluoride. By applying the neutralization of rotaxane, new rotaxane switching system was developed.

3) Development of novel rotaxane catalyst

It was revealed that the use of Pd-templated macrocycle catalyst enables the acceleration effect of polymer reactions via an intermediary formation of the pseudorotaxane, which is dependent on a high association constant and a proximity effect between the components originating from the topological structure of the catalyst.

4) Development of new chemical ligation tool

For the construction of highly sophisticated macromolecular architectures, sufficiently stabilized homoditopic nitrile *N*-oxide was developed as a new chemical ligation tool, which enables catalyst- and solvent-free polymerization and cross-linking reaction between unsaturated bond-containing fragments.

2. List of Publication

Original Paper

1) "Neutralization of *sec*-Ammonium Group Unusually Stabilized by the "Rotaxane Effect": Synthesis, Structure, and Dynamic Nature of a "Free" *sec*-Amine/Crown Ether-Type Rotaxane", Nakazono, K.; Takata, T.* *Chem. A Eur. J.* **2010**, *16*, 13783-13794.

2) "Axle Length Effect on Photoinduced Electron Transfer in Triad Rotaxane with Porphyrin, [60]Fullerene and Triphenylamine", A. Sandanayaka, H. Sasabe, T. Takata,* O. Ito,* *J. Phys. Chem. A*, **2010**, *114*, 5242–5250. [Selected as Cover Page Picture]

3) "Selective Transformation of A Crown Ether/sec-Ammonium Salt-Type Rotaxane to *N*-Alkylated Rotaxane", S. Suzuki, K. Nakazono, T. Takata*, *Org. Lett.* **2010**, *12*, 712-715.

4) "C-C Bond-Forming Click Synthesis of Rotaxanes Exploiting Nitrile *N*-Oxide" T. Matsumura, F. Ishiwari, Y. Koyama,* T. Takata*, *Org. Lett.* **2010**, *12*, 3828-3831.

5) "An Efficient Synthetic Entry to Rotaxane Utilizing Reversible Cleavage of Aromatic Disulfide Bond" T. Yoshii, Y. Kohsaka, T. Moriyama, T. Suzuki, Y. Koyama, T. Takata,* *Supramolecular Chem.* **2010**, *22*, 1029-0478.

6) "Poly(arylene sulfone)s containing 9,9'-Spirobifluorene: Synthesis and Excellent Optical Properties" H. Okuda, R. Seto, Y. Koyama, T. Takata,* *Polym. J.* **2010**, *42*, 795-798.

7) "Poly(arylene thioether)s Containing 9,9'-Spirobifluorene Moieties in the Main Chain: Masked Dithiol-based Synthesis and Excellent Optical Properties" H. Okuda, R. Seto, Y. Koyama, T. Takata,* *J. Polym. Sci. Part A.: Polym. Chem.* **2010**, 48, 4192-4199.

8) "9,9'-Spirobifluorene-Containing Polycarbonates: Transparent Polymers with High Refractive Index and Low Birefringence" R. Seto, T. Sato, T. Kojima, K. Hosokawa, Y. Koyama, G. Konishi, T. Takata*, *J. Polym. Sci. Part A.: Polym. Chem.* **2010**, 48, 3658-3667.

9) "Synthesis and Property of 9,9-Spirobifluorene-containing Aromatic Polyesters as Optical Polymers with High Refractive Index and Low Birefringence" R. Seto, T. Kojima, K. Hosokawa, Y. Koyama, G. Konishi, T. Takata*, *Polymer* **2010**, *51*, 4744-4749.

10) "Synthesis of Main Chain-Type Polyrotaxanes by New Click Polymerization Using Homoditopic Nitrile *N*-Oxides *via* Rotaxanation-Polymerization Protocol", Y.-G. Lee, Y. Koyama, M. Yonekawa, T. Takata*, *Macromolecules* **2010**, *43*, 4070-4080. [Selected as Cover Page Picture]

11) "Synthesis of acetylene-functionalized [2]rotaxane monomers directed toward side chain-type polyrotaxanes", K. Nakazono, K. Fukasawa, T. Sato, Y. Koyama, T. Takata*, *Polym. J.* **2010**, *42*, 208-215. [Selected as Cover Page Picture]

12) "High-Yield One-Pot Synthesis of Permethylated ▪-Cyclodextrin-based Polyrotaxane in Hydrocarbon Solvent through an Efficient Heterogeneous Reaction", K. Nakazono, T. Takashima, T. Arai, Y. Koyama, T. Takata*, *Macromolecules* **2010**, *43*, 691-696.

13) "Successive Catalytic Reactions Specific to Pd-Based Rotaxane Complexes as a Result of Wheel Translation along the Axle" N. Miyagawa, M. Watanabe, T. Matsuyama, Y. Koyama, T. Moriuchi, T. Hirao, Y. Furusho, T. Takata*, *Chem. Commun.* **2010**, *46*, 1920-1922. [Selected as Highlight Paper]

14) "Synthesis of a Kinetically Stabilized Homoditopic Nitrile *N*-Oxide Directed toward Catalyst-free Click Polymerization", Y.-G. Lee, M. Yonekawa, Y. Koyama, T. Takata*, *Chem. Lett.* **2010**, *39*, 420-421.

15) "Diphenolic 9,9-Diarylfluorene Trimers and Derivatives Possessing Flexible Alkylene Chain Spacers: Synthesis of the Monomers, Their Polymerization, and Properties of the Resulting Polymers" T. Hasegawa, Y. Koyama, R. Seto, T. Kojima, K. Hosokawa, T. Takata*, *Macromolecules*, **2010**, *43*, 131-136.

Review and Book

1) "9,9-Diarylfluorene Moiety Incorporated into Polymer Main Chains: An Essential Skeleton Exhibiting Prominent Physical, Chemical, and Optical Properties", Y. Koyama, K. Nakazono, H. Hayashi, T. Takata*, *Chem. Lett.* **2010**, *39*, 2-9.

2) "Thiazolium-Tethering Rotaxane-Catalyzed Asymmetric Benzoin Condensation: Unique Asymmetric Field Constructed by The Cooperation of Rotaxane Components", Y. Tachibana, N. Kihara, K. Nakazono, T. Takata*, *Phosphorus Sulfur, and Silicon and the Related Elements*, **2010**, *185*, 1182-1205.

3) *Handbook of Carbon Nano Materials. Vol. 2. Electron Transfer and Applications,* Toshikazu Takata, Osamu Ito (Chapter 15: Photoinduced Electron Transfer Processes of Fullerene

Rotaxanes), Ed. by F. D'Souza and K. M. Radish, World Scientific, New Jersry, 2011.

3. Invited/Plenary Talks in Conference

International Conference or Workshop

1) Takayu Arai and Toshikazu Takata, Cyclodextrin Oligomer for Supramolecular Cross-Linker Producing Quickly Thermo-Responsive Hydrogel, 15th International Cyclodextrin Symposium, Viena, Austria, May 9 – 12th, 2010

2) Toshikazu Takata, Recyclable and Thermo-responsive Polymers Possessing Mechanical Crosslinks, 2nd International Symposium on Polymer Materials Science and Technology, Harbin Engineering University, Harbin, China, May 31st – June 04 (Invited Lecture)

3) Toshikazu Takata, Recyclable Polymers and Thermo-Responsive Polymers Derived from Topological Cross-Links, Hokkaido University Graduate School of Science Seminar, Sapporo, June 30th – July 4th, 2010 (Invited Lecture)

4) Toshikazu Takata, New "Click Chemistry" Using Nitrile *N*-Oxide, Japan-Taiwan Bilateral Meeting, Hokkaido University, Sapporo, June 30th – July 4th, 2010 (Invited Lecture)

5) Toshikazu Takata and Fumitaka Ishiwari, One-Handed Helices Controlled by Rotaxane Chirality, Chirality 2010 (ISCD-22), Sapporo, July 12th – 15th, 2010 (Invited Lecture)

6) Toshikazu Takata, Synthesis, Structure Control, and Application of Stable and Dynamic Helical Polymers, Materials Department Seminar, Gwangju Institute of Science and Technology, Gwangju, Korea, Oct. 6th, 2010 (Invited Lecture)

7) Toshikazu Takata, Thermo-responsive Hydro Gels Possessing Mechanical Crosslinks, The Polymer Society of Korea, Daegu, Korea, Oct. 7th-8th, 2010 (Invited Lecture)

8) Toshikazu Takata, Synthesis and Application of Interlocked Molecules and Their Polymers Open Seminar of TIT and Tinghua University Program, Tinghua University, Beijing, China, Nov. 2nd, 2010 (Invited Lecture)

9) Toshikazu Takata, Chemistry of Macromolecular Self-Assembly: Synthesis and Application of Cyclodextrin-based Polyrotaxanes, Chemistry Department Seminar, Tinghua University, Beijing, China, Nov. 3rd, 2010 (Invited Lecture)

Domestic Conferences

Domestic Invited and Special Lectures: 17 Lectures

4. Patent

6 applications

5. Award

1) Toshikazu Takata, Prize for Science and Technology, The Commendation for Scienceand

Technology by the Minister of Education, Culture, Sports, Science and Technology, 2010.04.20

2) Toshikazu Takata, Prize for Science and Technology, The Chemistry Society Japan, 2011.03.27

3) Yasuhito Koyama, 1st Tanaka Rubber Science and Technology Award, Eno Science Foundation, 2011.02.25

4) Kazuko Nakazono, Chugai Pharmaceutical Co., Ltd. Award in Synthetic Organic Chemistry, Japan, 2011.03.1

5) Ayumi Kawasaki, Student, Poster Award, Teijin 21cent. Forum, Teijin, Shizuoka, 2011.01.29

6) Fumitaka Ishiwari, Student, Poster Award, 11th Ring-Tube Supramolecular Symposium, Ring-tube Supramolecular Society Japan, Tokyo, 2011.03.11

7) Chika Yamashita, Student, Poster Award, Kanto Branch Congress of Chemistry, The Chemistry Society Japan, Tsukuba, 2010.08.31

8) Hitoshi Okuda, Student, Poster Award, Kanto Branch Congress of Chemistry, The Chemistry Society Japan, Tsukuba, 2010.08.31

6. Others

1) Editor-in-Chief, Polymer Journal, 2008.06.01～

2) Introduced by *Synfacts* **2010**, 647.
Successive Catalytic Reactions Specific to Pd-Based Rotaxane Complexes as a Result of Wheel Translation along the Axle
Miyagawa, N.; Watanabe, M.; Matsuyama, T.; Koyama, Y.; Moriuchi, T.; Hirao, T.; Furusho, Y.; Takata, T.*, *Chem. Commun.* **2010**, *46*, 1920-1922.