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1. Outline of research results in 2010

1) Synthesis of hyperbranched polymers with controlled degree of branching

A linear polymer, hyperbranched polymers with various degree of branching, and 100 % hyperbranched polymers were successfully synthesised by self-polycondensation of 2,2,2-trifluoro-1-[4-(4-phenoxyphenoxy)phenyl]ethanone by using different amounts of trifluoromethanesulfonic acid from the same AB₂ monomer.

2) Thin film solar cells.

Well-defined coil-rod-coil triblock copolymer poly(4-vinyltriphenylamine)-*b*-poly-(3-hexylthiophene) -*b*- poly(4-vinyltriphenylamine) PTPA-P3HT-PTPA) was used as a surfactant for P3HT/PCBM based solar cells. The power conversion efficiency of the device was enhanced from 3.9 to 4.4%.

3) Proton exchange membranes for fuel cell application

Polymer electrolyte membranes based on cross-linked highly sulfonated multiblock copoly(ether sulfone)s (IEC = 2.99–3.40 mequiv/g) were prepared successfully by the reaction between the sulfonic acid groups in the main chains and 1,4-diphenoxybenzene as a cross-linker in the presence of the condensation agent. The **HSPx1-3** membranes, which represent the cross-linked **HSP1-3** membranes, demonstrated good mechanical strength in the dry state regardless of their high IEC values and the introduction of the cross-linking structure. **HSP1-3** showed higher proton conductivity than that of Nafion 117 in the range of 30–95% RH. Especially, the **HSPx3** membrane with the highest IEC value (3.40 mequiv/g) showed 2.4–3.6 times higher proton conductivity compared to Nafion 117 in the whole range of 30–95% RH.

2. List of publication

Original articles

1) Synthesis of amorphous copoly(thioether sulfone)s with high refractive indices and high Abbe numbers.

European Polymer Journal, 46, 34–41 (2010)

Y. Suzuki, T. Higashihara, S. Ando, M. Ueda

2) Synthesis of highly refractive and transparent polyimides derived from 4,4'-thiobis[2'',6''-dimethyl-4''-(*p*-phenylenesulfanyl)aniline].

J. Polym. Sci. Part-A, Polym. Chem., 48, 656-662 (2010)

N-H. You, T. Higashihara, S. Ando, M. Ueda

- 3) Synthesis of block copolymers consisting of poly(3-hexylthiophene) and polystyrene segments through ionic interaction and their self-assembly behavior.
Polym. J. 42(1), 43-50 (2010)
T. Higashihara, A. Takahashi, S. Tajima, S. Jin, Y. Rho, M. Ree, M. Ueda.
- 4) Thermotropic liquid crystalline polyimides with siloxane Linkages: Synthesis, characterization, and liquid crystalline behavior.
Macromolecules 43(2), 805-810 (2010).
Y. Shoji, R. Ishige, T. Higashihara, J. Watanabe, M. Ueda,
- 5) High performance volatile polymeric memory devices based on novel triphenylamine-based polyimides containing mono- or dual-mediated phenoxy linkages.
Macromolecules 43(3), 1236-1244 (2010)
T. Kurosawa, C-C. Chueh, C-L. Liu, T. Higashihara, M. Ueda, W-C. Chen.
- 6) Synthesis and characterization of highly refractive polyimides derived from thiophene-containing aromatic diamines and aromatic dianhydrides.
Macromolecules 43(4), 1836-1843 (2010).
N. Fukuzaki, T. Higashihara, S. Ando, M. Ueda.
- 7) Low-CTE photosensitive polyimide based on semialicyclic poly(amic acid) and photobase generator.
J. Polym. Sci. Part-A, Polym. Chem., 48, 1317-1323 (2010)
T. Ogura, T. Higashihara, M. Ueda
- 8) Facile access to internally functionalized dendrimers through efficient and orthogonal click reactions.
Chem. Comm. 46(9), 1556-1558 (2010).
T. Kang, R. Amir, A. Khan, K. Ohshimizu, J. Hunt, K. Sivanandan, M. Montanez, M. Malkoch, M. Ueda, C.J. Hawker.
- 9) Negative-working photosensitive poly(phenylene ether) based on poly(2,6-dimethyl-1,4-phenylene ether), a cross-linker, and a photoacid generator.
Macromolecules 43(6), 2832-2839 (2010).
K. Mizoguchi, T. Higashihara, M. Ueda
- 10) Optically transparent sulfur-containing semi-alicyclic polyimide with high refractive Index
Chem. Lett. 39, 392-393 (2010)
Y. Nakagawa, T. Ogura, T. Higashihara, M. Ueda
- 11) Highly refractive poly(phenylene thioether) containing triazine unit
Macromolecules 43(10), 4613-4615 (2010).
N-H. You, T. Higashihara, Y. Oishi, S. Ando, M. Ueda
- 12) Highly refractive polymer resin derived from sulfur-containing aromatic acrylate.

- J. Polym. Sci. Part-A, Polym. Chem.*, 48(12), 2604-2609 (2010),
N-H. You, T. Higashihara, S. Ando, M. Ueda
- 13) Highly sulfonated multiblock copoly(ether sulfone)s for fuel cell membranes
J. Polym. Sci. Part-A, Polym. Chem., 48(12), 2757-2764 (2010),
K. Nakabayashi, T. Higashihara, M. Ueda
- 14) Preparation of nanoporous poly(3-hexylthiophene) films based on a template system of block copolymers via ionic interaction.
Macromolecules, 43(11), 4843-4852 (2010).
A. Takahashi, Y. Rho, T. Higashihara, B. Ahn, M. Ree, M. Ueda
- 15) Synthesis of sulfur-containing poly(thioester)s with high refractive indices and high Abbe numbers
Polym. Chem., 1, 480-484 (2010)
N-H. You, T. Higashihara, Y. Suzuki, S. Ando, M. Ueda
- 16) Polymer electrolyte membranes based on cross-linked highly sulfonated multiblock copoly(ether sulfone)s.
Macromolecules, 43, 5756-5761 (2010)
K. Nakabayashi, T. Higashihara, M. Ueda
- 17) Enhancement of P3HT/PCBM photovoltaic efficiency using the surfactant of triblock copolymer containing poly(3-hexylthiophene) and poly(4-vinyltriphenylamine) Segments.
Macromolecules, 43(14), 6085-6091 (2010)
J-H. Tsai, Y-C. Lai, T. Higashihara, C-J. Lin, M. Ueda, W-C. Chen
- 18) Development of a chemically amplified photosensitive polyimide based on poly(amic acid), a dissolution Inhibitor, and a photoacid generator.
J. Photopolym. Sci. & Technol., 23, 483-488 (2010)
M. Sugiyama, T. Ogura, T. Higashihara, M. Ueda
- 19) Development of photosensitive poly(hydroxyimide) with high refractive index
J. Photopolym. Sci. & Technol., 23, 515-520 (2010)
T. Ogura, T. Higashihara, M. Ueda
- 20) Pattern formation of polyimide by using photosensitive polybenzoxazole as a top layer.
European Polymer Journal, 46(7), 1576-1581 (2010).
T. Ogura, T. Higashihara, M. Ueda
- 21) Molecular weight control of thermosetting poly(phenylene ether) copolymer produced by heterogeneous oxidative coupling polymerization
High Perform. Poly. 22, 458-467 (2010).
J. Nunoshige, H. Akahori, M. Ueda
- 22) A high performance polymer electrolyte membrane based on sulfonated poly(ether sulfone)

with binaphthyl units.

J.Mater. Chem. 20, 6662-6667 (2010).

T. Nakagawa, K. Nakabayashi, T. Higashihara, M. Ueda

- 23) Hyperbranched polymers with controlled degree of branching from 0 to 100%.

J. Am. Chem. Soc., 132, 11000-11001 (2010)

Y. Segawa, T. Higashihara, M. Ueda

- 24) Synthesis and liquid crystalline behavior of laterally substituted polyimides with siloxane linkages

Macromolecules, 43(21),8950-8956 (2010).

Y. Shoji, R. Ishige, T. Higashihara, S. Kawauchi, J. Watanabe, M. Ueda

3. **Invited presentation in International/domestic conference**

(3-1) International conference

- 1) AMPT 2010 Cheju, Korea, January 26, 2010

Development of Highly Refractive Polymers for CMOS Image Sensor and Optical Materials

M.UEDA

- 2) International Symposium on Polymer Chemistry, 蘇州, China, June-3, 2010

Optically transparent sulfur-containing polyimide-TiO₂ nanocomposite films with

High refractive index and negative pattern formation from poly(amic acid)-TiO₂ nanocomposite film

- 3) Tiwan-Japan Bilateral Polymer Symposium 7/1-3 2010 Sapporo

High Performance Polymer Electrolyte Membrane Based On Highly Sulfonated Poly(ether sulfone) with Binaphthyl Units

M.UEDA

- 4) Polycondensation 2010 9/5-8 Netherlands

Synthesis of hyperbranched polymers with controlled degree of branching

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- 5) The 9th China-Japan symposium of advance aromatic polymers in Suzhou,

Pattern formation of polyimide by using photosensitive polybenzoxazole as a top layer

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4. **Patent**

Total 7 (2009)