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## **1. Main Research Results**

### **Phase-segregated Nanostructured Polymer Template Film**

Several structural transcription and hybridization processes by using normally oriented hexagonal cylinder nanostructured thin films of amphiphilic liquid crystalline block copolymer have been demonstrated: (1) Total wet 16-nm-periodic nanopatterning on Si wafer substrate through block copolymer mask with ion transport channels, (2) single-atomically-deep nanohole array on atomically flat gold substrate, (3) silver nanoparticle array on flexible PET film, (4) mesoporous silica nanopillar array through block copolymer templating sol-gel reaction, (5) catalytic formation hydrogen peroxide by gold nanoparticles dispersed on silica nanopillar array, (6) conducting polymer nanowire array through electropolymerization using block copolymer template electrode and so on. Additionally, laboratory-GISAXS analysis on the microphase-separated nanostructure with layered structures of the liquid crystal domains was demonstrated.

## **2. List of publication (original article, comment/book)**

### **1) Original Paper**

- (1) R. Watanabe, K. Kamata, **T. Iyoda**; Smart block copolymer masks with molecule-transport channels for total wet nanopatterning: *J. Mater. Chem.*, **18**(45), 5482-5491 (2008).
- (2) R. Watanabe, K. Kamata, **T. Iyoda**; Nanodimple arrays fabricated on SiO<sub>2</sub> surfaces by wet etching through block copolymer thin films: *Jpn. J. Appl. Phys.*, **47**(6), 5039-5041 (2008).
- (3) A. Chen, M. Komura, K. Kamata, T. Iyoda; Highly ordered arrays of mesoporous silica nanorods with tunable aspect ratios from block copolymer thin films: *Adv. Mater.*, **20**(4), 763-767 (2008).
- (4) J. Li, Jingze, K. Kamata, **T. Iyoda**; Tailored Ag nanoparticle array fabricated by block copolymer photolithography: *Thin Solid Films*, **516**(9), 2577-2581 (2008).
- (5) S. Asaoka, N. Takeda, **T. Iyoda**, A. R. Cook, J. R. Miller; Electron and Hole Transport To Trap Groups at the Ends of Conjugated Polyfluorenes: *J. Amer. Chem. Soc.*, **130**(36), 11912-11920 (2008).
- (6) H. Oda, **T. Iyoda**, M. Nakagawa; Magnetic property and crystallinity of a Ni-P hollow microfiber affected by immersion in a NaOH aqueous solution: *Trans. Mater. Res. Soc. Jpn.*, **33**(1), 153-156 (2008).
- (7) J. Yoon, S. Y. Jung, B. Ahn, K. Heo, S. Jin, **T. Iyoda**, H. Yoshida, M. Ree; Order-Order and Order-Disorder Transitions in Thin Films of an Amphiphilic Liquid Crystalline Diblock Copolymer: *J. Phys. Chem. B*, **112**(29), 8486-8495 (2008),
- (8) A. Mori, J. Shikuma, M. Kinoshita, T. Ikeda, M. Misaki, Y. Ueda, M. Komura, S. Asaoka, **T. Iyoda**; Controlled homeotropic and homogeneous orientations for nanoscale phase-separated domain of light-emitting amphiphilic block copolymer bearing a 2,5-diarylthiazole moiety: *Chem. Let.*, **37**(3), 272-273 (2008).
- (9) I. R. Laskar, S. Watanabe, M. Hada, H. Yoshida, J. Li, **T. Iyoda**; Tuning surface interactions to

control shape and array behavior of diblock copolymer micelles on a silicon substrate: *Surf. Sci.*, **603**(4), 625-631 (2009).

(10) L. Song, **T. Iyoda**,; Supramolecular Framework Based on Pyridinodiketone Ligand via Non-classic Hydrogen Bonding: *J. Inorg. Organometal. Polym. Mater.*, **19**(1), 124-132 (2009).

(11) R. Watanabe, **T. Iyoda**, K. Ito; Nanostructured Titanium Oxide Fabricated via Block Copolymer Template: *Electrochemistry*, **77**(3), 214-218 (2009).

### 3. Invited/Plenary Talks in Conference

#### 1) International Conference or Workshop

(1) **T. Iyoda**, K. Ito; Block Copolymer Templating Processes for Highly Ordered Nanostructured Materials: IUMRS-ICA2008, symposium EE, December 12, 2008, Nagoya. (Plenary)

(2) **T. Iyoda**, K. Ito, and M. Komura; Roll-to-Roll Processable Nanocylinder Array Template Films of PEO- LC Block Copolymers: IUMRS-ICA2008, symposium Y, December 12, 2008, Nagoya. (Invited)

#### 2) Domestic Conferences

(1) **T. Iyoda**; Nanostructured Template Polymer Film with Microphase Separation: Mesoscale Chemistry in Kanto Regional Meeting of Chemical Society of Japan, Kiryu, September 19, 2008. (Invited)

(2) **T. Iyoda**; Nanostructured Template Polymer Film with Microphase Separation: The Society of Rubber Industry, Japan, Tokyo, September 12, 2008 (Invited)

(3) R. Watanabe, K. Ito, **T. Iyoda**; Block Copolymer Templating for Nanomaterials Engineering: The Society of Polymer Science of Japan, Research Group on Polymers for Microelectronics and Photonics, Tokyo, January 21, 2009. (Invited)

(4) **T. Iyoda**, K. Ito, M. Komura; Reliable Phase-separated Nanostructured Polymer Thin Films for Templating Engineering: The Society of Polymer Science of Japan, Polymer Frontier 21, Tokyo, February 21 (2009). (Invited)

### 4. Patent

1) Microphase-separated Films and their Fabrication Method; PCT/JP2008/066142

2) Fabrication Methods of Microstructured Materials and Microcoils; JP2008-067365

### 5. Others

#### 1) Award

(1) R. Watanabe, K. Ito, **T. Iyoda**; Most Impressive Presentation in 21st International Microprocesses and Nanotechnology Conference (MNC2008), October 29, 2008.: Total Wet Nanopatterning on SiO<sub>2</sub> and Au Surface via Self-assembling Block Copolymer Mask

## 2) International Collaborations

- (1) Dr. John R. Miller (Brookhaven National Laboratory, USA)

Charge transport along p-conjugated polyfluorene by pulse radiolytic technique was investigated.

An original paper on the collaborative work was published (S. Asaoka, N. Takeda, **T. Iyoda**, A. R. Cook, J. R. Miller, "Electron and Hole Transport To Trap Groups at the Ends of Conjugated Polyfluorenes", *J. Amer. Chem. Soc.*, **130**(36), 11912-11920 (2008)).

- (2) Prof. Jingze Li (University of Electronic Science and Technology of China, China)

Silver nanoparticle array was fabricated on a flexible plastic film through block copolymer

templating method was investigated. An original paper on the collaborative work was published (Jingze Li, Kaori Kamata, Tomokazu Iyoda, "Tailored Ag Nanoparticle Array fabricated by Block Copolymer Photolithography", *Thin Solid Films*, **516**(9), 2577-2581 (2008)).

## 3) Miscellaneous

- (1) International Symposium of Engineering Nano/Micro-Materials based on Self-assembling and Self-organization, **ISEM2008** in March 3-5, 2008 was held in Tokyo with 200 participants and its second symposium, **ISEM2008Returns** was held in December 8-10, 2008 with 120 participants.
- (2) The Third International Symposium on Integrated Macromolecular/Materials Engineering, **ISIMME2008** in Northwestern Polytechnics in Xi'an, China, was held with 180 participants including 43 Japanese scientists from 9 universities and institutes.

## 4) Others

Some researches are reported in Japanese press; such as,

- (1) "Periodic rearrangement of nano-dimples"; Nihon Keizai Shimbun, October 27, 2008
- (2) "Self-assembling processes as an ultimate energy-saving manufacturing technology"; Nikkei Sangyo Shimbun, November 13, 2008
- (3) "3D wiring in a single nanometer scale for high integration"; Nikkei Sangyo Shimbun, December 4, 2008