

**Junji Watanabe, Prof.**

**Department of Organic and Polymeric Materials**

## **1. Main Research Results**

Chiral smectic C ( $S_C^*$ ) in a main-chain type of polymer exhibits undulations on its glassy film surface; these undulations are produced by the helical assembly of polymer conforming to the helical field of chiral  $S_C^*$ . In this study, we have found a polarization modulation superimposed on the undulation from the combined observations of Kelvin force microscopy (KFM) and atomic force microscopy (AFM) images. This modulation is caused by the spontaneous polarization of each smectic layer; its direction is parallel to the layer and perpendicular to the tilt direction of molecules within a layer, and rotates around the helical axis. The polarization modulation length corresponds perfectly to the undulation length, i.e., helical pitch of chiral  $S_C^*$ . By clarifying the relative direction of the spontaneous polarization to the tilt direction of mesogens, we described how the polymers are accommodated to produce such a regular undulation and polarization modulation.

## **2. List of publication**

Original Papers

- 1) Spontaneous formation of Polar Liquid Crystal in lyotropic solution of helical polypeptide molecules  
Chu-Chun Yen, Yoshiaki Taguchi, Masatoshi Tokita, and Junji Watanabe  
Mol. Cryst. Liq. Cryst., 516, 91 – 98, (2010).
- 2) Unusual swelling of HPC with toluene, forming microspherical domain that causes beautiful coloration due to Christiansen scattering effect  
Susumu Edo, Kento Okoshi, Sungmin Kang, Masatoshi Tokita, Tatsuo Kaneko and Junji Watanabe  
Langmuir, 26, 1743–1746(2010)
- 3) Flexible, Transparent Nanocomposite Film with a Large Clay Component and Ordered Structure Obtained by a Simple Solution-Casting Method,  
K. Shikinaka, K. Aizawa, N. Fujimoto, Y. Osada, M. Tokita, J. Watanabe, K. Sigehara  
Langmuir, 26, 12493–12495(2010)
- 4) Thermotropic Liquid Crystalline Polyimides with Siloxane Linkages: Synthesis, Characterization, and Liquid Crystalline Behaviors  
Yu Shoji, Ryohei Ishige, Tomoya Higashihara, Junji Watanabe, and Mitsuru Ueda  
Macromolecules, 43, 805–810 (2010).
- 5) Impregnation of Ni-P Metal into Polymer Substrate via Catalyzation in  $Sc-CO_2$  and

Electroless Plating in Sc-CO<sub>2</sub> Emulsion

Byung-Hoon Woo, Masato Sone, Akinobu Shibata, Chiemi Ishiyama, Susumu Edo, Masatoshi Tokita, Junji Watanabe and Yakichi Higo,

Surface & Coatings Technology, 204, 1785-1792 (2010).

- 6) Unique Reflector due to Corrugated Multilayer Structure in Elytron of *Rhomborrhina unicolor*  
Susumu Edo, Kento Okoshi, Sungmin Kang, Masatoshi Tokita, and Junji Watanabe  
Jpn. J. Appl. Phys., 49, 047201-047205 (2010)
- 7) 全芳香族ポリエステルを超分子分極率  
川内 進・金子 将之・今瀬 達也・田口 吉昭・顔 竹君・姜 聲敏・戸木田 雅利・渡辺 順次  
高分子論文集、67、209-213(2010)
- 8) Formation of homochiral antiferroelectric ground state in asymmetric bent-shaped molecules  
Seng Kue Lee, Sungmin Kang, Masatoshi Tokita, and Junji Watanabe  
Liquid Crystal, 37, 593 (2010).
- 9) キラルバナナ分子がつくるキラル等方液体  
渡辺順次,  
Japanese Scientists in Science 2009, 40(2010)
- 10) Synthesis of liquid crystal molecules based on bisbiphenyl-diacetylene and their liquid crystallinity  
Makoto Uchimura, Sungmin Kang, Ryohei Ishige, Junji Watanabe and Gen-ichi Konishi  
Chem. Lett., 39, 513-515 (2010)
- 11) Anomalous Thermotropic Phase Behavior in Poly[*n*-decyl-(*RS*)-2-methylbutylsilane]s with narrow molecular weight distributions  
Kento Okoshi, Takahiro Hagihara, Michiya Fujiki, and Junji Watanabe  
Liquid Crystal, 37, 1183 (2010).
- 12) Electric-field-induced transition between ferro- and antiferroelectric ground states observed in the B7 phase of a bent-shaped molecule with alkylthio tails  
Seng Kue Lee, Xiaodong Li, Sungmin Kang, Masatoshi Tokita and Junji Watanabe  
J. Mater. Chem., 20, 3615-3618 (2010)
- 13) Spontaneous formation of polar liquid crystal in lyotropic solution of helical polypeptide molecules  
Chu-Chun Yen, Yoshiaki Taguchi, Masatoshi Tokita, and Junji Watanabe  
Mol. Cryst. Liq. Cryst., 516, 91 - 98, (2010).
- 14) Alternation of Thick and Thin Layers Observed in the Smectic Phase of Binary Mixtures of Rigid-Rod Helical Polysilanes with Different Molecular Lengths  
Kento Okoshi and Junji Watanabe  
Macromolecules, 43, 5177-5179 (2010).

- 15) Development of Laser Dyes to Realize Low Threshold in Dye-doped Cholesteric Liquid Crystal Lasers  
Makoto Uchimura, Yo Watanabe, Fumito Araoka, Junji Watanabe, Hideo Takezoe and Gen-ichi Konishi  
*Adv. Mater.*, 22, 4473–4478(2010)
- 16) Antiferroelectric switching between optically isotropic and birefringent B2 phases of bent-shaped molecules with high tilt angle of 45°  
Seng Kue Lee, Sungmin Kang, Masatoshi Tokita and Junji Watanabe  
*Jpn. J. Appl. Phys.*, 49, 080209–1–080209–3 (2010).
- 17) 主鎖型液晶高分子における高分子性と液晶性のインタープレーイ分子設計指針と液晶構造制御、渡辺順次、液晶—構造制御と機能化の最前線—、シーエムシー出版、(2010)
- 18) Control over internal structure of liquid crystal polymer nanofibers by electrospinning  
K. Nakashima, K. Tsuboi, H. Matsumoto, R. Ishige, M. Tokita, J. Watanabe, A. Tanioka  
*Macromol. Rapid Comm.*, 31, 1641 (2010)
- 19) Synthesis and Liquid Crystalline Behavior of Laterally-Substituted Polyimides with Siloxane Linkages  
Yu Shoji, Ryohei Ishige, Tomoya Higashihara, Junji Watanabe, and Mitsuru Ueda  
*Macromolecules*, 43, 8950 (2010)
- 20) Self-assembling Switchable Columnar phase in Achiral Bent-shaped Molecules with low Bent Angle and alkylthio tail  
Xiaodong Li, Sungmin Kang, Seng Kue Lee, Manabu Ito, Masatoshi Tokita and Junji Watanabe  
*Jpn. J. Appl. Phys.*, 49, 121701 (2010)
- 21) Regular undulation and polarization modulation observed on film surface of homogeneously aligned chiral  $S_C^*$  polymer  
Chunying Zhang, Ryo-hei Ishige, Ryou Yasumatsu, Sungmin Kang, Masatoshi Tokita and Junji Watanabe,  
*Soft Matter*, 7, 258–264 (2011).
- 22) フィルム表面の分極アンジュレーション構造—主鎖型高分子とキラル $S_C$ 液晶が奏でる魅惑の現象  
カン ソンミン、渡辺 順次、未来材料, 11, 10–17 (2011).
- 23) 末端が位置制御された棒状高分子のスメクチック液晶  
大越研人、渡辺順次、高分子、60、34–39(2011)
- 24) Cholesteric Induction Power Enhanced by Macrocyclization in Liquid Crystalline Dimer Having Chiral Spacer  
Manabu Itoh, Masatoshi Tokita\*, Hiromistu Hegi, Sungmin Kang, and Junji Watanabe  
*J. Mater. Chem.*, 21, 1697–1699(2011).

- 25) Two-Step Smectic CA LC Formation on Annealing Glassy Isotropic Liquid of Main-Chain Liquid Crystalline BB-5(1-Me) Polyester  
Ryohei Ishige, Masatoshi Tokita\*, Shin-ichiro Funaoka, Sungmin Kang, Junji Watanabe  
Macromol. Chem. Phys., 212, 48-54(2011)
- 26) Switchable columnar phase in bent-shaped molecules with low bent-angle naphthalene central core and alkylthio tail  
Sungmin Kang, Xiaodong Li, Masatoshi Tokita and Junji Watanabe  
Mol. Cryst. Liq. Cryst., in press.

### 3. Invited/Plenary Talks in Conference

International Conference or Workshop

- 1) Regular undulation morphology observed in fracture and film surfaces of glassy chiral SC\* solid  
Chun Ying Zhang, Susumu Edo, Ryouhei Ishige, Masatoshi Tokita and Junji Watanabe  
Proceeding in "SPIE", 25-28 January 2010, San Francisco (USA) (Invited lecture)
- 2) Switchable columnar phase composed of tube-like assembly of bent-shaped molecules with low bent-angle naphthalene central core and alkylthio tails  
Seng Kue Lee, Masatoshi Tokita and Junji Watanabe, 5th Japanese-Italian Workshop on Liquid Crystal (invited), July 6 - 9, 2010, Italy (Cetraro)