

**Junji Watanabe, Prof.**

**Department of Organic and Polymeric Materials**

### **1. Main research Results**

A variety of bent-core molecules exhibit smectic phases of planar fluid layers that are spontaneously both polar and chiral. We find that, due to intralayer structural mismatch, such layers are also only marginally stable against spontaneous saddle splay deformation, producing in many molecular systems a multilamellar sponge phase - a space-filling assembly of locally periodic fluid layers that on longer scales are driven into a disordered three dimensional interconnected labyrinth of nested tubes and saddles. Such structures are isotropic liquids exhibiting only short-ranged orientational and positional order, but, remarkably, are macroscopically spontaneously chiral even if made from achiral molecules, exhibiting conglomerate domains that have handedness as their only macroscopic broken symmetry.

### **2. List of publication**

Original Papers

- 1) Polarization splay as the origin of modulation in the B1 and B7 smectic phases of bent-core molecules  
D. A. Coleman, J. Watanabe, et al.,  
Phys. Rev. E77, 021703 (2008)
- 2) Alignment Structure Formed in Dimeric Liquid Crystal Molecules  
Hitoshi Sasaki; Masaya Furutani ; Atsushi Yoshizawa ; Teruki Niori ; Tatsuya Izumi ; Junji Watanabe ; Isa Nishiyama ; Hirokazu Furue  
Ferroelectrics, 365, 12-19 (2008)
- 3) Synthesis and Chemical Properties of Dielectric Polyphenylenes with Nitro Group.  
Masahiro Abe, Masatoshi Tokita, Junji Watanabe, Yoshimasa Sakai, Takakazu Yamamoto  
J. Appl. Polym. Sci., 111, 2426-2435 (2009).
- 4) Spontaneous deformation of main-chain liquid-crystalline elastomers composed of smectic polyesters  
K. Hiraoka, T. Tashiro, M. Tokita and J. Watanabe  
Liquid Crystals, 36,115 (2009).
- 5) Effect of Sulfur-containing Tail on Phase Behaviors of Bent-shaped Molecules

Based on Naphthalene Core

Xiaodong Li, Seng Kue Lee, Sungmin Kang, Masatoshi Tokita, Susumu Kawauchi,  
and Junji Watanabe

Chem. Lett. 38, 424-425 (2009)

- 6) Regular formation of chain folding in main-chain BB-3(2-Ph) polymer in smectic phase followed by columnar association of phenyl side group in propane spacer  
Ryohei Ishige, Yu Naito, Sungmin Kang, Masatoshi Tokita and Junji Watanabe  
Macromolecules, 2009, 42, 2557–2562.
- 7) Cyanobacterial Megamolecules Show Liquid Crystalline Phase in Very Dilute Solutions.  
Maiko K. Okajima, Daisaku Kaneko, Tetsu Mitsumata, Tatsuo Kaneko, Junji Watanabe  
Macromolecules, 42, 3057-3062 (2009).
- 8) Difference in steady shear flow viscosity between polar and non-polar nematic liquid crystals in aromatic polyesters derived from Vectra  
Yoshiaki Taguchi, Chu-Chun Yen, Sunming Kang, Masatoshi Tokita, and Junji Watanabe  
Macromolecules, 42, 3179-3185 (2009).
- 9) Solid-phase combinatorial synthesis of ester-type banana-shaped molecule by way of sequential palladium-catalyzed carbonylation  
Masahito Yoshida, Takayuki Doi, Sungmin Kang, Junji Watanabe and Takashi Takahashi  
Chem. Com., 2756-2758 (2009)
- 10) AFM Observation of Nano-Ordered Undulation Structure formed by Bent-shaped Molecules  
Susumu Edo, Sungmin Kang, Masatoshi Tokita and Junji Watanabe  
Jpn. J. Appl. Phys., 48, 030215 (2009)
- 11) Formation of banana phases in bent-shaped molecules with unusual bent angle as low as 60°  
Seng Kue Lee, Xiao Dong Li, Sungmin Kang, Masatoshi Tokita and Junji Watanabe  
J. Mater. Chem., 19, 4517-4522 (2009)
- 12) Synthesis of Thermotropic Liquid Crystalline Polyimides with Siloxane Linkages

Yu Shoji, Tomoya Higashihara, Junji Watanabe and Mituru Ueda  
Chem. Lett. 38, 716-717(2009)

- 13) Mesomorphic properties in Assymmetric Bent-shaped molecules with different linkage moieties as side wings  
Sungmin Kang, Seng-Kue Lee, Manabu Ito, Masatoshi Tokita, and Junji Watanabe  
Chem. Lett., 38, 852(2009)
- 14) Thermotropic Sponge Phases: Chiral isotropic liquids from achiral molecules  
L.E. Hough, J. Watanabe, et al.  
Science, 325, 452 (2009).
- 15) 液晶場を利用したブロック共重合体の相分離ナノ構造制御、戸木田雅利、渡辺順次  
繊維学会誌、65、277 (2009)
- 16) 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., in press.
- 17) Structural characteristics of the B6 phase for a bent-core molecular system observed through the B1 – B6 transition  
S. Kang, S. K. Lee, M. Tokita, and J. Watanabe  
Phys. Rev. E 80, 042703-1-042703-4(2009)
- 18) Unusual transformation of uniaxial orientation state to the polydomain state in polar nematic liquid crystals of aromatic polyesters  
Yoshiaki Taguchi, Chu-Chun Yen, Sunming Kang, Masatoshi Tokita, and Junji Watanabe  
J. Phys. Chem. B, 113, 5341 (2009)
- 19) Extremely low threshold in a pyrene-doped distributed feedback cholesteric liquid crystal laser  
Yo Watanabe, Makoto Uchimura, Fumito Araoka, Gen-ichi Konishi, Junji Watanabe and HideoTakezoe  
Appl. Phys. Express, 2, 102501-102503 (2009)
- 20) Entropically Driven Smectic A and A2 Phases Occurring in Binary Mixtures of

Rigid-Rod Helical Polysilanes with Different Molecular Weights

Kento Okoshi, Akiko Suzuki, Masatoshi Tokita, Michiya Fujiki, and Junji Watanabe

Macromolecules, 42, 3443-3447 (2009).

- 21) Regular network pattern evolution observed in phase separation in low-molecular-weight LC and LC block copolymer mixture  
Osamu Sato, Satoshi Masuyama, Sungmin Kang, Masatoshi Tokita and Junji Watanabe  
Macromolecules, 42, 5442-5445 (2009)
- 22) どんどんつながる高分子、渡辺順次編、丸善 (2009)
- 23) Parallel-Layer Orientation and Its Instability in Side-Chain Polymer Smectic Liquid Crystals under Shear Flow  
Masatoshi Tokita, Go Sugiyama, Satoshi Masuyama, Toshinari Ishii, Sungmin Kang and Junji Watanabe  
Macromolecules, 42, 8406-8410(2009).
- 24) 自己組織化ハンドブック、渡辺順次 構造色フィルム, NTS, (2009)
- 25) Synthesis of Tripod-shaped liquid crystals with sp<sup>3</sup> Nitrogen at the apex  
H.C.Jung, S.K.Lee, G. Lee, H.J.Shin, S.J.Park, J.G.Lee, J. Watanabe, H.Takezoe, K-T Kang  
Bull. Korean Chem. Soc. 30, 1946-1950 (2009)
- 26) 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)
- 27) Formation of homochiral antiferroelectric ground state in asymmetric bent-shaped molecules  
Seng Kue Lee, Sungmin Kang, Masatoshi Tokita, and Junji Watanabe  
Liquid Crystal, in press.
- 28) Synthesis of macrocyclized dimetric compounds and their liquid crystal transition

behaviors

Manabu Itoh, Masatoshi Tokita, Kaoru Adachi, Teruaki Hayakawa, Sungmin Kang, Yasuyuki Tezuka, and Junji Watanabe

Liquid Crystal, in press.

- 29) 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, in press.

- 30) Impregnation of Ni-P Metal into Polymer Substrate via Catalyzation in Sc-CO<sub>2</sub> 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, 2009, in press

- 31) Unique Reflector due to Corrugated Multilayer Structure in Elytron of *Rhomborrhina unicolor*

Susumu Edo, Sungmin Kang, Kento Okoshi, Masatoshi Tokita, and Junji Watanabe  
Jpn. J. Appl. Phys., in press

- 32) 全芳香族ポリエステル超分子分極率

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、印刷

### 3. Invited/Plenary Talks in Conference

International Conference or Workshop

- 1) Polar nematic phase in lyotropic solutions of poly( $\gamma$ -benzyl glutamate) and its temperature instability as detected by SHG measurement (invite lecture)

Chu-Chun Yen\*, Yoshiaki Taguchi, Masatoshi Tokita, & Junji Watanabe

In "The Taiwan-Japan Bilateral Polymer Symposium", April 23-24, 2009, Taipei, Taiwan.

- 2) Twofold helical inversion in the chiral SmC phase of optically active materials derived from (R)-(+)-1-(1-phenyl)ethylamine

Masakane Muto, Hideyuki Suzuki, Kaoru Fukuda, Seng Kue Lee, Sungmin Kang, Masatoshi Tokita, and Junji Watanabe (plenary lecture)

In Chirality, July 12-15, 2009, Colorado Denver, USA.

- 3) Temperature-induced reversible distortion along the director observed for monodomain nematic elastomer of cross-linked main-chain polyester (invited lecture)

Junji Watanabe, Proceeding for the international symposium on “Baekeland 2009 2<sup>nd</sup> International Symposium on Thermosets”, Antalya, Turkey, November 24-26, 2009.

- 4) 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 (Invited lecture)

Proceeding in “SPIE”, 25-28 January 2010, San Francisco (USA)

#### **4. Award**

nothing