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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) 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.
- 16) 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)
- 17) 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)
- 18) 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)
- 19) 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).

- 20) 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)
- 21) 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).
- 22) Synthesis of Tripod-shaped liquid crystals with sp³ 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)
- 23) 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)
- 24) 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.
- 25) 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.
- 26) 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.

- 27) Impregnation of Ni-P Metal into Polymer Substrate via Catalyzation in Sc-CO₂ and Electroless Plating in Sc-CO₂ 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
- 28) 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

3. Invited/Plenary Talks in Conference

- 1) Polar nematic phase in lyotropic solutions of poly(γ -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 2nd 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)