Mesophase of the third type of hockey-stick molecules: To be polar, or not to be polar, that is the question

E-Joon Choi,[a]* Kwang-Un Jeong,[b] and Jae-Hoon Kim[c]

[a]*Dept. of Polymer Sci. & Eng., Kumoh National Inst. of Tech., Gumi Gyeongbuk, Korea*
[b]*Dept. of Polymer-Nano Sci. and Tech., Chonbuk National Univ., Jeonju, Korea*
[c]*Dept. of Electronics and Communications Eng., Hanyang Univ., Seoul, Korea*

[Contact E-mail: ejchoi@kumoh.ac.kr]

Since Prof. Samulski's group reported 'real' hockey-stick-shaped molecules (HSMs) based on *p*-quinquephenyl, during the last two decades, there has been a substantial evolution in the molecular geometry of HSMs. At first glance, all HSMs may look like practical intermediate structure between those of rod-like (RLMs) and bent-core molecules (BCMs). However, in terms of molecular geometry, HSMs can be classified into three categories. In the first type, a rod-like mesogen possesses two flexible terminal chains which are connected to the para and meta position of terminal rings, respectively (Fig. 1c: HSM 1). In the second type, the asymmetric bent-core mesogen consists of two arms with roughly different numbers of aromatic rings and the short arm has a long enough chain (Fig. 1b: HSM 2). In the third type, the bent-core mesogen consists of two arms with significantly different numbers of aromatic rings and the short arm has no terminal chains (Fig. 1d: HSM 3).

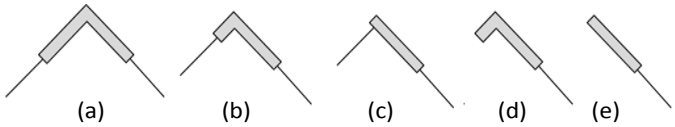

Fig. 1. Evolution between rod-like and bent-core LC molecules (gray block = mesogenic unit; black line = flexible terminal): (a) bent-core molecule; (b-d) hockey-stick-shaped molecules; (e) rod-like molecule.

Mostly two arms of the reported HSMs are long enough to pack in a bent direction. Obviously, it is known that a long enough aliphatic arm can help to make such packing. In this case, the polar smectic phase can be derived in similar manner to bent-core liquid crystals (BCLCs). On the other hand, in the case of the third type of HSM reported herein, the aspect ratio of one arm is too short to act as a mesogen, regardless of the substituent type, and there is no sufficiently long aliphatic chain arm to enable packing of a BCLC. Therefore, it is very interesting whether the HSM 3 can be packed along the tip-direction like a conventional BCLC. In the case of the structure shown in the recent article there is no flexible chain on the long arm side of the mesogen. However, since a flexible chain exists in the short arm side, the molecule can persist a V-shape as a whole, and thus, the packing effect will be similar to that of the conventional BCLC. Recently, we reported the synthesis and mesogenic property of the third type of HSMs in which the central core is *m*-phenylene. However, these molecules show no polar smectic phases even though they formed a bilayer molecular orientation. Therefore, we can claimed that the third type of HSMs cannot be packed in the same manner with a conventional BCLC. In this study, we have synthesized new HSMs with a naphthalene core. We finally found a polar smectic phase. Based on these findings, we have suggested that the polar smectic phase herein can be derived by a chevron structure rather than bookshelf one. In conclusion, the third type of HSM can be considered a new type of HSM, because it no longer reveals the same packing with the BCLC, and instead it can build a chevron structure to show a mesomorphism between rod and bent mesogenic molecules.

References

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Brief Biography

E-Joon Choi is a Full Professor of Kumoh National Institute of Technology (KIT), Korea. He received his B.S. and Ph.D. degrees in Chemistry from Korea University. In 1988-1989, he was a Postdoctoral Research Associate, at Department of Macromolecular Science and Engineering in Case Western Reserve University, USA. After that he has been working for KIT for 30 years. In 1993-1994, he was a Research Officer at Department of Chemistry in the University of Queensland, Australia. In 2001 Summer He was invited by Prof. Chien to work with him at Liquid Crystal Institute in Kent State University. In 2003-2004, he was a Visiting Scholar at Department of Chemistry in the University of North Carolina, USA. He was former President of Korea Liquid Crystal Society and Co-chair of ACLC2016. He is Vice President of the Polymer Society of Korea. He has published about 90 refereed papers and issued dozens of patents. Recently, he joined Editorial Board of Liquid Crystals. His major research interest is the design and synthesis of novel organic and polymeric materials for the advanced application in the field of information and display science and technology.