

# Formation of complex LC phases by catechol based bolapolyphiles

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T-shaped and X-shaped bolapolyphiles are able to form a wide variety of new LC phases, among them various liquid crystalline honeycomb structures with prismatic cells of different shapes ranging from triangular to hexagonal and beyond [1,2]. Recent simulations show that T-shaped bolapolyphiles with a swallow-tail lateral chain can form different cubic phases [3], in agreement with previous experimental evidences[4,5].

Herein we report a new type of catechol based  $\pi$ -shaped polyphilic molecules with two linear alkyl or semiperfluorinated chains which are located at the central benzene ring of the  $p$ -terphenyl based rigid core (Figure 1). The compounds were synthesized, their mesophase behaviour fully characterised by XRD, DSC and polarizing microscopy (POM) and the phase sequences compared with related compound with a single swallow tailed lateral substituent. Depending on the chain length and side chain structure, a series of very different and highly complex LC phases was observed. Besides the polygonal honeycomb phases, either with square, hexagonal or rectangular lattice, two different types of cubic phases, and also correlated lamellar phases were found. The rectangular columnar phase represents a honeycomb composed of octagonal and pentagonal prismatic cells in a ratio 1:2, leading to a tiling pattern resembling that of BIK type zeolites [2]. With longer chains two cubic phases, formed by longitudinal rod-bundles, one with  $la3^-d$  lattice (double gyroid) [4], and the other with  $Fd3^-m$  lattice were found. The latter is a single diamond phase adding to the previously reported double diamond phase ( $Pn3m$ ) [5]. The lamellar phases occurring besides these new types of *tricontinuous* cubic phases represent layers with the rod-like unit arranged parallel to the layer planes. Thus the overall phase sequence on increasing the lateral chain volume is from polygonal honeycombs via longitudinal rod-bundle networks to longitudinal rod-layers. The correlation between adjacent rod-layers leads to the observed  $p2mm$  symmetry of the correlated lamellar phases for compounds with alkyl chains and  $c2mm$  symmetry for compounds with semiperfluorinated chains.

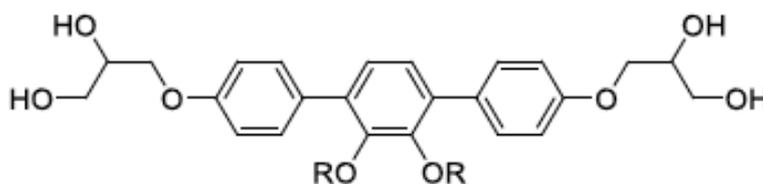


Figure 1: Structure of discussed catechol based bolapolyphiles ( $R = C_nH_{2n+1}$  or  $(CH_2)_nC_mF_{2m+1}$ ).

## References

- [1] C. Tschierske, *Angew. Chem.* **125**, 8992 (2013).
- [2] S. Poppe, A. Lehmann, A. Scholte, M. Prehm, X. Zeng, G. Ungar, C. Tschierske, *Nature Commun.* **6**, 8637 (2015).
- [3] Y. Sun, P. Padmanabhan, M. Misra, F. A. Escobedo, *Soft Matter* **13**, 8542 – 8555 (2017).
- [4] F. Liu, M. Prehm, X. Zeng, C. Tschierske, G. Ungar, *J. Am. Chem. Soc.* **136**, 6846-6849 (2014).
- [5] X. Zeng, M. Prehm, G. Ungar, C. Tschierske, F. Liu, *Angew.Chem. Int. Ed.* **55**, 8324– 8327 (2016).

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