

## Non-symmetric banana-shaped liquid crystals with two different terminal alkoxy tails

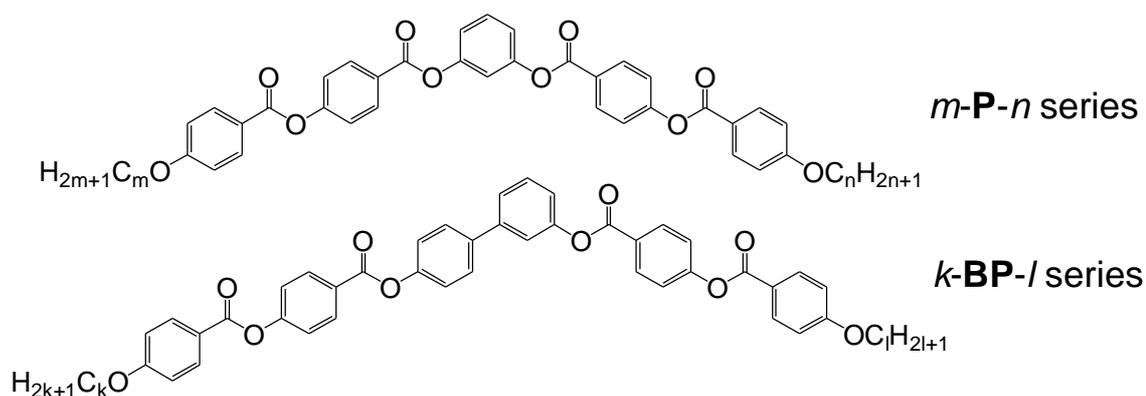
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### Introduction

Of all banana-phases known the most interesting is the B<sub>2</sub> phase in which the bent molecules are closely packed in layers. The molecules are tilted with respect to the layer normal. Current response measurements of the compounds which exhibit the B<sub>2</sub> phase gave evidence that the ground state is antiferroelectric (SmCP<sub>A</sub>) [1].

In the last seven years numerous series of banana-shaped compounds have been synthesized and investigated. To study the influence of structure variations on the mesomorphic properties and the transition temperatures different parts of the bent-core molecules have been varied; the nature and position of (polar) substituents [2], the nature and direction of the linking groups between the aromatic rings [3], and the length of the terminal alkyl tails [4]. Non-symmetric compounds with different linking groups in each wing of the molecules [5], or non-symmetrically substituted central groups (3,4' substituted biphenyl) [6] have also been studied extensively. Here we present two series of banana-shaped compounds in which the lack of symmetry was derived solely from the difference in length of the two terminal alkoxy chains (**P-series**) or from the 3,4' substituted biphenyl central group and the difference in length of the two terminal alkoxy chains (**BP-series**)



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## Results

The mesomorphic properties of the non-symmetric compounds in the  $m$ -**P**- $n$  series are represented schematically in figure 1. The transition temperatures of three symmetric compounds of the  $m$ -**P**- $n$  series ( $m = n$ ) are also presented in this figure. The properties of the symmetric compounds with  $m = n = 1 - 18$  were recently published [7].

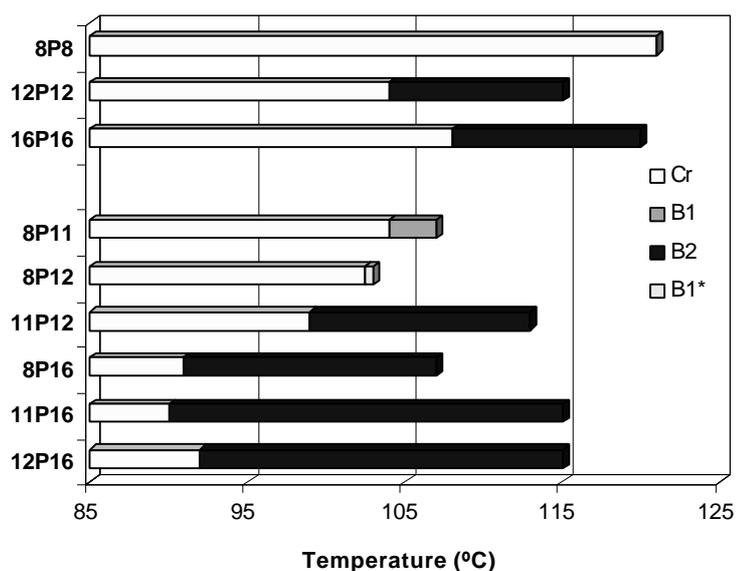


Figure 1. Mesomorphic properties of the compounds in series  $m$ -**P**- $n$ .

Two of the synthesized non-symmetric compounds, **8-P-11** and **8-P-12**, exhibit the columnar  $B_1$  phase. This mesophase is also observed for the symmetrical compound **8-P-8**. The transition temperatures have decreased, but the liquid crystalline range is still very small. All other non-symmetric compounds exhibit the  $B_2$  phase. Figure 2 shows the electric response of compound **12-P-16** under a triangular wave voltage.

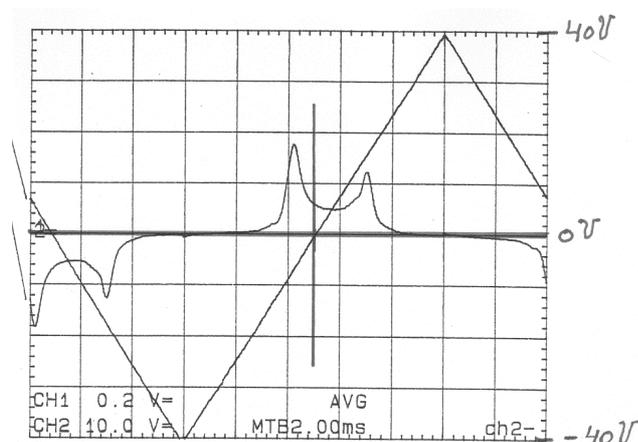


Figure 2. Switching current response obtained in the  $B_2$  mesophase of **12-P-16**.

Two peaks were recorded during a half period indicating antiferroelectric switching behaviour. The spontaneous polarization determined by integration of the switching current peaks was 870 nC / cm. The switching behaviour is unchanged when compared to the symmetric compounds. Melting points are lowered most efficiently if the difference in number of C-atoms in the terminal tails is  $\sim 5$ . The lowering of the melting points in this series of compounds can be  $\sim 20^\circ\text{C}$  with retention of the desired  $B_2$  phase.

To further investigate the influence of two different terminal tails we have synthesized a second series of compounds in which the central phenyl group of the  $m\text{-P-}n$  series is replaced by a biphenyl group. The mesomorphic properties of the non-symmetric compounds in the  $k\text{-BP-}l$  series are represented schematically in figure 3. The transition temperatures of three compounds with the same tail lengths ( $k = l$ ) of the **BP**-series are also presented in this figure. The symmetric compounds with  $m = n = 8 - 14$  are known from literature [6]. As predicted by Shen et al. [6] the transition from the  $B_1$  phase to the  $B_2$  phase occurs in the **P**-series at **9-P-9** to **10-P-10** [7] and in the **BP**-series at **11-BP-11** to **12-BP-12** [6] due to the enlargement of the rigid core.

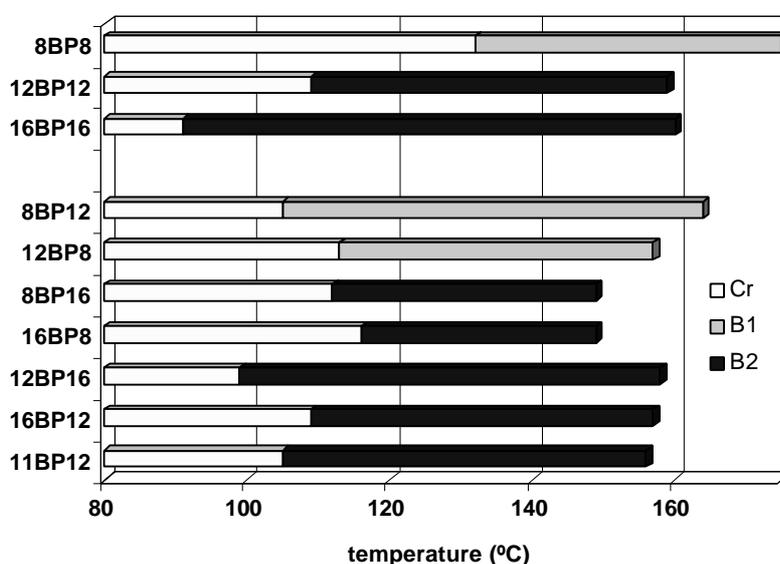


Figure 3. Mesomorphic properties of the compounds in series  $k\text{-BP-}l$ .

All three pairs of non-symmetric compounds (**8-BP-12** and **12-BP-8**; **8-BP-16** and **16-BP-8**; **12-BP-16** and **16-BP-12**) of the  $k\text{-BP-}l$  series show the same unexpected trend. The compounds with the shortest chain attached to the para-position of the biphenyl group have the lower melting points. In contrast to the **P**-series, the melting points of the non-symmetric compounds in the **BP**-series have not lowered when compared to the symmetric compounds. Apparently it is not possible to lower melting points in this series of compounds if the terminal tails differ four

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or more C-atoms. To investigate whether a smaller difference in length of terminal tails will result in a lower melting point we have also synthesized compound **11-BP-12**. The isotropization temperature of **11-BP-12** is almost unchanged when compared to **12-BP-12**.

Both compounds exhibit the B<sub>2</sub> mesophase. The melting point is slightly lowered which supports our theory that for the compounds in series **k-BP-l** only a small difference in number of C-atoms in the terminal tails is needed to lower the melting point. In all cases the long-tailed compounds retained the desired switchable B<sub>2</sub> phase.

## Conclusions

This study has shown that introduction of two different terminal alkyl chains can lower the melting points of banana-shaped compounds exhibiting the switchable B<sub>2</sub> phase. This method seems only effective however when the central part of the molecule is itself symmetric.

Surprisingly, the non-symmetrical compounds in the **k-BP-l** series with  $k < l$  (shortest terminal tail attached to the para-position of the central biphenyl group) give the lowest melting points.

Disappearance of the switchable B<sub>2</sub> phase by introducing two different terminal tails could in all cases be avoided.

## References

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