Novel columnar-calamitic phase sequences in a binary system of bent-core and rod-like mesogens

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We describe here X-ray, electrical switching and dielectric measurements on a binary system comprising achiral bent core and chiral rod-like components \cite{1}. While the pure bent core compound exhibits a single mesophase, namely, the B2 phase, the rod-like compound shows smectic A and smectic C\textsuperscript{*} mesophases. A particular mixture, studied in detail, presents a novel sequence of three columnar type B1 phases, smectic A $\rightarrow$ B1\textsubscript{OPAF1} $\rightarrow$ B1\textsubscript{OPAF2} $\rightarrow$ B1\textsubscript{TPAF} $\rightarrow$ smectic C\textsuperscript{*} phase, as the sample is cooled, where the subscripts O, T, P, F and AF indicating, respectively, orthogonal, tilted, polar, ferroelectric and antiferroelectric property, with the B1 phases being of the B1\textsubscript{rev} type (Figure below shows the XRD pattern obtained in each of these phases). In the electrical switching measurements a twin peak profile -- characteristic of the antiferroelectric structure -- is seen for the B1\textsubscript{OPAF} phases, but with no textural change, except on a transient scale. On the other hand the B1\textsubscript{TPAF} phase which also shows an antiferroelectric-type switching, exhibits clear changes between the field-off and field-on states, as well as for the two signs of the field. This phase also possesses a three-time higher value of polarization than the smectic C\textsuperscript{*} phase indicating the stronger influence of the polar ordering. Dielectric studies show the presence of a soft mode relaxation in the vicinity of the B1\textsubscript{OPAF2}$\rightarrow$B1\textsubscript{TPAF} transition with the relaxation frequency of the mode exhibiting a behavior similar to that seen for the smectic A-smectic C\textsuperscript{*} phase transition. Mean field coefficients determining the soft mode behavior as well as the thermal variation of the tilt angle have been determined.