the literature. The last chapter, Chapter 9, reports a sequence of cases studied by the authors concerning the dynamics of liquid crystalline dendrimers. The first case is about end-on organosiloxane tetrapodes with strong terminal dipoles showing smectic A and smectic C phases. $^1$H NMR relaxometry resulted to be very useful to study the layer undulation motion, while in the case of organosiloxane octopodes with lateral mesogens, this technique allowed a good characterisation of re-orientational motions and columnar deformations. The chapter ends with the case of several polyamidoamine liquid crystalline dendrimers. A quite complete bibliography concludes the book.

*NMR of Liquid Crystal Dendrimers* is a well-written book. The scheme of the chapter is clear, and repetition of concepts is carefully avoided. Figures are almost all in black and white; probably the presence of colours would have increased the quality of the book. The book provides a very good overview of the field of liquid crystalline dendrimers studied by NMR and it can be of interest for researchers and graduate students aiming to deepen both experimental and theoretical aspects of NMR spectroscopy applied to the investigation of the fascinating liquid crystalline dendrimers.

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**Bent-shaped liquid crystals: structures and physical properties**, by H. Takezoe and A. Eremin, Boca Raton, CRC Press, 2017, 267 pp., £170 ($220, 170 Euro) (hardcover) ISBN-13: 9781482247596

For roughly two decades, we have now had some new additions to the zoo of liquid crystal phases, bent-core liquid crystals, which for individual phases that are distinctly different from calamitic and discotic ones. These have raised much attention due to the observation of chiral effects like helical superstructures, ferroelectricity or antiferroelectricity from achiral mesogens.

Now that the field has somewhat matured, the first comprehensive monograph was published by CRC Press of the Taylor & Francis Group, after only a few journal review articles had appeared in literature before. The publication is thus timely and very much needed in the field of liquid crystals, since bent-core liquid crystals are still a major aspect of research in the field. On somewhat more than 260 pages and in nine chapters, Hideo Takezoe and Alexey Eremin, both leading experts in the field, summarise the current state of knowledge of these interesting materials. As written in the subtitle of the book, a special emphasis is placed on the structures of phases and their physical properties, rather than materials and their synthesis.

As usual, the monograph proceeds in Chapter 1 with a very brief introduction into liquid crystals and the mesogenic state of matter before it provides a historical outline of the factors leading to the discovery of polarity and chirality of bent-core phases. Personally, I like these historical comments, because they put a research topic into the perspective of the whole field. Who would have thought that Daniel Vorländer was the first to synthesis bent-core mesogens in 1929, when those materials only gained real interest from about 1996 onwards? With Chapter 2 we jump straight into the theoretical descriptions of bent-core phases, summarising the work of Brand, Cladis, Lubensky, Bisi, Lorman and others who proposed a phenomenological approach. Molecular approaches, mainly going back to the work of Osipov, and computer simulations (Boulder group), are further introduced and discussed.

By far the longest chapter of the book, Chapter 3, is not surprisingly devoted to the structures of different bent-
core phases. Here, the authors have done a very good job in accumulating all reports on different phases and behaviour observed. The different peculiarities of the fluid smectics are discussed, random phases with a large susceptibility towards induced tilt are introduced and orthogonal polar and tilted phases described. The structures are well illustrated by schematic figures, and some exemplary experimental textures and data displayed, showing ferroelectric and antiferroelectric behaviour. Different frustrated states are pointed out, such as the polarisation-modulated phases, the helical nanofilament phase and the dark conglomerate phase. At last, the columnar phase is introduced, before moving on into the somewhat exotic regions of more complicated molecules, such as dimers, trimers, oligomers, polymers, dendrimers and other unconventional bent-core molecular structures like hockey-stick shapes. With about 200 references, this chapter can well serve as an exhaustive summary of the structures of bent-core phases.

In Chapter 4 the nematic phase of bent-core molecules is singled out and discussed in more detail. At first glance it appears that the nematic phase of bent-core molecules is equivalent to the calamitic counterpart in such aspects as flexoelectricity or electro-convection, albeit more pronounced and with much larger values. On a closer look, subtle differences can be observed. Convection patterns are richer with respect to field amplitude and frequency, the occurrence of Blue Phases can be observed, the elastic properties are different and there are indications for biaxiality in the thermotropic nematic phase. Also, a new phase appears, the so-called twist-bend nematic phase, $N_{TB}$ which has a twist pitch of only a few molecular lengths. The properties of this phase are discussed in detail, as far as they have been revealed to date.

Chapter 5 is one of the more general treatments of bent-core phases, here, with respect to chirality. The origin of chirality from achiral molecules is discussed, as is the enhancement of chiral host phases through doping with achiral bent-core molecules. Spontaneous symmetry breaking, chiral domain formation and the control of chirality are introduced.

In the remaining chapters, more specialised aspects are discussed with respect to bent-core liquid crystals. Chapter 6 provides a summary of the non-linear optical properties of bent-core mesogens. Chapter 7 treats bent-core phases in restricted geometries, such as freely suspended films, fibres and filaments and topographic confinement. The effects of mixing bent-core mesogens with other materials are discussed in Chapter 8. The first aspect that comes to mind would in fact be the mixing with common calamitic mesogens. This leads to rather complex phase diagrams, two-phase regions or the calamitic nematic acting as a ‘softener’ or solvent, being incorporated into the existing structures, for example in the process of swelling helical nanofilament phases. For the latter, of course also standard, isotropic organic solvents can be used. An interesting aspect is the addition of nanosized particles to bent-core phases. At last, Chapter 9 introduces possible applications of bent-core mesogens and phases. First attempts to build displays on the basis of bent-core phases were made, but also non-display applications lie at hand, such as pyroelectric and piezoelectric devices, or second harmonic generation.

In scope and presentation, the current text is a timely and comprehensive addition to the ever growing ‘liquid crystal library’. Bent-Shaped Liquid Crystals was one of the books that was still missing, while the field has matured enough to go beyond a simple review article. The two authors have put in considerable effort to collect detailed material to cover the whole of the field, which is also reflected by the numerous references provided. In conclusion, this book can be warmly recommended to anyone who is involved in the field of bent-core phases, or who wants to get a first overview of this aspect of liquid crystal research. I certainly enjoyed reading through the text, which is also illustrated with a lot of very good and informative schematic figures (unfortunately collected in colour only in a middle section, not where they were discussed in the text), and it will be a very helpful reading and an excellent reference work for some of my future research.

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