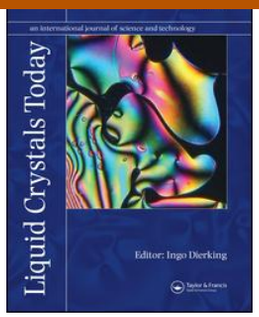

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Polymer modified liquid crystals

edited by Ingo Dierking, London, W1J 0BA, UK, published by the Royal Society of Chemistry, Burlington House, Piccadilly, 2019, £159 (Hardbound), 180 (Euro), $200, ISNN: 2048-7681

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BOOK REVIEW

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Liquid crystals when combined with other soft matter systems such as polymers, provide materials with unique properties. Both polymer stabilised liquid crystals (PSLCs) and polymer dispersed liquid crystals (PDLCs) have been active areas of research for more than three decades. The subject of polymer stabilisation is well known for its benefits in extending the phase temperature range of liquid crystal phases, such as blue phases. The polymer dispersed liquid crystals are known through their application in privacy windows, which are employed in office spaces and private houses. There are a couple of specialised books available on the topic of PSLCs, which usually focus on a specific mesophase of interest, the influence of polymer stabilisation and their applications. There are also detailed books separately written for PDLCs and their applications. The book *polymer modified liquid crystals* edited by Ingo Dierking combines both polymer stabilised and polymer dispersed liquid crystal topics, denoted as 'polymer modified liquid crystals'.

The book by Dierking combines fundamental physics, theoretical considerations, device design and fabrication with present and future prospects of applications of both PSLCs and PDLCs, in a single text. The book is written in a style, which would particularly appeal to non-experts in liquid crystals and for postgraduates pursuing studies in soft matter. The editor, Ingo Dierking, has worked in the field of polymer modified liquid crystals for two decades and is well known for his studies on understanding the fundamental physics of polymer modified materials and also their combination with nano- and micro-particles, the relationship between polymerisation conditions, polymer network morphology, interfacial interaction between liquid crystal and polymer network and the electro-optic properties of these materials.

The book is a part of the Soft Matter series of the Royal Society of Chemistry. It is organised into 16 chapters. The book starts with an introduction to the subject of liquid crystals and polymer modified liquid crystals. In fact, the two topics PDLCs and PSLCs form the two ends of the same 'liquid crystal + polymer' phase diagram and an in-depth understanding of the phase diagram itself is very intriguing. The richness of the polymer modified liquid crystals is highlighted by Soule et al., in chapter 2, page 20. They quote 'the phase diagram (referring to the phase diagram of the polymer modified liquid crystals) may include multiple phases, and phase transition dynamics involves the evolution of conserved and non-conserved order parameters. Each order parameter can undergo a phase transition following different dynamic laws and with different kinetic coefficients and they may evolve through different mechanisms; but on the other hand they are coupled and they cannot be analysed independently. This complex behaviour leads to complex morphologies … ' Bouchakour et al., in Chapter 4 further explains the intricacy and beauty of polymer modified materials. They provide a comparative study of phase diagrams, kinetics of polymerisation, crosslinking and phase separation, morphologies and electro-optical responses, for a rapid photo-polymerisation process and a rapid curing by electron beam irradiation. There are several ways by which the process of polymerisation is carried out in polymer modified liquid crystals. The book focuses on three most commonly used methods: photo-curing, electron beam curing and electro-polymerisation. A detailed review of these topics is covered under chapter 3, 4 and 10.

Comprehensive descriptions of PDLCs and PSLCs are separately provided in chapter 5 and 6, respectively. There are several chapters on how polymers could be utilised to stabilise various mesophases and each of the mesophases including, nematic, chiral nematic, ferroelectric liquid crystal and antiferroelectric liquid crystals, blue phases and frustrated phases, are covered in separate chapters. The book also covers topics such as stabilisation of discotic liquid crystals and some recent research on liquid crystal nanoparticle composites. It is fascinating to see how the same polymers affect different mesophases. Dierking points this out in Chapter 12, page 290 and says '… polymer stabilisation in the twist grain boundary state of a liquid crystal produces a discretely helical polymer network structure in contrast to a continuously helical structure formed in the cholesteric phase. In terms of the stabilising effect of the polymer network, TGB networks are similar to those of cholesteric phases'.

There are dedicated sections in a couple of chapters, which cover the applications of polymer modified liquid crystals. Particularly, the applications in gratings and smart windows (chapter 1 and 5), fringe-free switching, micro-lenses (chapter 7), switchable mirrors (chapter 8), displays for wide viewing angle (chapter 9), memory devices (chapter 11), are discussed. In addition to practical applications, the chapters also discuss the challenges and complexities of fabrication and the importance of fundamental material properties. For example, Morris in chapter 7, page 133 says 'while most reports refer either indirectly or demonstrate directly that the network (referring to the network in PSLCs) consists overwhelmingly of a mesh of polymer fibrils, the precise morphology and architecture of the polymer network does, unsurprisingly, depend upon a number of factors including the chemical structure of the monomers the polymerisation conditions; the process by which order is imparted onto the polymer network by the nematic LC; and the anisotropic diffusion process that arises

during cross-linking, which can occur at different rates depending upon the nature of the monomers and the conditions under which the network has been formed.'

The book has beautiful and relevant diagrams, photographs and graphical representations. The subject is covered in an informal simple and discussion style, which makes it easy to follow even if the reader is a non-specialist. Each chapter is self-contained but also makes a continuation to the story told before. The chapters are reasonably well referenced. As someone who started working in the field of polymer modified liquid crystals, just a couple of years ago, I found the book extremely relevant. The scope of polymer modified liquid crystals is vast and there are several new directions that are emerging. For example, polymers to create liquid crystal templates and micro-patterning. The book briefly touches upon these areas.

In conclusion, the book *Polymer-modified Liquid Crystals* covers a wide variety of concepts in the subject area from fundamentals to exciting cutting edge research to the current state of art to future potential applications. It was a great joy to read this book and I definitely recommend it to all my post-graduates. It is also a valuable addition to the groups pursuing active liquid crystal research.

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