Liquid-crystal nanomaterials: tribology and applications, by Sergey F. Ermakov, Nikolai K. Myshkin, Cham, Springer, 2018, 215 pp., £140,- ($170,- or 160,- Euro), (Hardback), ISBN 978-3-319-74768-2, also available as paperback for £130,- and in the Kindle Edition for £66.

The main topic of this monograph is largely summarised by its subtitle. It discusses from both a theoretical, but much more so an experimental point of view the lubrication properties, friction and rheology of liquid crystal based systems and their applications from engineering to medicine. The book was published as part of the Springer Series in Materials Science (Vol 267) and is divided into five chapters.

As common, chapter 1 provides the reader with an introduction to the liquid crystalline state of matter, distinguishing thermotropic and lyotropic systems, and generally introducing the different phases for calamitic and discotic mesogens. At this point it becomes apparent that the authors see liquid crystals as nanomaterials, hence the title of the book: Liquid-Crystal Nanomaterials. Personally, I find this somewhat misleading and quite irritating, because the community attaches a different meaning to the word nanomaterials than simply something larger organic molecules. In the following the reader is taken through the optical properties, but not by introducing the birefringence of nematics, but rather straight away by discussing the phenomenon of selective reflection of cholesterics. The temperature dependence of the cholesteric pitch is then introduced, albeit with some very old, presumably hand drawn representations of measurements. The anisotropy of physical parameters such as the dielectric constants and the electro-optic Fredericks transition is then discussed under the heading of ‘Physical Anisotropy and Applications of Cholesteric liquid-crystal nanomaterials’, with the help of diagrams that are not particularly clear. When reading through the introductory chapter, one does not have the impression that much effort has been devoted to present a modern, up-to-date introduction into the field of liquid crystals. This is not helped by an apparent lack of language editing on the parts of Springer publishers.

The introduction to tribology and lubrication of solids in Chapter 2 takes up much more space than that given to the structure and properties of liquid crystals in the first chapter. Modern antifriction additives are discussed for passive and active friction control, as are the effects of lubricant films on the friction of solids. This includes fine fluid layers on solid surfaces and their surface forces, boundary effects and hydrodynamic effects. An interesting and modern aspect in the form of medical applications is treated in some detail when discussing friction and lubrication in body joints. The chapter is well referenced, although again much of the mentioned literature is three or more decades old.

With chapter 3 the text becomes quite a bit more technical and construction oriented as some of the measurement apparatus for experimental tests of liquid crystals seem to have been specifically constructed. The discussion firstly includes tribo-engineering tests. Standard equipment is described, as well as high-precision rheology, an experimental setup for simulating friction in joints and equipment for metal-biopolymer coupling. Secondly, methods to determine structure and composition of additives are pointed out. These include infrared spectroscopy and concentration determination via measurements of the rotation of the polarisation plane of linearly polarised light.

The tribological properties of liquid crystals are then analysed in detail in chapter 4. Several scenarios are discussed with plenty of data for friction coefficients in the case of liquid crystals on chemically inactive materials, metal surfaces, and the interaction with solids. The role of liquid crystal lubricants in friction and wear is presented, as well as temperature dependent lubrication in the case of cholesterics.

The last chapter 5 then outlines a number of different practical tribology applications of liquid crystals in engineering and medicine, for example in internal combustion engines, as anti-wear additives in engine oil, in the process of polishing diamonds, and finally the friction adjustment in joints.

To conclude, it may be fair to say that this is a monograph that covers a quite specialised topic related to liquid crystal research. And this topic is not what one might expect from the title. This is not a text about nanoparticles in various liquid crystal phases, but rather an account of liquid crystals and especially cholesterics, used in tribology and lubrication. This will make the book interesting to some specialists, but it is not a must-have text that one would expect to find at every postgraduate’s office desk.

Ingo Dierking
Department of Physics and Astronomy,
The University of Manchester, Manchester, UK

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