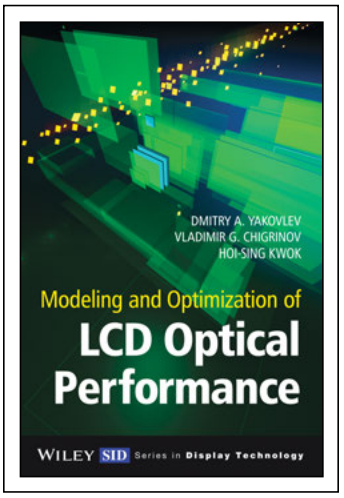
Modeling and Optimization of LCD Optical Performance, by Dmitry A. Yakovlev, Vladimir G. Chigrinov, and Hoi-Sing Kwok. Wiley, 2015.

Reviewed by Sally Day



Modeling and Optimization of LCD Optical Performance is one of the latest books in the SID–Wiley Series on Display Technology. It is written by Dmitry A. Yakovlev, Vladimir G. Chigrinov, and Hoi-Sing Kwok. The book is a detailed treatise on the methods of modeling the optical properties of the classic liquid-crystal (LC) modes: twisted nematic (TN), supertwisted nematic (STN), and ferroelectric LC (SSFLC). The chapters tend to alternate between detailed descriptions of theory, starting from how Maxwell's equations are used to provide the matrix methods for accurate modeling and practical examples in which the models are applied. The theories are described thoroughly, leading into discussions of the most important aspects that must be included in order to obtain precise simulation of the optical performance of displays. The book assumes a working knowledge of liquid-crystal physics and device structures.

For example, the authors apply the Jones matrices to some LC layers and investigate different parameter spaces, thereby anticipating the different polarization modes and states for a number of different LC modes. This is followed by a discussion of the modes and an analysis of the case for reflective modes, explaining how mode analysis can aid in the choice of LC structure in display design. An example is given for the design of bistable displays. This is presented along with an interesting analogy that includes Smith charts, a section that is likely to be interesting to electronic engineers in particular.

Different liquid-crystal modes are described, along with a theory that can be used to predict some of the liquid-crystal director structure and visco-elastic behaviors. Examples are given of modeled results, with a discussion of viewing-angle properties provided before the modeling methods have been fully explored. Necessarily, the modes that are described are those for uniform pixels, thereby excluding the modes now commonly found in high-performance LCDs.

From these more practical aspects, the authors return to the mathematics of matrices, radiometric quantities, and how these are represented in Jones matrices. A subsequent chapter discusses the simulation of TN and STN, *i.e.*, distorted chiral structures, and explains the analysis that is needed to understand fully the experimental results required for the exact design of high-performance displays. This chapter also has a discussion of compensation films.

Real displays will have scattering elements, may diffract light, and use light that is not monochromatic, and these issues are considered, together with information about some of the common additional layers in LCDs, such as ITO, alignment layers, and glass. An ensuing discussion goes back to Maxwell's equations and discusses the so-called Berreman method, well known to those who model LC optics. The use of eigenwave representation is described, and there is a discussion of the methods together with detailed descriptions of modeling of interfaces, again an important consideration for displays where high brightness, energy efficiency, and excellent contrast ratios are required.

A library of codes is provided online with the book, and two chapters provide details on this. There is a discussion of some of the shortcomings of the various Jones-matrix methods and an analysis of when these shortcomings are significant, together with applicable numerical methods. Some of the less-accurate methods are nonetheless useful because of the insight that they offer. There is a discussion of the comparison of modeling and experiment and how parameters of the LC layer can be obtained from the inverse problem. Only in the final chapter is there mention of the now commonly used LC modes – IPS, FFS, PVA, and MVA; however, as is said, the rigorous methods described in this book cannot easily be applied for accurate modeling over the whole pixel area. Example results are given using director simulation software available to the authors.

Overall the book should be useful to researchers and engineers who have a working knowledge of LCDs and are interested in the detailed theory of the methods for precise and accurate modeling of the optics and optical performance of LCDs. A slight shortcoming of the book is that some of the figures are not fully labeled, but they can be understood from reading the relevant text. This work is a useful addition to the book series as a thorough exploration of the modeling of the optics of LCDs *via* Jones and other matrix modeling methods. ■

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