

Essentials of Polarized Light Microscopy

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This book has twenty chapters, eight appendices and a glossary, as follows: Chapter 1 Introduction; Chapter 2 Identifying Characteristics of Particles; Chapter 3 The Low-Power Microscope; Chapter 4 The Polarising Microscope; Chapter 5 Mechanical Alignment of the Polarising Microscope; Chapter 6 Köhler Illumination; Chapter 7 Micrometry; Chapter 8 Crystal Morphology; Chapter 9 Basic Optics; Chapter 10 Sample Preparation; Chapter 11 Particle Identification: Ordinary Light; Chapter 12 Particle Identification: Plane Polarised Light; Chapter 13 Particle Identification: Crossed Polarisers; Chapter 14 Conoscopy; Chapter 15 Microchemistry; Chapter 16 Fluorescence Microscopy; Chapter 17 Basic Contrast Methods; Chapter 18 Ancillary Techniques; Chapter 19 Using Immersion Objectives; Chapter 20 Putting It All Together; Appendix A Recommended Reading List; Appendix B Chemical Reagent Set; Appendix C Crystallographic Symbols; Appendix D Miller Indices; Appendix E Optical Properties of Non-Opaque Materials; Appendix F Trigonometric Functions Table; Appendix G Summary: Polarised Light Microscope Observations; Appendix H Useful Equations; Glossary and Index.

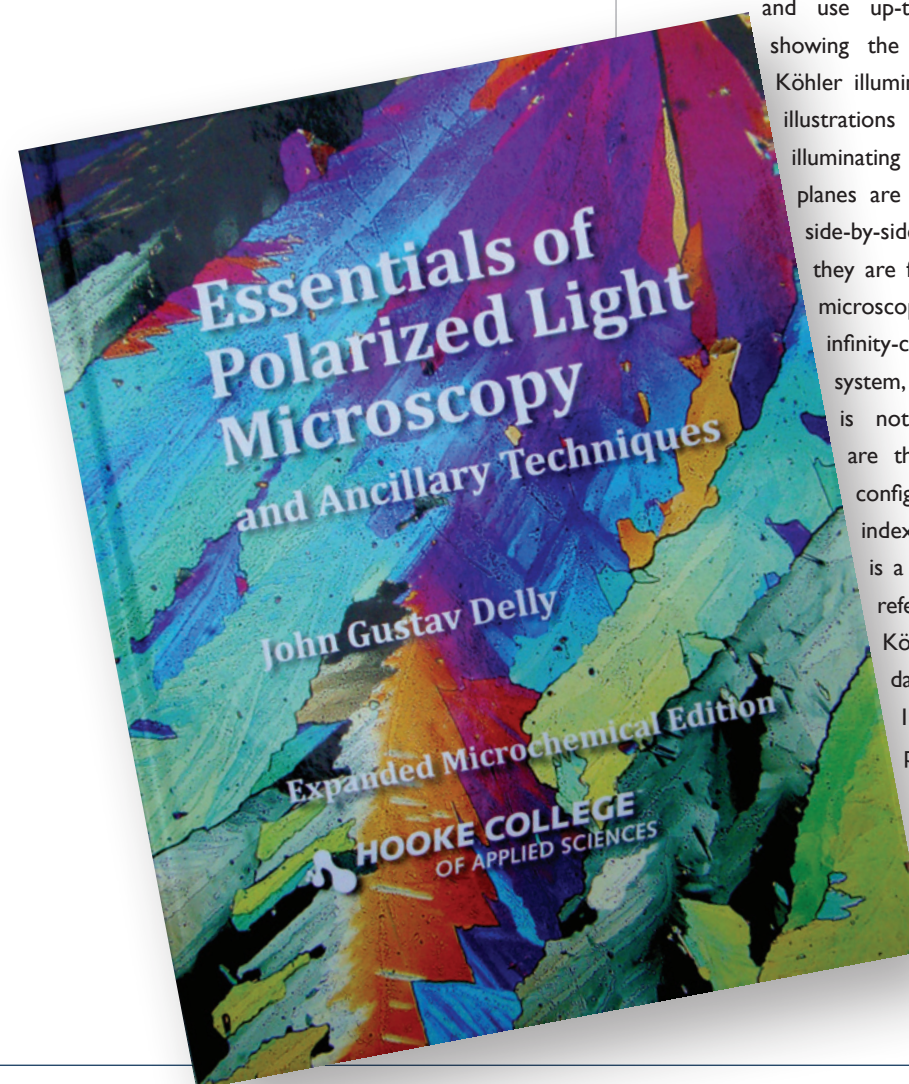
Anyone who has been active in the microscopy community for any decent length of time will know John Delly who works at the McCrone

Group. He is an excellent didactic teacher, widely-respected for his knowledge and ability to teach and instruct. In this case, the promotional blurb on

the Hooke College website is true: “*Polarized Light Microscopy and Ancillary Techniques* is a culmination of seventy-plus years of microscopy know-how, skills, and techniques boiled down into its essential elements. Written in an accessible style supported by abundant and vivid colour photos, photomicrographs and illustrations, it almost feels like the author is standing over your shoulder, guiding you along through your study of polarised light microscopy”. It is also a substantial book, measuring 23 x 29 cm (9 x 11.5 inches) and weighing 2.5 kg (5lbs 8oz). The book is an impressive 5.5 cm (2.2 inches) thick. The hardcover binding and printed cover illustration are of very high quality and colour reproduction.

The introductory Chapter 1, at two pages, is the shortest I’ve ever seen but is an excellent introduction to particle microscopy. Chapter 2, again short at six pages, and including beautiful illustrations, summarises the characteristics whereby particles can be identified. Chapters 3 to 7 in just over 50 pages, cover the use of low-power stereo microscopes; the polarising microscope; how to centre the objective and the stage on-axis; setting up Köhler illumination and how to calibrate a micrometer eyepiece. All this information is simply explained and concisely presented.

The chapter describing Köhler illumination is adequate and well-illustrated, but I feel that Delly has missed an opportunity here to incorporate and use up-to-date ray diagrams showing the optical pathways of Köhler illumination. The lavish 3-D illustrations of the imaging and illuminating sets of conjugate planes are split over two pages side-by-side for comparison, but they are for a finite tubelength microscope. The modern infinity-corrected tubelength system, whilst mentioned, is not illustrated. Neither are these two microscope configurations listed in the index or the glossary. It is a pity that most of the references concerning Köhler illumination are dated, and those from 1946 and 1947 are of no practical use, and now merely of historical interest. I suggest Evennett (1983) and Hammond & Heath (2006), both available online,





would have been more helpful references. Many microscopists and students may never feel they have the need to calibrate a micrometer eyepiece, relying rather on image-acquisition software, but someone has to calibrate that software and this chapter is one of the best, profusely illustrated, explanations that I have encountered.

Chapter 8 is a very comprehensive and practical chapter on crystal morphology which explains this difficult subject well with instructions for making paper crystal models. The reader is presented with a unique, practical and very helpful explanation of a topic that so many microscopists find difficult to understand. The next few chapters cover basic optics, then observing particles using non-polarised light, plane polarised light and under crossed polars. Refractometry, dispersion staining and spindle stages are all very well explained with copious illustrations. Delly has previously written on the use and the history of the Michel-Lévy chart. Chapter 13 is a practical and very helpful explanation of the measurement of birefringence and the use of the chart and of compensators to identify crystal inclusions, or indeed any material in a sample. There then follows a series of 20 practical experiments – all illustrated – to explain the properties of light between crossed polars and how to use compensators to measure birefringence. If you want a practical and definitive

chapter on conoscopy, you need look no further. This is by far the best explanation I have seen on this topic, including optical indicatrices, wave and ray velocity surfaces and the more complex biaxial indicatrix. There is a very thorough treatment of how first to estimate and then measure the optical axial angle, $2V$. The chapter concludes with a very helpful illustrated interference figure gallery, for rarely do crystal forms present themselves ideally under the microscope. This gallery is clearly the fruit of many years of knowledge and of practical teaching experience. Only two – admittedly small – issues come to mind: it is a pity that the Michel-Lévy chart is not included as a larger pull-out chart in the Appendices, and I don't think the colour entirely matches that of the definitive Zeiss (Oberkochen) standard. John has not described the use of the Universal (Federov) four-axis stage. I know: this piece of equipment is very rarely used nowadays on the petrographic microscope, but it would have been useful to have a description in this, the definitive and comprehensive textbook on polarised light, and optical mineralogy. For a discussion of the purpose and use of the Universal stage, the reader should refer to Hallimond (1970) and Kile (2009).

The chapter on fluorescence is short, but very practical. The explanation on how to align a short-arc mercury burner is very well illustrated using an Olympus BX51 stand as an example (used because this is the equipment at Hooke College for which this book is the course manual). Again, Delly could have updated this chapter and included an explanation of the more recent and widespread use of metal halide and LED illuminators. It is followed by Chapter 17 dealing with all the main contrast enhancement methods: oblique illumination; darkfield illumination; Rheinberg illumination; phase contrast and DIC which are explained in turn. I was surprised to find the Heine condenser mentioned and illustrated, for this is now a rare niche application. Also, the illustrations of differential interference contrast could have benefitted from pictures of up-to-date equipment and DIC sliders. However, this point regarding DIC equipment is a very minor issue.

The final three chapters, 18-20 wrap up the message of this book. Chapter 18 covers the use of circular polarisers to eliminate extinction; slightly uncrossed polars and parallel polars to view the complementary Newtonian interference colours, which is useful when determining the weaker-coloured higher orders. I'm pleased to see this technique covered in the book. The rest of chapter 18 describes the use of hot stages for thermo-micro analysis. Perhaps this section could have been expanded into a separate chapter, and the descriptive terms used more precise, for a great many particle characteristics can be analysed using thermal methods. Chapter 19 is a very practical chapter on using immersion objectives. This chapter includes a comprehensive and very important discussion of the importance of coverslip thickness, which I am forever explaining to staff and students of my core facility. I am particularly pleased to see this essential subject dealt with so well. The last chapter, 20, on particle identification and sub-titled 'putting it all together' does exactly what it says on the tin. It draws all the techniques previously discussed and takes the reader through a practical procedure for identifying an unknown particle. A helpful analysis chart is included that readers can copy and use, plus an A4 page with an aide-memoire that can similarly be copied and kept by the microscope for reference.

A page count of all the chapters in this book reveals that those explaining crystal morphology, the behaviour of polarised light, conoscopy and microchemistry (which has been expanded in this 2nd edition) run to over 300 pages – 44 per cent of the total. The book can be read continuously from start to finish but, like any good textbook, the chapters stand alone as teaching and reference entities in their own right. There are Further Reading lists at the end of most chapters which are useful, if a bit dated. Within the page margins there are either short pale blue boxes of information and guidance (e.g. Weiss parameters as the fore-runner of Miller indices) or yellow boxes with a hazard warning strip (e.g. focusing with the Becke line, or

temperature control for Meltmount preparations). These advisory boxes are not excessive, but they are very practical and useful.

Although this book is primarily intended as course material for Hooke College, the teaching arm of the McCrone group, it is nevertheless the last word on polarised light microscopy and optical mineralogy. It is intended not only for mineralogists, but those who must use polarised light microscopy in a practical manner to solve problems: contaminant identification, forensic analysis, health hazard monitoring, trace evidence analysis, to name a few applications. *Essentials of Polarized Light Microscopy and Ancillary Techniques* is written in an easily readable style. It is extremely well illustrated with much helpful and practical advice. As such it is ideal for a novice or the experienced practitioner in industrial and commercial microscopy. It is also suitable for the keen amateur (the Quekett Club review by Phil Greaves is available online) as well as professionals, and I have no hesitation in recommending this book to all serious microscopists. I am delighted to own a copy.

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