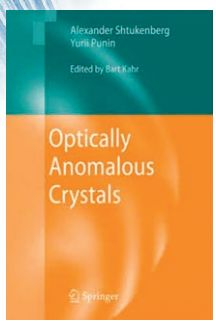
Optically Anomalous Crystals



Edited by *Alexander Shtukenberg, Yurii Punin* and *Bart Kahr*. Springer, Dordrecht 2007. 277 pp., hardcover $ 159.00.—ISBN 978-1-4020–5287-3

In 1992 *Angewandte Chemie* published a review article on optically anomalous crystals by B. Kahr and J. M. McBride (*Angew. Chem.* **1992**, *104*, 1; *Angew. Chem. Int. Ed. Engl.* **1992**, *31*, 1). It provided an interesting analysis, from both historical and conceptual viewpoints, on a subject that has fascinated and puzzled numerous crystallographers since about 1815, when Brewster reported the first anomalies of doubly refracting crystals. The present volume constitutes a comprehensive and detailed review of the current state of knowledge about anomalous crystals. This is actually an expanded and updated English version of a book published in Russian by Nauka in 2004, written by A. Shtukenberg and Yu. O. Punin, two crystallographers who are experts on crystal growth. *Optically Anomalous Crystals* has also benefited from the editorship of Bart Kahr, one of the foremost leaders in the fields of crystal design and chiral crystals. The book is particularly timely, as it represents the most serious attempt to cover this area in detail since the first book by Reinhard Brauns (*Die optischen Anomalien der Kristalle*) appeared as early as 1891. In short, optical anomalies occur when crystals have a degree of symmetry lower than would be expected from their morphology or X-ray diffraction data. A similar phenomenon is the occurrence of an anomalous linear birefringence in cases where such a birefringence would not be expected.

This work is arranged in five major chapters. The table of contents is well laid out, making it easy to locate any specific research trend. I found both the introductory remarks and Chapter 1 (34 pp.) to be particularly appealing for the nonspecialist as well as the specialist, as they put the subject in the appropriate perspective and provide a useful tutorial on crystal optics, with a discussion of linear optical phenomena and the most common classes of optical anomalies that are encountered. Chapter 2 deals with stress-induced birefringence phenomena (piezooptical effects), which may be associated with inclusions, crystal defects or dislocations, thermal variations, or compositional inhomogeneities (heterometries). All these are illustrated in detail by descriptions of model systems, mostly involving minerals and inorganic salts. The section on temperature-induced stress is especially important, as this phenomenon can occur in synthetic crystals grown from the melt (e.g., by the well-known Czochralski method). Chapter 3 (pp. 95–161) presents a comprehensive analysis of kinetic order–disorder transformations of the crystal structure. A description of the Curie symmetry principle (often referred to as the Neumann–Curie principle in the context of crystal symmetries) leads into detailed subsections on growth desymmetrization and its experimental detection. The discussion of anomalous pleochroism and dyed crystals (systems exhibiting anomalous absorption) is especially relevant from the historical and practical viewpoints, as has been described previously in a more comprehensive treatment by Kahr and Gurney (*Chem. Rev.* **2001**, *101*, 893). Chapter 4 is focused on heterogeneous crystal structures, often resembling single crystals, which have different domains within the micrometer scale, usually with dimensions exceeding the wavelength of light. Lastly, Chapter 5 deals with systems in which optical anomalies arise from multiple or mixed sources.

In principle, this monograph is intended to be a useful text for crystallographers and mineralogists, in other words for readers who already have enough background on crystal symmetries, mineral systems, or polarizing microscopy. Most chapters contain a significant amount of theory, and for the practitioner the mathematics may be somewhat daunting. However, the strength of this book certainly lies in the numerical models that provide an in-depth treatment of the properties in question. The text is aimed at a potential readership that consists of solid-state chemists and materials scientists whose interest is focused on crystalline materials, as well as stereochemists and physicists interested in optical phenomena. For such scientists, the book is full of theory and illustrative examples of topics such as linear dichroism, molecular recognition and desymmetrization, syntaxy, uniaxial and biaxial crystals, enantiomorphous twinning, and epitaxy, which are properties of many anomalous crystals.

The text is illustrated by many figures and black-and-white photographs, some of which are reproduced again at the end as beautiful color plates. This book is well referenced (pp. 213–231), with authors listed in alphabetical order and full title citations, many of which were hitherto only available in Russian. Four appendices are provided, along with an index, which is rather short (chemicals, minerals, and other keywords have been omitted). Any further improvement should pay attention to other optical anomalies, especially negative refractive indexes (metamaterials), and should include more examples of organic crystals.

Despite these minor criticisms, this is an authoritative and insightful book on a fascinating research topic. For the specialist, it is an invaluable work of reference and source of information and inspiration; those unfamiliar with this field will find stimulation and entertainment by browsing the book. It is hoped that a future edition will be considered before the next century.

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