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Refractive Indices of Solids

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Foreword

Refractometry, i.e. measurements of refractive indices (RIs) (n) of glasses, fine powders and amorphous solids at normal or elevated temperatures and pressures, provides the information that is often in accessible to other physical methods. In particular, refractometry is successfully applied to examining the effects of shock-wave compression on condensed matter, both during the compression itself (which lasts less than a microsecond!) and in the samples recovered after unloading. Most recently, a method of measuring RIs of nanoparticles in colloidal solutions was developed, allowing to determine their composition and structure. Applications of refractometry to the study of electronic structure of simple and complex compounds even today has an advantage over other physical methods in some particular areas, e.g. metallisation of solids under high pressure, the nature of hydrogen bonds, or mutual influence of atoms in coordination compounds.

In the present work, we briefly summarise the physical foundations and structural applications of refractometry, the methods and results of measurements of RIs in elementary solids, binary and ternary inorganic compounds, complex (coordination) and organic crystalline substances. Extensive crystallo-optical studies, especially in the area of coordination compounds, were carried out by Soviet (Russian) scientists whose results are little known in the West, and this book has also the purpose of rectifying this deficiency. Unlike other available handbooks, this one pays attention to the effects of particle sizes, of pressure and temperature on the RIs of solids, including physical aftereffects in the structure and properties of shocked substances as well as anomalous dispersion of light and optical homogeneity in mixtures and solid solutions. Besides traditional techniques of RI measurements, we describe our development of the immersion method to enable studying highly refractive powder substances.

The earlier tables of RIs [1–5] listed also the densities and crystallographic parameters of the materials. We believe this is no longer necessary (except for substances previously unreported) because this information is readily available from structural databases and other online sources.

Regarding minerals, we give the data only for those of rational composition (daltonides), because optical properties of solid solutions usually can be calculated

by additivity. For all RIs listed in this book, we provide references, except those taken from above-mentioned reference sources [1–5] or measured by ourselves and not yet published. The book consists of four chapters, dealing, respectively, with the physical theory, methods and results of RI measurements of various solids, and scientific and technological applications of these results.

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Abstract

This book highlights the basics of crystal optics methods and refractive index (RI) measurement techniques in various solids, as well as their scientific and technological applications. Besides conventional methods of RI measurements, it describes special techniques where the former are impractical, e.g. for highly refracting powders, solids with anomalous dispersion of light and colloids. The tables compile all available RI measurements for elementary solids, binary, ternary and coordination compounds, as well as some small-molecule and polymeric organic substances.

Keywords Crystal optics · Anisotropy of solids · Optical/structural refractometry · Size effect · RIs of anhydrous solids · Ternary halides · Ternary oxides · Silicates · Uranium compounds · Organic substances

Part I
Physical Definitions, Measurements and Applications of Refractive Indices