Functional Cobalt Oxides

FUNDAMENTALS, PROPERTIES, AND APPLICATIONS

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Preface

When one looks around, one's apparels are found to made of many materials, which are said to reach 50,000 varieties. Surprisingly, these materials are composed of at most about 50 kinds of elements. Among them, the transition metals have a high melting point, high density, and multivalence. This book deals with oxide materials, including the transition metal Co, but the elementary Co itself with the 29th Clarke number exhibits ferromagnetism, as well as Ni and Fe, and has been used as a dye and a pigment to produce the well-known cobalt blue. There is a view according to which Co was designated by H. Brandt in 1735, and its name stems from German word "*Kobold*." In this connection, I may add that the name appears in a worldwide animation, *Mightly Atom*, created by O. Tezuka, as the name of the brother of the main character, Atom. Moreover, Co has been also widely used as alloys with Fe, Ni, and Cr: Ni-Fe-Co alloy is employed as a binder between glass and metal and Cr-Co-W alloy is dental or surgery material.

The book is motivated by the desire to describe why cobalt oxides have drawn much interest as functional materials, together with their peculiar physical properties partially originating from a rich variety of valences and spin states of Co ions. The leading role of the physical phenomena dealt with in this book is owed to the electron. The electron, discovered by J. J. Thomson in 1897, is a particle that cannot be far resolved under normal conditions and has a wave nature as well. Wave-particle duality was evidenced by experiments using the double split performed by C. Jönsson, P. G. Merli, and A. Tonomura in 1961, 1974, and 1989, respectively.

In the Co oxide system, the strong correlation between electrons generally plays a substantial role, where the conventional one-electron approximation fails. In particular, the characteristics of

Co ions in oxides should be focused on in comparison with other transition metals. This book starts with the basis of one-electron band theory and advances toward the stage of strong electron correlation systems and furthermore progresses to cover up-to-date topics such as huge thermoelectric power, superconductivity, and intrinsic inhomogeneity, etc. This book would be of interest to graduate students and researchers in the fields of physics, chemistry, and materials science. Aside from helping readers in the pencil-and-paper solution of problems, the discussion, which this book aims at developing, may be useful for understanding the essence of functional materials.

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