New Books: *Superconducting State: Mechanisms and Materials* by V.Z. Kresin, S.G. Ovchinnikov, and S.A. Wolf

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The book entitled *Superconducting State: Mechanisms and Materials* by V.Z. Kresin (VZK), S.G. Ovchinnikov (SGO), and S.A. Wolf (SAW) published by Oxford University Press (2021) discusses both of the most important aspects of superconductivity: theory and applicable superconducting materials. Superconductivity (SC) has become a vast field, and this book shows how far it has come in the past 100 years. Along with reviewing significant research and experiments, the authors share their own insight and experience in this exciting and evolving area. The three authors are well-known scientists to the *Journal of Superconductivity and Novel Magnetism* community. Thus, no further introduction is needed. VZK and SAW are the establishers of this journal and served as chief editors for many years (VZK continues to date), whereas SGO is one of the co-editors of this journal.

Since the discovery of superconductivity in 1911 ($T_c = 4.2$ K), a great number of theoretical and experimental efforts have been made to describe this new phase of matter that emerged in many body systems. In this regard, theoretical models have been presented, the most famous of which was the Bardeen–Cooper–Schrieffer (BCS) theory, which can only describe conventional superconductors. With the discovery of a new class of high- T_c superconductors (HTS) in 1987, the theoretical explanations became a new challenge in the field of condensed matter physics. This unexpected discovery (maximum T_c of 134 K) opened a new area in the history of SC, and experimental researchers continued trying to find new compounds with higher T_c values. These superconductors are often characterized by the anisotropic character in the SC gap functions with nodes along a certain direction in the momentum space. Since the pairing interactions have an important role in the SC gap structure, their determinations are very important to explain the basic

pairing mechanism. In this regard, this book includes valuable theoretical and experimental discussions about the properties of conventional and unconventional superconductors.

The purpose of this book is to review, as completely as possible, the theory of SC from classical to modern models and summarizes vast SC materials and their fabrication methods. The book also deals with the recently discovered hydride superconductors, which exhibit, under high pressures, T_c values and other SC features close to ambient temperature. Emphasizing key developments in the early 1950s and 1960s, the book looks at how SC started to permeate society and how most of today's applications are based on the innovations of those years. It also explores the genuine revolution that occurred with the discovery of HTS, leading to emerging applications in power storage and fusion reactors.

This book is not a textbook. Various important topics of SC such as transport properties, ac responses, and surface SC are not addressed here. Due to its precise language and numerous explanatory illustrations, it is suitable as a summarizing book, with the level rising smoothly from chapter to chapter, such that scientists can build on their newly acquired knowledge. The book holds ~500 pages and contains 10 main chapters. Basically, it may actually be divided into unequal three main parts, as the title emphasizes: theory and materials and to similarities to the SC state in nature. An extensive vast list of more than 1700 references provides an overview of the most important publications on the SC topic. It also contains 5 appendixes which describe various physical subjects which contribute to understanding the SC phenomena. The three parts are as follows.

Part 1: Theory (chapters 1–3). Beginning with a historical survey, the authors' main aim is to review, as completely as possible, the theory of SC from classical models, focused on the principles of the microscopic mechanisms of SC (BCS), to more recent developed models. This part is done in a systematic, well-written, and enlightening manner. The question and discussion of the absence of an upper limit for

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T_c is illuminating and appealing. In chapter 3, the authors describe the main principles of spectroscopic methodology for the analysis of energy gaps, gapless SC, the isotope effect, and various fluctuations in superconductivity.

Part 2: Materials (chapters 4–8). This is the major part of the book which is devoted to experimental methods such as STM, PVD, and CVD and to the various SC materials. First, the authors describe the different HTS copper oxide-based materials and manage to discuss the various models to explain their high T_c values. After discussing the inhomogeneous superconductors and the pseudo-gap state properties above T_c, they return to the conventional metallic and intermetallic systems. They also provide an extensive description of the new SC hydride-based materials which show SC features under high pressures around room temperature. They also well discuss other SC systems such as the ruthenates, heavy fermions, WO_x oxides, and topological superconductors. The last chapter deals with the old organic SC families and includes the more recent carbon-based ones: fullerene, graphene, and interface SC materials.

Part 3: Similarities (chapters 9 and 10). Here, systems which are not superconducting but possess similarities to

SC in their mechanism, such as pair correlations and/or crystallographic structures, are described. (i) The peculiar magnetic phenomena of the manganite materials such as their colossal magnetoresistance features are extensively discussed. The manganites show many similarities to the HTS curates, including closed related structures. (ii) The last chapter, titled as “Superconducting States in Nature,” contains a unique and essential guide to objects in nature, such as atomic nuclei, the nucleons, and several biological active systems in which pair correlations play a dominant role.

This book will thus be a valuable contribution to the field of superconductivity and also an important milestone in the life of our *Journal of Superconductivity and Novel Magnetism*.

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