Preface

From the time of publication of the first edition of the monograph (2007), the rapidly changing world of superconductivity ensured a whole set of new discoveries and achievements in theoretical and experimental aspects, as technologies and applications. In my view, three main achievements generated constant interest of the scientific society to this area, namely (i) discovery of superconductive pnictides in 2008 with temperature of superconductive transition equal to 56 K that is near the liquid nitrogen temperature (77 K), allowing in many researches to relate these superconductors to HTSCs, (ii) active invasion of nanotechnology approaches and methods in processing and investigations of HTSCs that allowed one to significantly modernize the processing techniques and obtain HTSCs with improved structure-sensitive properties, and (iii) growing application of non-conventional superconductors with enough high superconductive properties (in particular, MgB_2) leading to considerable reducing price of the numerous superconductive goods.

All these achievements (but not only they) contributed to the modernization of the first edition. The second edition includes two additional chapters but a majority of the other chapters and appendices were either reworked or considerably extended. The main results of the book are devoted to traditional HTSCs of Y(*RE*)BCO and BSCCO families, and also superconductive pnictides demonstrating many common features with the pointed layered HTSCs, while the main trends in development of superconductivity also are discussed in detail. I am hoping the book can help many students to better understand and study this very interesting region of modern Physics and Material Science.

The author would be grateful for reports of typographical and other errors to be sent via the following e-mail: ppr@math.rsu.ru.

Rostov-on-Don, August 2012 I. A. Parinov

Preface to the First English Edition

In 2006, the scientific society was celebrating the twentieth anniversary of the discovery of the high-temperature superconductivity by George Bednorz and Alex Müller. Dynamically developing researches in this field give new and new scientific results. This caused a significant modernization of the English edition compared to the Russian one [806], which was written in 2003. Considerable changes have been introduced in Chaps. 1–3 and Appendix A, in particular, the new Sect. 3.1.2 is devoted to acoustic emission study of BSCCO/Ag tapes under bending. The new Chap. 4 is devoted to carbon problem in HTSC and includes as "old" text from Sects. 2.6 and 7.7 of the Russian edition, as "new" text (Sects. 4.3 and Appendix B), presenting mathematical modeling of the brittle carbonate formation and following fracture during interaction of YBCO with CO_2. The main aims of the monograph have been retained and connected with Material Science of HTSC and their mathematical modeling. Comparatively, lower attention has been devoted to Physics of HTSC. The main results as before have been related to the YBCO and BSCCO families, while the main trends in R&D of other superconductors have also been marked.

The author would be grateful for reports of typographical and other errors to be sent via the following web-page http://www.math.rsu.ru/niimpm/strl/welcome.en.html, where an up-to-date errata list will be maintained.

Rostov-on-Don, December 2006 I. A. Parinov

Preface to the Russian Edition

The discovery in 1986 of high-temperature superconductors (HTSC) on the base of copper oxides with the temperature of superconducting transition that is greater than the temperature of low-cost, nontoxic, and accessible liquid nitrogen (77 K), marked a qualitative jump in the development and application of new technical conductors, devices for energy transmission, transformation, and storage. Together with enough high-critical temperatures T_c, an intrinsic brittleness of oxide cuprates, the layered anisotropic structure, and the super-short (~ 1 nm) coherence length ξ, presenting itself as a spatial characteristic of superconducting electrons, are other main features defining HTSC microstructure and properties. Due to the above-mentioned peculiarities, even the existence of an intergranular boundary could be enough to suppress superconductivity, but the structure-sensitive properties of HTSC systems depend greatly on the weak links of intergranular boundaries, by manufacturing them in the polycrystalline form, demonstrating coexistence of inter- and transgranular currents. Also, superconductivity can be destroyed after the attainment of the critical value of the external magnetic field H_{cm}. The interfaces of the "superconductor-normal metal", "superconductor-insulator" and other types based on them are the localization places of different defects. The microstructure features, connected with phase composition, domain structure, crystallographic properties, and existence of structure defects, pores, microcracks, inclusions, etc., define directly useful properties of HTSC materials and composites. The main goal of this monograph is to study the microstructure, strength, electromagnetic, and superconducting properties. Another aim includes discussion of the optimization directions for the fabrication techniques, superconducting compositions, external loading, and thermal treatments to obtain HTSC, possessing improved and more controlled physical and mechanical properties. The link "composition-technique-experiment-theory-model" investigated in the book, assuming considerable HTSC defectiveness and structure heterogeneity, forms a whole picture of modern representations on the microstructure, strength and connected with them the structure-sensitive properties of the materials considered. Special attention in the book is devoted to Bi-Sr-Ca-Cu-O and Y-Ba-Cu-O families that today are most important for applications.

The monograph is addressed to students, post-graduate students, and specialists taking part in the development, preparation, and researching new materials. The author has the pleasure to thank the Russian Foundation for Basic Research, Russian Department of Education and Science, Soros Foundation and American International Program COBASE (Collaboration in Basic Science and Engineering), grants of which during the last decade have rendered considerable financial support and promoted to publish this book.

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Corrections and proposals by the book readers will be considered with thanks. They could be presented by E-mail: ppr@math.rsu.ru.

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