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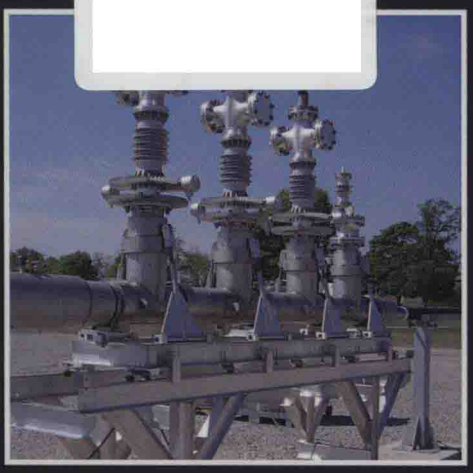

Superconductors in the Power Grid

Materials and Applications

Edited by Christopher Rey

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Number 65

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This book is dedicated to my two daughters Samantha and Lilliana,
for providing me a purpose in life,
and
to my mother and father, for love and encouragement, past and present.

Preface

The purpose of this book is to provide an overview of the use and impact of high temperature superconductors (HTS) in the electric power grid. With chapters written by a number of distinguished technical experts from around the world, the book updates a number of earlier books and reviews and introduces some important new material in this rapidly developing field. The book is written at a level geared toward those with a basic science and engineering background, professional R&D managers in energy technology companies, and academic/government researchers, with a basic familiarity with Maxwell equations and electromagnetism. The book starts off with a broad and introductory overview of the electric power grid, of superconductivity basics, and of the use and impact of HTS in the grid starting from the early days of projects sponsored by the US Department of Energy to the present-day sophisticated installations around the world. This chapter concludes with a look at future prospects for superconductor-based devices in the electric power sector.

The book next gives an overview of superconductivity itself, including both low temperature superconductors and HTS, and how their properties, particularly their magnetic behavior and current carrying properties, are both similar and different. It is suggested that the reader unfamiliar with the phenomenon of superconductivity start off by thoroughly reading Chapter 2, before proceeding to the other chapters.

The next two chapters then lead the reader through the fabrication processes of the two types of HTS wires most widely used in electric power devices, namely the so-called (1) first generation (1G) bi-oxide power-in-tube tapes and round wires and (2) second generation (2G) RE–Ba–Cu–O coated conductors.

The book then examines one of the most commercially promising HTS applications for the power grid: power cables, including their various demonstration projects and tests results. A special feature is an in-depth discussion of fault-current-limiting (FCL) cables, which have not been treated in detail in the technical literature heretofore. Four separate chapters are dedicated to HTS cables including (1) HTS three-phase AC cables, including FCL cables, (2) HTS DC cables, (3) HTS gaseous He cooled cables, and (4) cryogenic cooling of HTS cables.

The book next examines a variety of other HTS-enabled devices which bring novel functionality to the electric power sector, including: HTS fault-current limiters, HTS motors and generators, HTS SMES, and HTS transformers. Finally, the book concludes with a brief overview of HTS-based projects in China.

Acknowledgements

As with any large collection of technical and scientific work, there are many contributors and collaborators required to bring the effort to fruition. I would first like to acknowledge and thank all of the authors for contributing their many wonderful chapters and hope that the reader enjoys learning from them, as much as I enjoyed reviewing them. I would also like to thank the publisher for agreeing to edit and publish a book on high temperature superconductivity in the electric power grid. This important and fascinating topic is one that has captured my interest since the early days of its exploration and investigation. I would also like to thank the editors for their tireless and endless chasing down of the status of chapter manuscripts and for the countless e-mails that were exchanged in the editing of this book.

There is one individual that I would like to call out 'a very special thanks and acknowledgement' in the editing of this book on HTS in the electric power grid – that person is Alex Malozemoff. Without the help (and more specifically intervention) of Alex, this book would not have been completed. Towards the end, Alex was the true driving force behind its completion and on multiple occasions had to inspire me to actually finish it. When the effort seemed hopeless and far from its completion, Alex helped review additional chapters and came to the rescue in coauthoring two additional chapters including his excellent work in the books introductory chapter. I take great enjoyment when I hear him tell others that his additional effort in seeing this book to completion was only because he did not want to see his first chapter's effort go to waste! Although he is unaware, I first met Alex at a Gordon Research Conference when I was in graduate school studying the magnetic behaviour of the newly discovered HTS materials. The knowledge and insight that he showed during the early days of this discovery into this phenomenon was impressive. I would have never guessed back then that I would get to coauthor a chapter with him regarding high temperature superconductivity. It was an honour to coauthor Chapter 2 on the fundamentals of superconductivity and you can see his expertise in magnetic phenomena of these materials scattered throughout this chapter.

Finally, I would like to express my appreciation to my two daughters Samantha and Lilliana who bring me joy and happiness which inspires each and every day.