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K. Watanabe
M. Motokawa
(Eds.)

Materials Science in Static High Magnetic Fields



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Preface

There is no strict definition of the term “High Magnetic Field”. It has been proposed to use this term for magnetic fields that are technically difficult to generate and therefore need special equipment or large resources. Static fields above 20 T are apparently high magnetic fields in this sense, but in the case of pulsed field 40 T is easy to obtain and any field lower than this approximate limit should not be considered as “high”. When a static field is used for materials processing, even 10 T is considered as “high” because the long-term use of a conventional superconducting magnet is difficult.

Recently, there has been much technical progress in producing high magnetic fields, both pulsed and static; in large part this is due to the development of new materials. Complicated poly-helix coils are now replaced by simple Bitter coils made with plates of CuAg alloy with high strength and high conductivity; these are used in both water-cooled and hybrid magnets (now up to 45 T at NHMFL, the US National High Magnetic Field Laboratory at Tallahassee, Florida). By using CuAg wire, a nondestructive pulsed field record of 80 T has been achieved at Osaka University. For daily use in experiments, 70–75 T should soon become available. Major facilities for static high fields worldwide are planning to generate fields over 40 T by increasing the electric power.

On the other hand, the use of static high magnetic fields is expanding. Formerly these were used mainly in physics, i.e. for measuring physical phenomena, and for the characterization of materials. Application to so-called materials processing like crystal growth or heat treatment is more recent. Development of cryogen-free superconducting magnets surely contributes much to the expansion of high field applications.

The aim of this book is to survey the activities of high field applications, mainly those that are pursued at the High Field Laboratory for Superconducting Materials (HFLSM) that is attached to the Institute for Materials Research (IMR) at Tohoku University. Each chapter is composed of a general introduction to the subject and of detailed experimental results with explanations. Many books have been published concerning high magnetic fields and related subjects, but it is still considered worthwhile to publish this book as a volume of the series “Advances in Materials Research”, in order to survey the current status of materials science in static high magnetic fields.

The editors are grateful to Dr. Satoshi Awaji for his help in compiling this book in its present form. They very much appreciate Prof. Yoshiyuki Kawazoe, the editor of this book series, for the original suggestion and encouragement to publish this book.

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