Recrystallization and the related annealing phenomena which occur during the thermomechanical processing of materials have long been recognised as being both of technological importance and scientific interest. These phenomena are known to occur in all types of crystalline materials; they occur during the natural geological deformation of rocks and minerals, and during the processing of technical ceramics. However, the phenomena have been most widely studied in metals, and as this is the only class of material for which a coherent body of work is available, this book inevitably concentrates on metallic materials. Although there is a vast body of literature going back 150 years, and a large collection of reviews which are detailed in chapter 1, there have only been two monographs published in recent times on the subject of recrystallization, the latest nearly 20 years ago. Since that time, considerable advances have been made, both in our understanding of the subject and in the techniques available to the researcher.

Metallurgical research in this field is mainly driven by the requirements of industry, and currently, a major need is for quantitative, physically-based models which can be applied to metal-forming processes so as to control, improve and optimise the microstructure and texture of the finished products. Such models require a more detailed understanding of both the deformation and annealing processes than we have at present. The development of the underlying science to a level sufficient for the construction of the required models from first principles provides a goal for perhaps the next 10 to 20 years.

The book was written to provide a treatment of the subject for researchers or students who need a more detailed coverage than is found in textbooks on physical metallurgy, and a more coherent treatment than will be found in the many conference proceedings. We have chosen to emphasise the scientific principles and physical insight underlying annealing rather than produce a comprehensive bibliography or handbook.

Unfortunately the generic term annealing is used widely to describe two metallurgical processes. Both have a common result in that a hardened material is made softer, but the mechanisms involved are quite different. In one case, associated with the heat treatment of ferrous materials, the softening process involves the $\gamma \rightarrow \alpha$ phase transformation. In the second case, which is the one relevant to this book, the softening is a direct result of the loss via recovery and recrystallization, of the dislocations introduced by work hardening.

It is not easy to write a book on recrystallization, because although it is a clearly defined subject, many aspects are not well understood and the experimental evidence is often poor and conflicting. It would have been desirable to quantify all aspects of the
phenomena and to derive the theories from first principles. However, this is not yet possible, and the reader will find within this book a mixture of relatively sound theory, reasonable assumptions and conjecture. There are two main reasons for our lack of progress. First, we cannot expect to understand recovery and recrystallization in depth unless we understand the nature of the deformed state which is the precursor, and that is still a distant goal. Second, although some annealing processes, such as recovery and grain growth are reasonably homogeneous, others, such as recrystallization and abnormal grain growth are heterogeneous, relying on local instabilities and evoking parallels with apparently chaotic events such as weather.

It must be recognised that we are writing about a live and evolving subject. Very little is finished and the book should therefore be seen as a snapshot of the subject at this particular time as seen by two scientists who are undoubtedly biased in various ways. We hope that when a second edition of this volume is produced in perhaps 10 years time, or a new treatment is attempted, many aspects of the subject will have become clearer.

Recovery and recrystallization depend on the nature of the deformed state and involve the formation, removal and movement of grain boundaries. For these reasons we have included treatments of the deformed state in chapter 2, and the nature of grain boundaries in chapter 3. These are both large topics which merit complete books in themselves, and we have not attempted a comprehensive coverage but have merely aimed to provide what we regard as essential background information in order to make the volume reasonably self-contained. Chapter 4 is concerned with the migration and mobility of grain boundaries, and this contains some background information.

The main topics of the book – recovery, recrystallization and grain growth are covered in chapters 5 to 11 and include specific chapters on ordered materials, two-phase alloys and annealing textures. In order to illustrate some of the applications of the principles discussed in the book we have selected a very few technologically important case studies in chapter 12. The final chapter outlines the ways in which computer simulation and modelling are being applied to annealing phenomena, and in the appendix we provide an introduction to the measurement and representation of textures for the benefit of readers who are not specialists in this area.

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August 1994

The need to reprint the book has provided an opportunity for us to correct some of the errors and to carry out minor modifications to the text.

May 1996