Preface

This small book is written mainly for beginning graduate students and researchers in solid-state physics, who are thinking of growing single crystals in order to study their physical properties.

For students and professional scientists alike, solid-state physics offers many fascinating research topics. Superconductivity that competes and coexists with magnetic order; a new type of ferroelectricity arising at magnetic transitions; and quantum materials that conduct electriticity only along their surfaces—these are just few examples of what solid-state physicists today are trying to understand and find possible uses for. To study these phenomena, researchers perform various kinds of measurements, from simple resistivity tests to state-of-the-art experiments at multi-national synchrotron facilities. Common to all these studies, however, is the need to obtain high-quality single crystals for detailed investigation.

This book focuses on the principles and techniques of growing high-quality single crystals using the flux method. Although it is only one technique among many for growing crystals, the flux method is favored by many solid-state physicists. In this method, single crystals are obtained by cooling a hot molten liquid of the desired compound dissolved in a flux (another term for flux is solvent; flux growth is also called high-temperature solution growth). Because it is possible to find a flux for most inorganic materials, the technique can be used to obtain a wide variety of crystals having sizes of the order of several millimeters—an appropriate dimension for most physical measurements. Moreover, the flux method only requires a standard electric furnace and crucible, and does not demand too much time and effort on the part of the scientist. In other words, by using the flux method, the novice researcher can learn to grow many crystals without becoming a dedicated crystal grower.

This book assumes that the reader has some knowledge of the basic concepts of solids, such as crystal structure and chemical bonding. On the other hand, no hands-on experience in research is assumed and it is hoped that the practical approach of this book will be of help in setting up a lab and conducting successful crystal growth. Since oxides represent one of the most widely studied groups of compounds, many examples in this book come from experiments on oxide systems.

Nevertheless the flux technique can be equally applied to other materials, and this point is emphasized in various parts of the book.

I would like to thank the editors and reviewers for many suggestions which improved the quality of this book. My appreciation also goes to all those who have helped me in my crystal growth activities over the years. Most of the illustrations in this book were prepared by Rie Tachibana and Marisa Tachibana.

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http://www.springer.com/978-4-431-56586-4

Beginner's Guide to Flux Crystal Growth
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2017, IX, 130 p. 63 illus., 41 illus. in color., Softcover
ISBN: 978-4-431-56586-4