

# Preface

*How many have truly benefited from my classes I cannot judge. But I have the consolation that one person has learned much thereby, and that is me.*

*Ludwig Boltzmann, Vienna, 1905 [1]*

This book is a distillation based on more than three decades of teaching university courses and providing professional seminars on solidification, casting and welding of metals, and crystal growth. The courses themselves were offered for many years at Rensselaer Polytechnic Institute and, most recently, at the University of Florida. Their purpose, consistently, was to present to a variety of engineering and science students a logical progression of the essential elements of materials science relevant to molten phases and processes leading to their crystallization. This text provides a comprehensive survey of scientific and engineering fundamentals for understanding crystallization processes, dwelling especially on applications to pure materials, metallic alloys, oxides, semiconductors, and polyphase systems. The didactic approach adhered to derives in large measure from the author's personal lecture notes that were prepared annually for one-semester courses populated by advanced undergraduate and graduate students in materials science, chemical and mechanical engineering, geology and physics. This book is designed for teaching this group, as well as for professionals interested in specific topics or exposure to integrated aspects of solidification and crystal growth.

The development of most chapters included herein favors, where appropriate, a quantitative approach, augmented by scientific descriptions anchored in materials science and condensed matter physics. Familiarity with the calculus, ordinary and partial differential equations, and at least introductory chemical thermodynamics is assumed, all of which will prove helpful to most readers. Due care has been taken to provide the reader comprehensive, logical developments supported by citations of pertinent research papers and helpful reviews. Although the literature on solidification and crystal growth still lacks a consistent, canonical terminology, I have endeavored, with some personal biases, to apply best practices throughout, as I observed their application by other researchers and thoughtful authors attentive to this field.

The text's present author, in various ways, has also attempted to mirror the approach and logical structure so successfully used in Professor Bruce Chalmers's highly regarded monograph by the same title, published almost 50 years ago [2], while Dr. Chalmers was Gordon Mackay Professor of Metallurgy at Harvard University. I used Professor Chalmers's book when first teaching the subject of solidification and crystal growth; his book was reprinted for my classes in later years through the gracious permission of his estate. That work remained our background text, as I expanded some topics using my personal notes to up-date them or to introduce new ones. The present book, as already mentioned, resulted from those serial teaching efforts, through steady improvements based on feedback from students and colleagues, and progress in the field. This book is written with the express desire that it recaptures at least some of the spirit and purpose originally stated by Bruce Chalmers, namely,

...to provide a critical review of the state of knowledge and understanding of the process of solidification, defined for this purpose as the discontinuous change of state from liquid to crystalline solid.

Professor Chalmers's personal charm, his many research contributions, his unique technical and expository style, and, of course, his book itself, were mainstays in the early development of solidification science. It is the author's further hope that the current monograph will continue to assist students and practicing scientists and engineers in obtaining a firmer grasp of this interesting and important field, which has continued its development at a brisk pace ever since the publication of Professor Chalmers's, *Principles of Solidification*.

I owe thanks to former students for their feedback each year that I taught this subject, which collectively helped shape the present form and content of this volume. My deepest appreciation extends to my dear friend Professor Markus Rettenmayr, Friedrich Schiller University, Jena, Germany, who provided numerous useful comments, alternative perspectives, and detailed suggestions for improving the clarity and consistency of the book, and who was willing to read critically an early draft of this work; to my friend and collaborator Professor Paulo Rios, Universidad Federal de Volta Redonda, Brazil, for his encouragement, discussions, and unflagging interest in my writing this book; and to my friend and colleague Professor Diran Apelian, Worcester Polytechnic Institute, who successfully located out-of-print reference materials that proved so useful.

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of book writing, along with her provisioning countless nourishing snacks and meals that kept me going through the writing of this work.

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## References

1. E. Broda, *Ludwig Boltzmann, Man · Physicist · Philosopher*, Ox Bow Press, Woodbridge, CT, 1983, p. 102.
2. B. Chalmers, *Principles of Solidification*, Wiley, New York, NY, 1964.

Principles of Solidification

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Concepts

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