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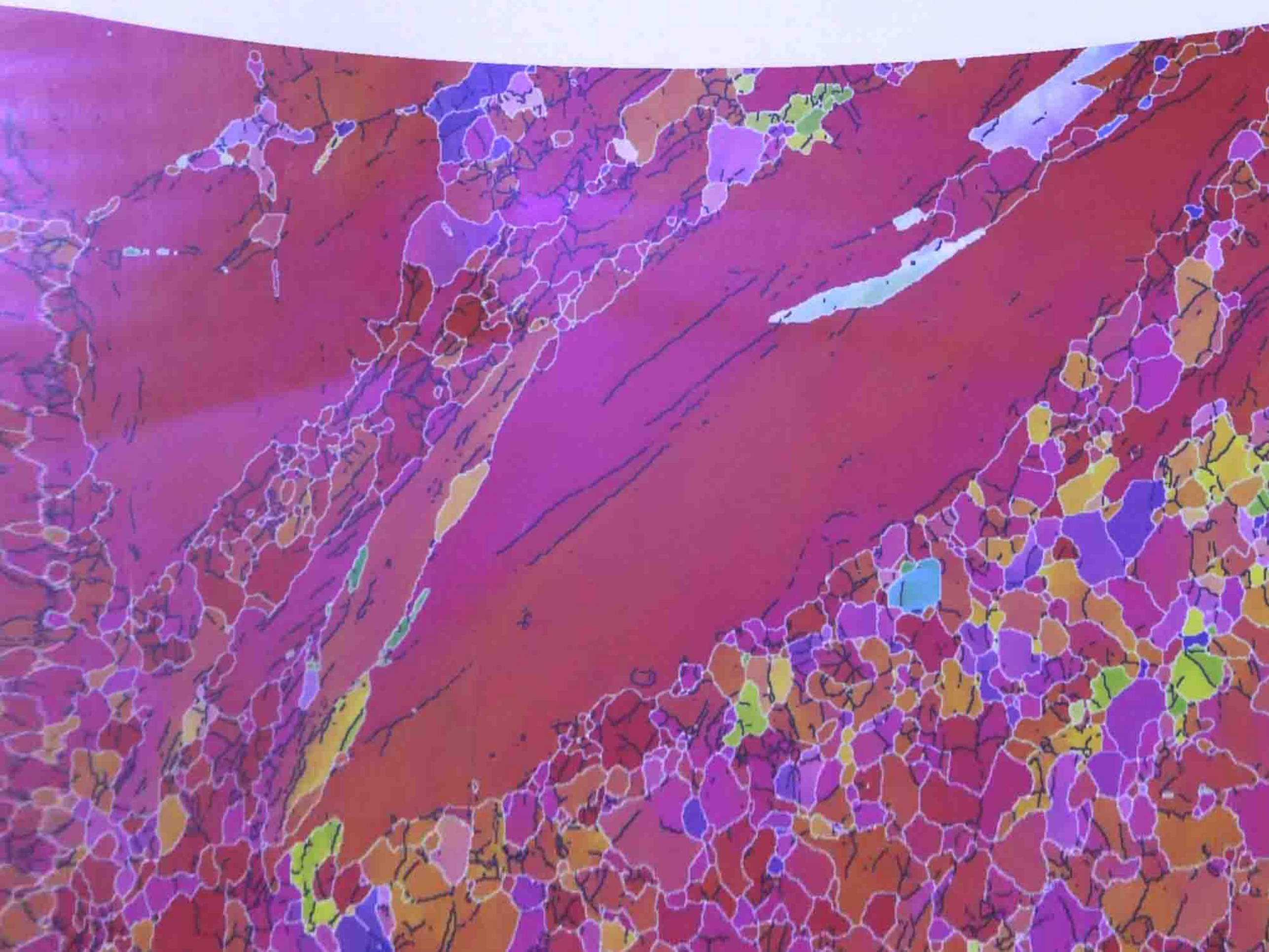
Microstructural Design of Advanced Engineering Materials



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Preface

Properties of crystalline engineering materials are directly related to their microstructure, defined as the spatial distribution of elements, phases, defects, and orientations. In view of the dramatically increased specific property material requirements during the past decades, the efforts to understand how the granular microstructure of polycrystals develops and how it can be influenced and predicted became extremely important, since microstructure control is crucial, both for improvement of materials performance and design of advanced materials with tailored properties.

The topic of microstructural design of advanced materials was recently the focus of a special symposium,[1)] in honor of Professor Dr rer. nat. Dr h.c. Günter Gottstein (*Günter Gottstein Honorary Symposium on Characterization and Design of Microstructure for Advanced Materials*), which was held in the frame of the MSE 2012 (Materials Science and Engineering) Congress in Darmstadt, Germany, September 25–27, 2012, organized by the Deutsche Gesellschaft für Materialkunde (DGM).

This book represents a collection of manuscripts written by leading scientists in the field of microstructural design of engineering materials, who were invited to deliver keynote lectures at the Günter Gottstein Honorary Symposium. This provided a unique opportunity to bring together experts in various aspects of microstructure design and to address a wide range of topics, which are crucial for predicting and controlling the microstructure evolution, including crystal plasticity due to slip, twinning, and grain boundary motion; nucleation during recrystallization; grain boundary migration under various forces; impact of boundary junctions; interfacial anisotropy and solute segregation, interaction between interfaces and particles, and so on. As obvious from the reviews comprising this book, an interaction between various research approaches – experiment, microstructural modeling, computation, and theory – is indispensable for successful and effective microstructural design of advanced engineering materials.

The book is subdivided into four parts, beginning with the modeling of the basic processes of microstructure development, that is, crystal plasticity, deformation, and

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recrystallization in different metallic materials subjected to various processing routes including severe plastic deformation. The second part addresses grain boundaries and interfaces, their kinetics and thermodynamics, and their effects on microstructure evolution. The third part is dedicated to advanced experimental methods to characterize the microstructure and to elucidate the underlying mechanisms of its development. The final chapters comprise various applications – grain boundary engineering for improving fracture resistance of various metals and alloys and microstructural design of advanced high temperature materials.

The editor is grateful to all authors for their engagement and cooperation as well as the Wiley-VCH editorial team for the enthusiasm and help to prepare and publish this book and in such a way to celebrate Professor Günter Gottstein and his unique contributions to Materials Science.

Aachen, January 2013 *Dmitri A. Molodov*

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