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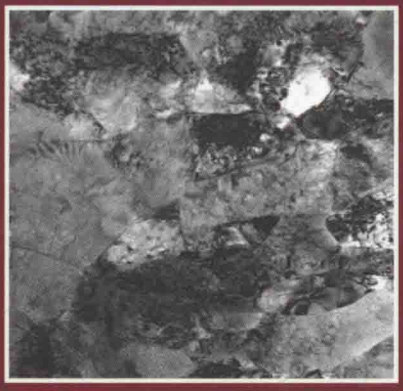

金属成形过程中的组织演化

Microstructure evolution in metal forming processes

Edited by Jianguo Lin, Daniel Balint and Maciej Pietrzyk

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影印版说明

本书总结了大量关于金属塑性成形过程中微观组织演变的建模和控制的最新研究结果，深入系统地讨论了钢变形过程中的微观组织演化规律，综述了钢相变的建模模拟、统一本构方程和微合金钢的加工硬化，分析了包括铝材成形中的时效行为等在内的其他材料成形加工中的微观组织演化现象。

金属成形过程中的组织控制是人们长期致力研究的课题。本书适合冶金、材料加工等行业的工程技术人员使用，也可供高等院校相关专业的师生参考。

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Contents

Part I

General principles

1

Understanding and controlling microstructural evolution in metal forming: an overview

T. ISHIKAWA, Nagoya University, Japan

Abstract: This chapter describes the importance of microstructure control in metal forming. The physical metallurgy of the thermo-mechanical treatment used is dependent on the various metallurgical mechanisms involved in processing. The development of the structure by thermo-mechanical treatment is a result of the interrelation of recrystallization, grain growth, precipitation and transformation. A basic overview of these phenomena and their modeling is provided, along with an explanation of the strengthening mechanisms and the relation between microstructure and mechanical properties in metallic materials, especially steels. Basic techniques for the control of microstructure evolution are described and, finally, future trends are outlined.

Key words: thermo-mechanical control processing TMCP, recrystallization, recovery, grain growth, precipitation, transformation, controlled rolling.

1.1 Introduction

Thermo-mechanical control processing (TMCP) is now a widely used method for controlling microstructure and the resultant (principally mechanical) properties in both the ferrous and the nonferrous industries.[1–5] Correct control of the microstructure, in addition to the selection of appropriate alloying elements and a suitable composition, is therefore extremely important. There are many potential benefits offered by appropriate TMCP, particularly if the same properties can be achieved by optimizing the microstructure without the addition of alloying elements, especially rare earth elements and minor metals. Use of common metals rather than rare elements also contributes substantially to environmental conservation.

Previously, the prediction and control of microstructural evolution and mechanical properties relied on the knowledge and experience of the individual engineer. In steelmaking, where processing is complex and a dynamic microstructure evolves, these individual predictions are time-consuming, requiring a great deal of effort. Furthermore, consistent control is almost impossible. However, recent advancements in physical metallurgy, in rolling and metal forming technology, in thermo-mechanical processing, and in computer engineering have allowed microstructures and mechanical properties during production to be predicted. Computer-integrated manufacturing is leading to increased productivity, reduced manufacturing costs, savings in materials and improvements in product quality (Fig. 1.1).[6] Changes in microstructures and