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Masumi Saka
Editor

Metallic Micro and Nano Materials

Fabrication with Atomic Diffusion

Springer

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ISSN 1612-1317 e-ISSN 1868-1212

ISBN 978-3-642-15410-2 e-ISBN 978-3-642-15411-9

DOI 10.1007/978-3-642-15411-9

Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2010936451

Cover design: deblik, Berlin

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Recently, various kinds of micro and nano metallic materials have been produced by using different chemical or physical techniques, and these materials have been found to possess excellent mechanical, electrical, optical and thermal properties compared with their bulk states. These micro and nano metallic materials are therefore expected to be key elements of future technologies and will be widely used to overcome worldwide issues in energy, food, health, etc. Needless to say, in many cases for particular applications, further research and development are needed to resolve the wide gap that exists between research status and their availability for practical applications.

This book covers many peripheral technologies that can be employed to effectively use existing micro and nano materials for future applications, as well as the relevant fabrication technologies. In this book we mainly examine physical methods for forming micro and nano metallic materials by controlling the diffusion of atoms, although many micro and nano metallic materials can be synthesized based on chemical reactions. Two different atomic diffusion phenomena that can be utilized for fabricating micro and nano metallic materials are introduced. The first of these is 'electromigration', which is driven by a high density flow of electrons, and the other is 'stress migration', which relies on a gradient of hydrostatic stress in the material. Techniques for evaluating the mechanical and electrical properties of these materials are also described with some practical examples. Moreover, 'modification' technologies for these materials such as cutting, welding and bending are described, along with some of their applications.

This book is consisted of six chapters. (I) Introduction: Scope of This Book. (II) Basis of Atomic Diffusion: Theoretical Background of Two Phenomena of Atomic Diffusion, i.e., Electromigration and Stress Migration. (III) Fabrication of Micro and Nano Metallic Materials: Typical Micro and Nano Metallic Materials Formed by Atomic Diffusion with Details of the Fabrication Procedures. (IV) Evaluation of Mechanical Properties: Techniques for Evaluating the Mechanical Properties of Micro and Nano Metallic Materials, such as the Concentrated-Mass Cantilever, some Kinds of Bending Tests, etc. (V) Evaluation of Electrical Properties: Techniques such as the Four-Point AFM Probe, Microwave AFM Probe, etc. for

Evaluating the Electrical Properties of Micro and Nano Metallic Materials. (VI) Modification of Nano/Micromaterials: Welding and Cutting Technologies with Joule Heat for Micro and Nano Metallic Materials, together with some Applications, and Bending of Metallic Nanowires to form Nanocoils. The authors hope that this book will play a role in making readers familiar with the key techniques in the field of micro and nano metallic materials.

The authors wish to express their gratitude to Professor Emeritus Hiroyuki Abé, Tohoku University, for his valuable advice and thankworthy encouragement to our research activities. Also we appreciate colleagues at Tohoku University; Dr. Shien Ri, Mr. Takao Shōji and Ms. Hiromi Sugawara, for their kind help in preparing the manuscript of this book. The techniques covered in this book are based on the research by the authors "Formation of Metallic Nanomaterials by Controlled Atomic Accumulation and Their Characterizations" supported by Grant-in-Aid for Scientific Research (S) 18106003.

Sendai, June, 2010 Masumi Saka

Hirosaki , June, 2010 Kazuhiko Sasagawa

Akita, June, 2010 Mikio Muraoka

Akita, June, 2010 Hironori Tohmyoh

Nagoya, June, 2010 Yang Ju

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