This book describes advances in the field of superplasticity. This is the ability of certain materials to undergo very large tensile strains, a phenomenon that has increasing commercial applications, but also presents a fascinating scientific challenge in attempts to understand the physical mechanisms that underpin it. Breakthroughs include the development of superplasticity in metallic materials at very high strain rates that are of interest to the automobile industry.

The authors emphasize the materials aspects of superplasticity. They begin with a brief history of the phenomenon. This is followed by a description of the two major types of superplasticity – fine-structure and internal-stress superplasticity – together with a discussion of their operative mechanisms. In addition, microstructural factors controlling the ductility and fracture in superplastic materials are presented. The observations of superplasticity in metals (including alloys of aluminium, magnesium, iron, titanium and nickel), ceramics (including monolithic alloys and composites), intermetallics (including iron, nickel, and titanium base), and laminates are thoroughly described. The technological and commercial applications of superplastic forming and diffusion bonding are presented and examples given.

This book will be of interest to graduate students and researchers in materials science and engineering, especially those working in the aerospace and automobile companies.

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Superplasticity in metals and ceramics

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Contents

Preface

Superplasticity, the ability of certain materials to undergo very large tensile strains, was first described in 1912. It became the subject of intense research in the early 1960s following a review of Soviet work and the illustration of the potential commercial applications of superplasticity.

There have been enormous advances in the field, of superplasticity since that time. The field has clear commercial applications, but also retains fascinating scientific challenges in understanding the underpinning physical mechanisms. Recent breakthroughs include the development of superplasticity in polycrystalline ceramics, composites and intermetallics, and also the observation of superplasticity in metallic materials at high strain rates. Superplasticity at high strain rates, in particular, is expected to have a significant technological impact on promoting the commercial applications of superplastic materials.

This book emphasizes the materials aspects of superplasticity and thus was written from the materials point of view. A brief history of the development of superplasticity is first introduced. Then, the two major types of superplasticity, i.e. fine-structure and internal-stress superplasticity, and their operative mechanisms are discussed. Other possible superplastic mechanisms, such as Class I solid solutions and superplasticity at dynamic high strain rates are also described. In addition, microstructural factors controlling the ductility and fracture in superplastic materials are presented. The observations of superplasticity in metals (including Al, Mg, Fe, Ti, Ni), ceramics (including monolithics and composites), intermetallics (including Ni-, Ti-, Fe- aluminides), metal-matrix composites (including Al-, Mg- base), and laminates are thoroughly described. Finally, the technological and commercial applications of superplastic forming

and diffusion bonding are presented and many examples are given. Over eight hundred literature citations are included in this book.

The book is recommended as a useful reference source for the practicing engineer involved in the design, processing, and manufacture of engineering structural materials. In addition, the book is ideally suited as a text for Superplasticity courses or as supplementary use for Materials Processing, Manufacturing, High Temperature Deformation, and Mechanical Berhavior courses. The materials should be of most interest to Departments of Materials Science and Engineering, Metallurgy, Ceramics, Mechanical Engineering, Aerospace Engineering, Manufacture and Processing Engineering.

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