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Current Trends in Friction Stir Welding (FSW) and Friction Stir Spot Welding (FSSW)

An Overview and Case Studies

Springer

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Foreword

In the coming years, the increase usage of lightweight alloys to replace traditional steel components is part of the aims in the transportation industry. Welding similar and dissimilar materials is an important element in the manufacturing industry. The joining of lightweight metals such as aluminium requires high heat input in the weld region due to its high thermal and electrical conductivity. This results in higher energy consumption and consequently in higher costs and may lead to large heat distortion as well as poor joint strength. On the other hand, friction stir welding (FSW) and friction stir spot welding (FSSW) between aluminium and copper could be useful in the fabrication of electrical connections and components.

The development of solid-state welding of similar and dissimilar materials has provided several benefits over the past years. FSW and FSSW are solid-state welding techniques that are environmentally friendly and are attractive areas of research and development. These joining techniques provide more advantages when compared with some of the more traditional techniques. These advantages include the elimination of solidification cracking, porosity and liquation cracking. This book presents the current trends on FSW and FSSW of similar and dissimilar materials with a focus on the joining of aluminium and copper.

This book provides a number of benefits for researchers and professionals in this field, as well as for experts. The information in the book provides a good platform for future research in the field of FSW and FSSW, and this would lead to the optimization of processes. The authors of this book have worked and have numerous publications in the field of FSW and FSSW and are accomplished researchers in these fields. Thus, the authors are well positioned to write this book. The book comprises six chapters; Chap. 1 gives an overview of different welding techniques with the focus on FSW and FSSW. The different process parameters, joint configurations and the applications of FSW and FSSW are also outlined in Chap. 1. Chapter 2 presents the current state of FSW and FSSW of aluminium and copper. Studies conducted in FSW and FSSW of aluminium and copper are summarized regarding the microstructure evolution and the mechanical properties. This could provide a good comprehension of the current state of the two processes and lead to the optimization of the two welding methods. The current state of FSW and

FSSW of similar aluminium and similar copper is presented in Chap. 3. Selected studies are summarized in terms of the tool geometries, process parameters and the resulting microstructure and mechanical properties. Furthermore, Chap. 3 also provides information which will enable researchers conduct further studies in order to expand the use of the two techniques in various industries. From Chap. 4 to 6, the authors present a case study on the joining of AA1060 to C11000 using FSSW. The case study focused on the microstructure evolution, mechanical properties such as microhardness, shear tensile strength and residual stresses. Furthermore, an investigation on the presence of intermetallics and electrical properties of the produced spot welds is presented. Interestingly, a statistical analysis was conducted and presented.

By presenting an original research on the successful joining of aluminium to copper using FSSW, the authors provide confidence to designers and engineers to consider FSSW for a wider usage in different sectors. Furthermore, the overview on the current state of FSW and FSSW of similar and dissimilar materials will give a substantial background on the current state of these two techniques. The book will also serve as a resource for researchers dealing with various challenges in joining of similar and dissimilar materials.

Therefore, I strongly recommend this book to the readers because of the benefits the book will provide, and I believe that this book will assist new researchers in the field of FSW and FSSW to have a required understanding to succeed in these research fields.

Furthermore, I encourage the readers to take full advantage of this interesting book since it is among the few if not the only book which provides an overview on FSSW between aluminium and copper through many chapters.

The joining of aluminium and copper is particularly interesting, as it can help in the field of electromobility to realize significant weight and cost savings.

Prof. Stefan Böhm

Preface

There are numerous new applications in many industries, including the following: power generation, chemical, petrochemical, nuclear, aerospace and manufacturing. The evolving application required the development of new ways of joining similar and dissimilar materials; and this led to the development of friction stir welding (FSW) and friction stir spot welding (FSSW) for similar and dissimilar materials. There are many books on friction stir welding of similar and dissimilar materials; but the friction stir spot welding process has not yet been given similar attention as an emerging technology. Therefore, this book focuses on reporting the current trends on friction stir welding and friction stir spot welding—with the emphasis on friction stir spot welding between aluminium and copper.

Chapter 1 introduces the theories on different welding techniques. Furthermore, the current state of friction stir welding and friction stir spot welding between aluminium and copper is presented. Chapter 2 presents an overview on friction stir welding and friction stir spot welding between aluminium and copper, with the focus on the microstructural evolution, chemical properties and mechanical properties. The current state of friction stir spot welding and friction stir welding of similar aluminium and similar copper materials is presented in Chap. 3.

Joining dissimilar materials is essential for the manufacturing of various structures and parts in the industrial sector. Materials, such as aluminium and copper, are commonly used in engineering structures and parts. This is due to their unique performance, including higher electrical conductivity, heat conductivity, corrosion resistance and mechanical properties. But the two materials have different melting points, namely 660.3 °C for aluminium and 1085 °C for copper. Consequently, Chaps. 4–6 presents case studies on the joining of aluminium and copper in terms

of the microstructural evolution, the mechanical and electrical properties, and the residual stresses. This book is intended to present the current trends on FSW and FSSW, to enable both engineers and researchers to explore the further development of these two techniques.

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