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Force Sensors for Microelectronic Packaging Applications

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Preface

This book describes a new family of integrated force sensors based on a standard industrial microcircuit technology. The sensors are mainly applied as real-time in situ monitors of the thermosonic wire bonding process commonly used in microelectronics manufacturing.

The background of the book is an eight year long collaboration project between the Physical Electronics Laboratory (PEL) at the Swiss Federal Institute of Technology (ETH), Zurich, and ESEC SA, Cham, both in Switzerland. The work was sponsored by ESEC, the Swiss Commission for Technology and Innovation (CTI), and the Swiss Federal Priority Program MINAST. The project goal was to develop new sensing schemes to better understand bonding processes, facilitate product development and finally improving the existing bonding process, by combining the expertise in integrated sensor development of PEL with the state-of-the-art microelectronic bonding processes of ESEC. During the collaboration project, two of the authors started and finished their disserations which form parts of this book.

In microelectronic manufacturing the thermosonic bonding of gold wires onto aluminum metallization is the most frequently used process for electrical chip to package interconnection. It is a permanent requirement to bond thinner and thinner wires faster and faster. Process mastery is unusually difficult to achieve compared with that of other processes in the field of microelectronics assembly and packaging. We believe miniaturization and cost reduction in this field are tasks that need to be addressed with new technologies, such as the microsensor technology presented in this book.

After an introduction to the wire bonding process in Chap. 1, the reader is guided through the sensor design concept in Chap. 2 and the description of the measurement system in Chap. 3 which also describes an ultrasonic capillary simulation model used to obtain the vibration profile. Chapter 4 summarizes the thorough characterization of the microsensors. Their application for the bonding equipment development, bonding process understanding, and flip-chip reliability characterization is described in Chap. 5, followed by conclusions and an outlook in the last chapter.

The authors are indebted to many colleagues and former students at ESEC and PEL for stimulating discussions, helpful comments, and useful suggestions. In particular, the help of Dr. Daniel Bolliger, Martin Zimmermann, Dr. Christoph Maier, Wan Ho Song, Jan Mattmüller, Antoine Delacrétaz, Stefan Odermatt, Maurice Zacchardi and Andres Erni is gratefully acknowledged. The substantial contributions of Michael Althaus and Quirin Füglistaller to the electronics and software are highly

appreciated. With their help the measurement technology presented here has reached the high level of user friendliness which enables any ESEC R&D engineer to use it independently. The continuous support by Prof. Dr. Henry Baltes, director of the Physical Electronics Laboratory (PEL) at ETH Zurich, is gratefully acknowledged. Last but not least our special thanks go to Prof. Dr. Oliver Paul and Hans-Ulrich Müller who, nine years ago, were the first to initiate the real-time use of microsensors for microelectronics packaging processes.

April 2004
Cham, Switzerland, and Atlanta, USA

Jürg Schwizer
Michael Mayer
Oliver Brand

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