Preface

Microsystems technology (MST) or Microelectromechanical systems (MEMS) how it is called in America is a comparatively young emerging technology, which allows building up miniaturized devices such as microvalves for implantable medicament dosing systems or micro-total analysis systems (μTAS) which shall provide a miniaturized laboratory on a polymer chip just a few centimeters in size. The first steps to MST had been done more than 30 years ago when anisotropic etching of silicon was discovered [1] and sacrificial layer technique was invented [2].

Nowadays, MST is a well-established technology which is the basis of many products. Modern life in many fields is based on a variety of microsystems unnoticed by most of us. In most cars, microsensors for the measurement of acceleration, yaw rate, pressure, and flow are implemented. Watches, hearing aids, mobile phones, beamers, ink-jet printers, PCs, and catheters for minimal invasive surgery are other examples of applications which became possible in the present form by microtechnologies only. Accordingly, many jobs are available in microtechnique and much more jobs are depending on it.

In previous decades, the fabrication techniques of MST had been the main issue of research and development resulting in today's more or less standard production processes such as bulk silicon etching, reactive ion etching, surface micromachining, micromolding, silicon fusion bonding, etc. These processes are well described in several text books [3–6], and, therefore, are available for both industry and teaching at universities.

However, MST is not only characterized by its novel fabrication processes. The transition to smaller dimensions is combined with the need for a change in design also. A miniaturized sensor or actuator requires a different design due to both the new fabrication techniques and the smaller scale which results in a change of the significance of effects and forces. For example, capillary force is of no importance in the macroscopic world, while it may be used as the driving force in microscopic designs. The piezoelectric effect and thermal strain are known and need to be considered in macroscopic engineering but play a much more important role in MST.

Until now, there is no textbook which describes the design of micro systems systematically. Therefore, this book was written to fill this gap. It is based on a course given at RWTH Aachen University and Tsinghua University in Beijing for undergraduate students in their fifth or higher semester. This book may be used as

the basis for similar courses, for self-study, or as a reference for the experienced engineer. All the equations presented here are not limited to microsystems but are valid in general. Therefore, this book may help also engineers working in different fields.

This book does not describe the fabrication processes of MST but can be understood without knowing these processes. It provides the basic equations needed to calculate or at least estimate the order of magnitude of the effects and forces which are important in MST. For quick reference, these equations are presented in tables which are found in an index on page xxi.

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