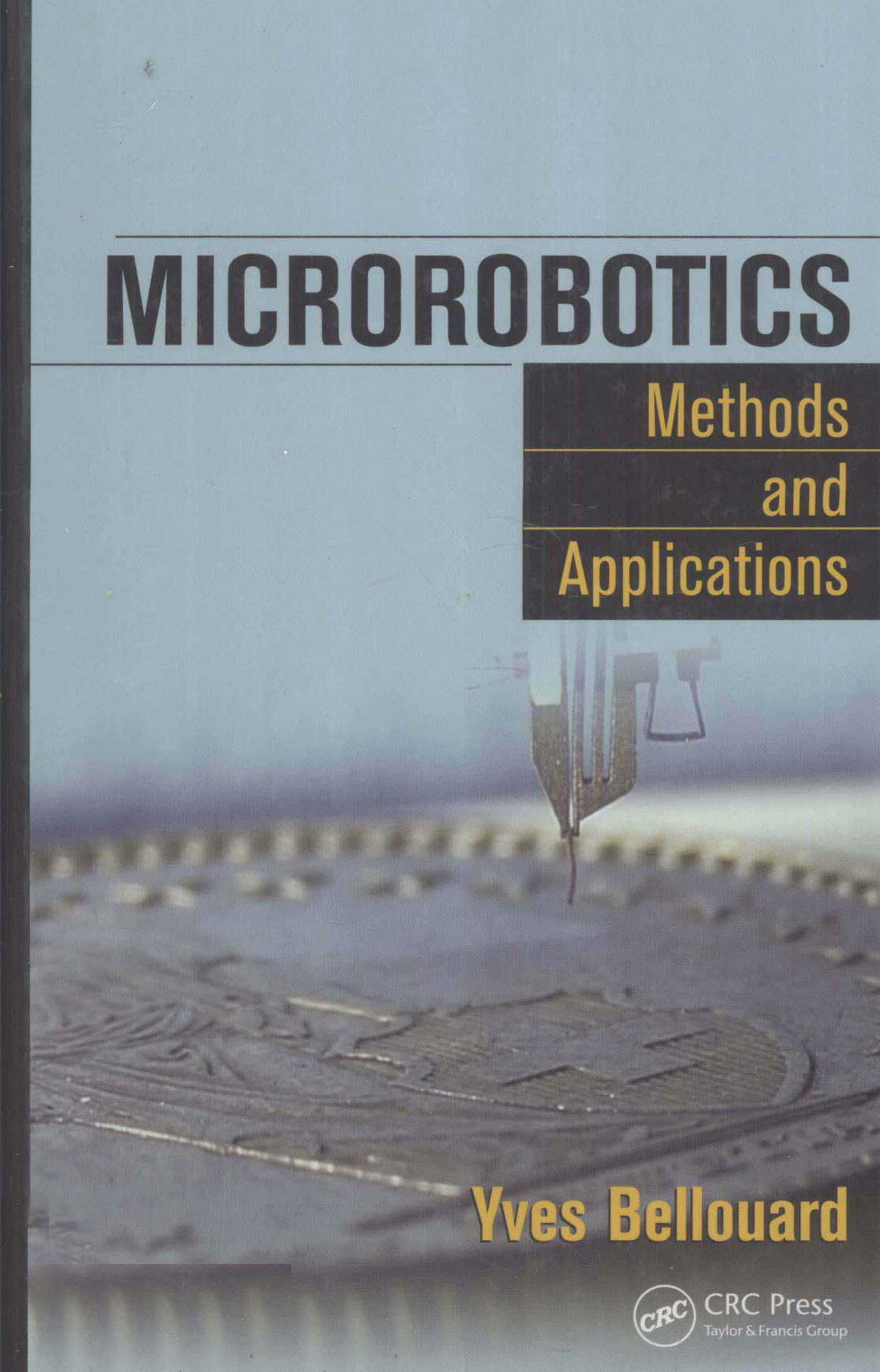


MICROROBOTICS

A microscopic image showing a robotic probe tip positioned over a microchip. The probe is a small, metallic, V-shaped structure with a fine tip. The microchip below it is a dark, rectangular surface with intricate, light-colored circuit patterns. The background is a soft, out-of-focus blue and white, suggesting a laboratory or industrial setting.

Methods
and
Applications

Yves Bellouard



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To Marie-France and H  lo  se

Preface

From conception to realization, this book covers all aspects of miniaturized systems that physically interact and manipulate objects at the microscale. It provides an understanding of this multidisciplinary field, which combines areas of materials science, mechanical engineering, and applied physics. It also describes how to implement various methods suitable for addressing microrobotics problems and includes numerous exercises as well as homework problems.

This book envisions the future of microrobotics and explores its potential contributions to technology with a broad overview of the current state of the art from the perspectives of research and industry.

It is primarily a textbook and may be used for undergraduate and graduate teaching activities; it may also be of particular interest to practicing engineers and scientists. It is essentially based on lectures that I delivered at the Rensselaer Polytechnic Institute in Troy, New York, and later at Eindhoven University of Technology (TU/e) in the Netherlands.

With this book, my prime objective is to stimulate the interests of engineering students and engineers for design-oriented multidisciplinary activities. This is an excellent topic to reach out across disciplines that are usually taught in different faculties or departments.

The book is written so that it does not require extensive prerequisites. The first chapters introduce basic results from strength of materials, mechanics, and applied physics that are needed for the understanding of the following chapters. Numerous exercises are provided to better understand the content of this book. Solutions and additional materials useful for teaching activities can be found at the companion Web site for this book provided by the publisher.

I am very thankful to Professor Reymond Clavel (known worldwide for his invention of the Delta-robot) at Ecole Polytechnique Fédérale de Lausanne (EPFL), who first introduced me to the field of microrobotics. His laboratory and more generally EPFL have undoubtedly made very significant contributions to the field of microengineering, that are broadly recognized today. Several of these achievements have been illustrated in this book.

I also gratefully acknowledge suggestions, comments, and support from former colleagues and friends, namely, Dr. Jean-Marc Breguet (Centre Suisse d'Electronique et Microtechnique—CSEM), Professor Rolf Wuethrich (Concordia University), Professor John Wen and Glenn Saunders (Rensselaer Polytechnic Institute), Professor Max-Olivier Hongler (EPFL), Dr. Benjamin Potsaid (Thorlabs/Massachusetts Institute of Technology), Professor

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Dr. Bellouard has published several journal and conference papers covering various aspects of micro/nanoscale engineering and, in particular, microrobotics.

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