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## Preface

Electrical impedance tomography (EIT) seeks to recover the electrical conductivity distribution inside a body from measurements of current flows and voltages on its surface. The vast and growing literature reflects many possible applications of EIT techniques, *e.g.*, for medical diagnosis or nondestructive evaluation of materials.

Since the underlying inverse problem is nonlinear and severely ill-posed, general purpose EIT reconstruction techniques are likely to fail. Therefore it is generally advisable to incorporate a-priori knowledge about the unknown conductivity. One such type of knowledge could be that the body consists of a smooth background containing a number of unknown small inclusions with a significantly different conductivity. This situation arises for example in breast cancer imaging or mine detection. In this case EIT seeks to recover the unknown inclusions. Due to the smallness of the inclusions the associated voltage potentials measured on the surface of the body are very close to the potentials corresponding to the medium without inclusion. So unless one knows exactly what patterns to look for, noise will largely dominate the information contained in the measured data. Furthermore, in applications it is often not necessary to reconstruct the precise values of the conductivity or geometry of the inclusions. The information of real interest is their positions and size.

The main purpose of this book is to describe fresh and promising techniques for the reconstruction of small inclusions from boundary measurements in a readable and informative form. These techniques rely on accurate asymptotic expansions of the boundary perturbations due to the presence of the inclusions. The general approach we will take to derive these asymptotic expansions is based on layer potential techniques. This allows us to handle inclusions with rough boundaries. In the course of deriving our asymptotic expansions, we introduce new concepts of generalized polarization tensors (GPT's). GPT's contain significant information on the inclusion which will be investigated. We then apply the asymptotic expansions for designing efficient direct

reconstruction algorithms to detect the location, size, and/or orientation of the unknown inclusions.

This book would not have been possible without the collaborations and the conversations with a number of outstanding colleagues. We have not only profited from generous sharing of their ideas, insights and enthusiasm, but also from their friendship, support and encouragement. We feel specially indebted to Gen Nakamura, Jin Keun Seo, Gunther Uhlmann and Michael Vogelius. This book is dedicated to our friendship with them.

We also would like to thank our colleagues Mark Asch, Yves Capdeboscq, and Darko Volkov for reading parts of the preliminary version of the manuscript and our students Ekaterina Iakovleva, Eunjoo Kim, Mikyoung Lim, Kaouther Louati, Sofiane Soussi, Karim Touibi, and Habib Zribi for providing us with numerical examples or/and carefully reading our manuscript.

During the preparation of this book we were supported by ACI Jeunes Chercheurs (0693) from the French Ministry of Education and Scientific Research and Korea Science and Engineering Foundation through the grant R02-2003-000-10012-0.

Paris and Seoul,  
May 2004

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Reconstruction of Small Inhomogeneities from  
Boundary Measurements

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2004, X, 242 p., Softcover

ISBN: 978-3-540-22483-9