

Preface

Theoretical modelling of transient electroanalytical experiments is commonly accomplished by formulating and solving initial or initial-boundary value problems that describe transport of reactants, homogeneous and heterogeneous reactions, and other phenomena taking place in electrochemical systems. The conversion of these problems into integral equations, subsequently solved analytically or numerically, is a classical modelling method which has contributed significantly to the development of electroanalytical techniques. Although this method has limitations (compared to direct solutions of differential equations by finite difference, finite element, or similar methods), it can be more rewarding (in cases when it is applicable) owing to additional theoretical insights that it offers. It can also bring a reduction of the costs of numerical simulations, albeit at the expense of extra human effort needed for the derivation of the integral equations. The method is therefore worthy of application and development. Unfortunately for anybody willing to learn and use the method, its theoretical principles and example applications are scattered in the electrochemical literature, and none of the existing textbooks provides its comprehensive description. Even the last edition of the monograph by Dieter Britz, “Digital Simulation in Electrochemistry” (Springer, Berlin, 2005), which is currently the most thorough compendium of numerical methods used for simulating transient experiments, devotes only two pages to the integral equation method.

At the same time, integral equations arising in electroanalytical chemistry remain almost unknown to mathematicians or computational scientists engaged in studies of integral equations, and are rarely used as examples, or as an inspiration for research.

The present book is intended to help electrochemists, mathematicians, and computational scientists, to get acquainted with the integral equation method in electroanalytical chemistry, by providing a (hopefully) comprehensive state-of-the-art overview of the method and its applications. It is hoped that the book will stimulate interdisciplinary research, resulting in new developments of the method, and enlargement of its application scope.

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