Preface

This book was motivated by the extensive amount of literature dedicated to nanocrystalline (NC) materials published over the last two decades. The authors have been greatly interested in this new emerging field and wished to provide a comprehensive state-of-the-art text on the matter. Therefore, this oeuvre is suited for graduate students and research scientists in mechanical engineering and materials science. All chapters are written such that they can be read independently or consecutively.

Since their discovery in the early 1980s, NC materials have been the subject of great attention, for they revealed unexpected fundamental phenomena, such as the breakdown of the Hall-Petch law, and suggested the possibility of reaching the ever-so-challenging large-ductility/high-yield stress compromise. Although the problem of describing the behavior of NC materials is still challenging, numerous fundamental, computational, and technological advances have been accomplished since then. Most of these are presented in this book. By raising the difficulties and remaining problems to solve, the book highlights new directions for research to develop rigorous and complete multi-scale methods for NC materials.

The introduction of this book chronologically summarizes the different advances in the field. Chapter 1 is dedicated to the presentation of the most commonly employed processing methods. Chapter 2 presents the microstructures of NC materials as well as their elastic and plastic responses. Additionally, Chapter 6 introduces a discussion of several plastic deformation mechanisms of interest. In all other chapters, modeling techniques and advanced fundamental concepts particularly relevant to NC materials are presented. For the former, continuum micromechanics, molecular dynamics, the quasi-continuum method, and nonconventional finite elements are discussed. For the latter, grain boundary models and interface modeling are discussed in dedicated chapters. Given the vast diversity of subjects encompassed in this book, references are provided for readers interested in more specialized discussion of particular subjects. Applications of each concept and method to the case of NC materials are presented in each chapter. The last two chapters of this book are dedicated to more advanced material and aim at showing original methods allowing multi-scale material's modeling.

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