Preface

Tribology is the science and technology of interacting surfaces in relative motion and of related subjects and practices. The nature and consequences of the interactions that take place at the moving interface control its friction, wear and lubrication behavior. Understanding the nature of these interactions and solving the technological problems associated with the interfacial phenomena constitute the essence of tribology. The importance of friction and wear control cannot be overemphasized for economic reasons and long-term reliability.

The recent emergence and proliferation of proximal probes, in particular tip-based microscopies and the surface force apparatus and of computational techniques for simulating tip-surface interactions and interfacial properties, has allowed systematic investigations of interfacial problems with high resolution as well as ways and means for modifying and manipulating nanostructures. These advances provide the impetus for research aimed at developing a fundamental understanding of the nature and consequences of the interactions between materials on the atomic scale, and they guide the rational design of material for technological applications. In short, they have led to the appearance of the new field of nanotribology and nanomechanics.

The field of tribology is truly interdisciplinary. Until 1980s, it had been dominated by mechanical and chemical engineers who conduct macro tests to predict friction and wear lives in machine components and devise new lubricants to minimize friction and wear. Development of the field of nanotribology has attracted many more physicists, chemists, and material scientists who have significantly contributed to the fundamental understanding of friction and wear processes and lubrication on an atomic scale. Thus, tribology and mechanics are now studied by both engineers and scientists. The nanotribology and nanomechanics fields are growing rapidly and it has become fashionable to call oneself a "tribologist." The tip-based microscopies have also been used for materials characterization as well as for measurement of mechanical and electrical properties all on nanoscale. Since 1991, international conferences and courses have been organized on this new field of nanotribology, nanomechanics, and nanomaterials characterization.

There are also new applications which require detailed understanding of the tribological and mechanics processes on macro- to nanoscales. Since early 1980s, tribology of magnetic storage systems (rigid disk drives, flexible disk drives, and tape drives) has become one of the important parts of tribology. Microelectromechanical Systems (MEMS)/ Nanoelectromechanical Systems (NEMS) and biodevices, all part of nanotechnology, have appeared in the marketplace in the 1990s which present new tribological challenges. Another emerging area of importance is biomimetics. It involves taking ideas from nature and implementing them in an application. Examples include Lotus effect and gecko adhesion. Tribology of processing systems such as copiers, printers, scanners, and cameras is important although it has not received much attention. Along with the new industrial applications, there has been development of new materials, coatings and treatments such as synthetic diamond, diamondlike carbon films, self assembled monolayers, and chemically grafted films, to name a few with nanoscale thicknesses.

It is clear that the general field of tribology has grown rapidly in the last 30 years. Conventional tribology is well established but nanotribology and nanomechanics are evolving rapidly and have taken the center stage. New materials are finding use. Furthermore, new industrial applications continue to evolve with their unique challenges.

Very few tribology handbooks exist and these are dated. They have focused on conventional tribology, traditional materials and matured industrial applications. No mechanics handbook exists. Nanotribology, nanomechanics, and nanomaterial characterization are becoming important in many nanotechnology applications. A primer to nanotribology, nanomechanics, and nanomaterial characterization is needed. The purpose of this book is to present the principles of nanotribology and nanomechanics and applications to various applications. The appeal of the subject book is expected to be broad. The first edition was published in 2005 and the second in 2008. This third edition is an update based on recent developments.

The chapters in the book have been written by internationally recognized experts in the field, from academia, national research labs and industry, and from all over the world. The book integrates the knowledge of the field from mechanics and materials science points of view. In each chapter, we start with macroconcepts leading to microconcepts. We assume that the reader is not expert in the field of nanotribology and nanomechanics, but has some knowledge of macrotribology/ mechanics. It covers various measurement techniques and their applications, and theoretical modeling of interfaces. Organization of the book is straightforward. The first part of the book covers fundamental experimental and theoretical studies. The latter part covers applications.

The book is intended for three types of readers: graduate students of nanotribology/ nanomechanics/nanotechnology, research workers who are active or intend to become active in this field, and practicing engineers who have encountered a tribology and mechanics problem and hope to solve it as expeditiously as possible. The book should serve as an excellent text for one or two semester graduate courses in scanning probe microscopy/applied scanning probe methods, nanotribology/

nanomechanics/nanotechnology in mechanical engineering, materials science, or applied physics.

I would like to thank the authors for their excellent contributions in a timely manner. And I wish to thank my wife, Sudha, my son, Ankur, and my daughter, Noopur, who have been very forbearing during the preparation of this book.

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