

Preface

Tribology (from the Greek word τριβω “tribo” meaning “to rub”) is the interdisciplinary area of science and technology that involves the study of the interaction of solid surfaces in relative motion. Typical tribological studies cover friction, wear, lubrication, and adhesion. These studies involve the efforts of mechanical engineers, material scientists, chemists, and physicists. The word “tribology” was coined in the 1960s when it was realized that it may be beneficial for engineers and scientists studying friction, lubrication, and wear to collaborate in the framework of the new interdisciplinary area. Since then, many new areas of tribological studies have been suggested, which are at the interface of various scientific disciplines. These areas include nanotribology, biotribology, the tribology of magnetic storage devices, and micro/nanoelectromechanical systems. The research in these areas is driven mostly by the advent of new technologies and new experimental techniques for surfaces characterization.

Green tribology is a new, separate research area that is emerging, and it is defined as the science and technology of the tribological aspects of ecological balance and of environmental and biological impacts. There are a number of tribological problems that can be put under the umbrella of green tribology, and they are of mutual benefit to one another. These problems include tribological technology that mimics living nature (biomimetic surfaces) and thus is expected to be environment-friendly, the control of friction and wear that is of importance for energy conservation and conversion, environmental aspects of lubrication and surface modification techniques, and tribological aspects of green applications such as wind-power turbines, tidal turbines, or solar panels.

Since the 2000s, there have been several publications dealing with the economic and social implications of the ecological aspects of tribology. Most of these papers were prepared by economists and people involved in the strategic planning of research. The first scientific volume completely devoted to green tribology, which emphasized scientific rather than societal and economic aspects, appeared in 2010, and it was the theme issue of the *Philosophical Transactions of the Royal Society, Series A* (Volume 368, Number 1929) edited by M. Nosonovsky and B. Bhushan. In that volume, three areas of green tribology were identified:

biomimetic tribology, eco-friendly lubrication and materials, and tribological aspects of sustainable energy applications. The assumption was that combining these three areas, rather than focusing on narrow issues such as biodegradable lubrication, would mutually enhance them and establish new connections. Several workshops, conference sections, and symposia took place after that, which confirmed this inclusive approach, as well as the interest in green tribology in general.

The present publication in Springer to a certain degree extends that work: whereas some authors who participated in that volume also submitted their new results into the present volume, new authors participated as well. Prominent experts in various areas were invited that fit the definition of Green Tribology. The international group of authors include tribologists from the U.S., the U.K., Austria, Australia, Canada, India, South Africa, China, Israel, and Malaysia. Some of the authors are from academic institutions, while others are practical engineers from the industry. At University of Wisconsin–Milwaukee (UWM) a big group of tribologists has worked since 2009 on various aspects related to green tribology, and the results of their efforts are presented in the current volume. The biomimetic surfaces, including those using the Lotus, rose petal, gecko, and shark skin effects as well as tribology of human skin and hair were studied actively at the Ohio State University (OSU) in the past decade.

After a review of the current state of green tribology and its history, the main content of this book is divided into three parts. First, biomimetics in tribology is discussed, including biomimetic surfaces, materials, and methods. Biomimetic approaches follow the ways found in living nature and thus are expected to be eco-friendly. This includes non-adhesive surfaces mimicking flower (e.g., Lotus and rose) leaves, wetting transitions on these surfaces, biomimetic adhesion control for antifouling, polymeric and metal-based composite materials, and surfaces capable of friction-induced self-organization (self-lubrication, self-cleaning, and self-healing) as well as biomimetics in nanotribology. Second, green and sustainable materials and lubricants are reviewed. This involves water, ice, and natural oil-based lubrication, eco-friendly products for tribological applications involving natural fiber reinforced composites, fly ash, cements, and lubricant additives. The third part includes tribology of eco-friendly applications, such as wind turbines, biorefineries, and marine wave energy collectors. Some of the chapters emphasize the review of the current state of the area, while others stress the research conducted by the investigators.

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