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Book Review:
Nanoscience: Friction and Rheology on the Nanometer Scale

E. Meyer, RM Overney, K. Dransfeld, and T. Gaylog, World Scientific, Singapore, 1998; pp. 373
ISBN: 9810225628; $70.00

Friction is a ubiquitous natural phenomenon. It is largely due to friction that we are able to sense objects by touch and to manipulate them with precision. When under control, friction produces music in strings; it also causes large-scale disaster by cooperating ruthlessly with massive systems, as in earthquake. In modern technologies, such as in MEMs and magnetic data storage devices, it is mandatory to reduce friction well below their usual levels.

It is no wonder that mankind have tried to unravel the mysteries of friction since antiquity. Masters of ancient civilizations knew that friction increases with the roughness of solids and it decreases in the presence of liquid lubricants. The most systematic studies of friction were however pioneered by Bowden and Tabor, who investigated the intricate relationships between friction and adhesion as well as the area of contact between solids. The devices to measure friction between surfaces have now become extremely sophisticated. Significant breakthroughs have been made possible with the advents of surface force apparatus and atomic force microscopy, which provide information of interfaces at submicroscopic levels. Questions regarding friction have also become substantially interdisciplinary and matured. The field is moving forward so rapidly that documentation of these advances appears to be too daunting a task for a single practitioner in the field. “Nanoscience” owes its success to four unique practitioners who have harmoniously blended their respective strengths in order to produce a highly readable text.

The text is divided into nine chapters with plentiful of references. The first chapter is motivational and provides a nostalgic account of the early studies in friction by Desaguliers, da Vinci, Amontons, Euler and Coulomb. The second chapter is on instrumentation, which introduces the classical and modern methods of tribometry that include surface force apparatus, quartz crystal microbalance and scanning force microscopy (SFM). The reader gets first hands taste of SFM, which were largely pioneered by the authors. The third chapter introduces the different types of intermolecular forces that are important in order to understand how an SFM tip interacts with various surfaces. Chapters 4 and 6 discuss respectively the different models of friction pertaining to the dry and lubricated interfaces. While chapter 4 attempts to unfold the origin of friction at atomistic level, chapter 6 dwells on continuum mechanics, and the rheology in confined spaces. Both the chapters are masterfully written. The rather short chapter 5 catalogues various methods of dissipation that occurs in frictional sliding. Perhaps, this interesting chapter could have been written at a greater depth, even including a discussion on the generation and propagation of interfacial dislocations. Chapter 7 discusses how ultrasonic waves are generated in sliding friction and puts forth some provocative suggestions of how friction could even be modulated by ultrasonic waves. Chapter 8 describes, in some details, the typical experiments that are usually conducted using friction force microscopy. It discusses the roles of environment in nanotribological measurements and introduces the recent developments in the chemical force microscopy of organic monolayers. The last chapter (ch 9) is about the instrumental aspects of the friction force microscopy, which is added to the text as an appendix. The chapter provides valuable information about the fabrication and calibration of the AFM tips and cantilevers.

The text is very well written and is recommended for senior undergraduate and graduate students in science and engineering. It is a valuable resource for the novices as well as the experts working in the field of tribology.

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