Friction at the nanoscale

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PREFACE

Friction at the nanoscale

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Interfacial friction is one of the oldest problems in physics and chemistry, and certainly one of the most important from a practical point of view. Everyday operations on a broad range of scales, from nanometer and up, depend upon the smooth and satisfactory functioning of countless tribological systems. Friction imposes serious constraints and limitations on the performance and lifetime of micro-machines and, undoubtedly, will impose even more severe constraints on the emerging technology of nano-machines. Standard lubrication techniques used for large objects are expected to be less effective in the nano-world. Novel methods for control and manipulation are therefore needed.

What has been missing is a molecular level understanding of processes occurring between and close to interacting surfaces to help understand, and later manipulate friction. Friction is intimately related to both adhesion and wear, and all three require an understanding of highly non-equilibrium processes occurring at the molecular level to determine what happens at the macroscopic level. Due to its practical importance and the relevance to basic scientific questions there has been major increase in activity in the study of interfacial friction on the microscopic level during the last decade. Intriguing structural and dynamical features have been observed experimentally. These observations have motivated theoretical efforts, both numerical and analytical.

This special issue focusses primarily on discussion of microscopic mechanisms of friction and adhesion at the nanoscale level. The contributions cover many important aspects of frictional behaviour, including the origin of stick-slip motion, the dependence of measured forces on the material properties, effects of thermal fluctuations, surface roughness and instabilities in boundary lubricants on both static and kinetic friction. An important problem that has been raised in this issue, and which has still to be resolved, concerns the possibility of controlling frictional response. The ability to control and manipulate frictional forces is extremely important for a variety of applications. These include magnetic storage and recording systems, miniature motors, and more.

This special issue aims to provide an overview of current theoretical and experimental works on nanotribology and possible applications. In selecting the papers we have tried to maintain a balance between new results and review-like aspects, so that the present issue is self-contained and, we hope, readily accessible to non-specialists in the field. We believe that the particular appeal of this collection of papers also lies in the fusion of both experiment and theory, thus providing the connection to reality of the sometimes demanding, mathematically inclined contributions.

Profound thanks go to all our colleagues and friends who have contributed to this special issue. Each has made an effort not only to present recent results in a clear and lucid way, but also to provide an introductory review that helps the reader to understand the different topics.

