THE QUALITY OF MICROTRIBOLOGICAL MEASUREMENTS

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The stiction, high friction and wear associated with moving microsystems as well as tribological issues related to the micromachining of coatings on silicon and other surfaces have led to a strong interest in microtribology. In addition, even macroscopic studies can, in some cases, benefit from microtribological information. Microtribological instrumentation, home-built as well as commercial, now exist to study adhesion, friction and wear on the microscale. However, there is still a need to identify factors affecting the quality of microtribological data. Here quality means the meaningfulness of experimental results and their reproducibility when measured under similar conditions. While it should be possible to collect the same data (within reasonable experimental errors) for similar systems, on the microscale, there are many pitfalls that can affect data quality. Some of these pitfalls are unique to this regime. Most issues affecting data quality in microtribology can be classified into two groups: instrumental and sample-counterbody factors.

Instrumental issues such as the quality of the force transducer, usually a bending element of some kind, can play an important role. Variations in the accuracy of its construction can, for example, lead to a coupling of normal and lateral forces, causing inconsistencies when comparing results collected from different force transducers. Another important issue is the precision of the experimental configuration: even slight misalignments can result in “bad” data yielding a too high or low friction force (or coefficient). The degree of accuracy depends on the length scale of the experiment. Finally, environmental control is critical in some experiments as surface forces play a dominant role in the microtribological regime.

Sample-counterbody effects are also important and must be carefully considered when designing an experiment. Factors such as variations in the surface roughness of samples and/or counterbodies and changes of their surface properties during the course of an experiment can lead to data collection and reproducibility problems. In some cases such problems can also result in misinterpretation of the data. Controlling quality here is possible but by no means easy. It involves frequent comparisons with “standard” surfaces (samples and counterbodies), which themselves are a challenging subject.

This talk presents an overview of the problems affecting the quality of tribological data on the microscale.