The Triboelectric Component of Friction Force

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Introduction

Friction and triboelectrification of materials are well-known phenomena and have been exhaustively studied for many years. Despite the great technological advances, their mechanisms at the atomic/molecular level are not fully understood and still a matter of debate. Specifically, friction force is rarely correlated with the electronic properties of materials,[1] and triboelectrification,[2] which occurs whenever two solids rub or touch each other, remains among the most poorly understood concepts of solid-state physics.

Since electrostatic charges produced by mechanochemical reactions are always build-up at interfaces under relative motion and electrostatic interactions are long-range forces, we performed experiments dealing on the interconnection of electrostatic charges and the friction properties at different interfaces, where both phenomena were found to have a common microscopic origin.

Results e Discussion

Experiments to determine friction coefficients on tribocharged dielectric surfaces are highly affect by electrostatic charges. As a result, friction coefficients at the macro- and nanoscales increase many-fold when surfaces are tribocharged. Figure 1 shows the adhesion maps obtained by atomic force microscopy (AFM) on PTFE (polytetrafluorethylene) surface exposed to friction. The region of contact increases the pull-off force from 10 to 150 nN, reflecting on a resilient electrostatic adhesion between charged dielectrics and the tip probe. This strong electrostatic interaction reflects directly on the macroscopic friction force, specifically stick-slip phenomena (events of force maxima) recorded in a tribometer using the ball-on-disk geometry, where the metal ball was connected to the input of an electrometer measuring the electrical current, also called tribocurrent. Stick-slip phenomena are always accompanied tribocharging events at metal–insulator interfaces: injection of charged species from the metal into insulator followed by the flow of charges from insulator to the metal surface[3].

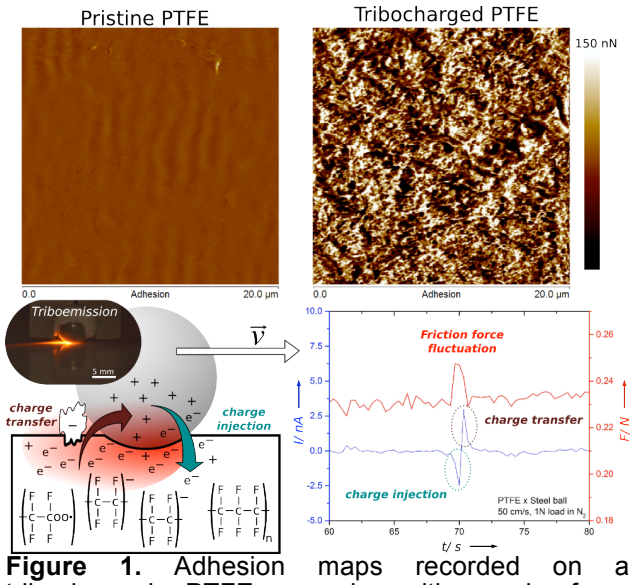

Figure 1. Adhesion maps recorded on a tribocharged PTFE sample with peak force nanomechanical quantitative AFM mode (PKQNM™) and tribocurrent recorded online and insitu during ball-on-disk experiments.

Conclusion

In conclusion, tribocharging may supersede all other contributions to macro- and nanoscale friction coefficients in dielectrics and other materials. Moreover, experiments suggest that both friction and triboelectrification have a common microscopic origin.

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