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APPLIED SCIENCES AND ENGINEERING

Minimizing friction, wear, and energy losses by eliminating contact charging

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Vishal

Important for those working on

Electrostatic charging (Dust)

Coatings.

Mass spec.

The Mosaic of Surface Charge in Contact Electrification

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When dielectric materials are brought into contact and then separated, they develop static electricity. For centuries, it has been assumed that such contact charging derives from the spatially homogeneous material properties (along the material's surface) and that within a given pair of materials, one charges uniformly positively and the other negatively. We demonstrate that this picture of contact charging is incorrect. Whereas each contact-electrified piece develops a net charge of either positive or negative polarity, each surface supports a random "mosaic" of oppositely charged regions of nanoscopic dimensions. These mosaics of surface charge have the same topological characteristics for different types of electrified dielectrics and accommodate significantly more charge per unit area than previously thought.

Control of Surface Charges by Radicals as a Principle of Antistatic Polymers Protecting Electronic Circuitry

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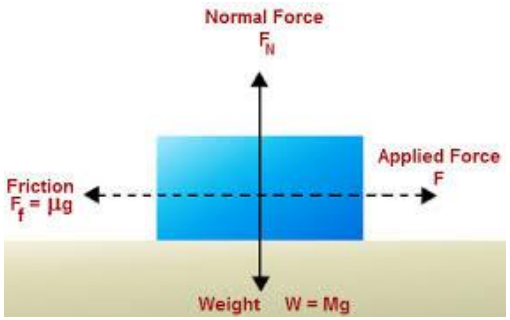
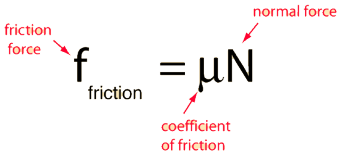
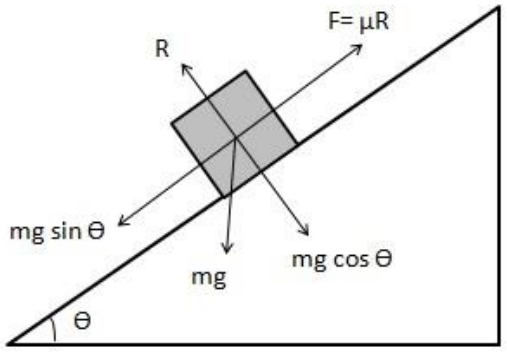
Bartlomiej Kowalczyk, Bartosz A. Grzybowski‡

Even minute quantities of electric charge accumulating on polymer surfaces can cause shocks, explosions, and multibillion-dollar losses to electronic circuitry. This paper demonstrates that to remove static electricity, it is not at all necessary to "target" the charges themselves. Instead, the way to discharge a polymer is to remove radicals from its surface. These radicals colocalize with and stabilize the charges; when they are scavenged, the surfaces discharge rapidly. This radical-charge interplay allows for controlling static electricity by doping common polymers with small amounts of radical-scavenging molecules, including the familiar vitamin E. The effectiveness of this approach is demonstrated by rendering common polymers dust-mitigating and also by using them as coatings that prevent the failure of electronic circuitry.

Introduction



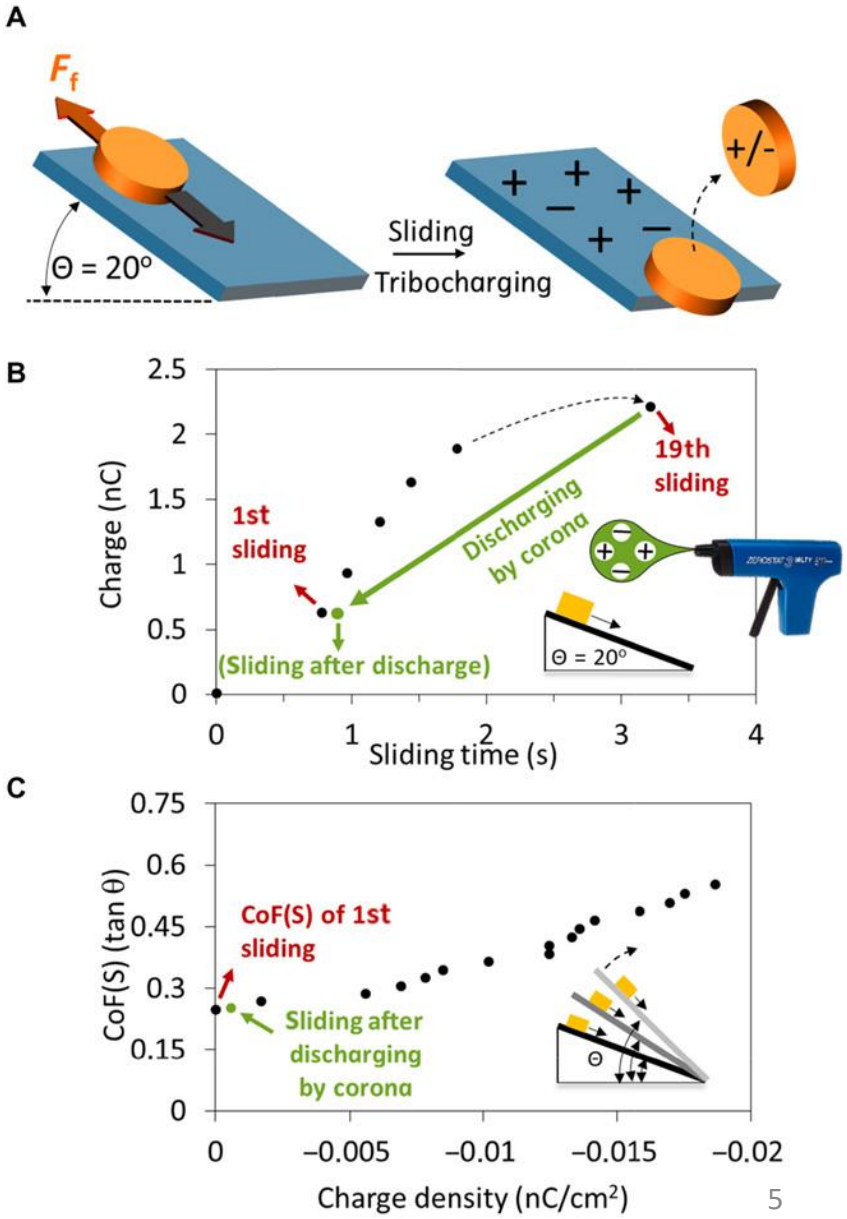




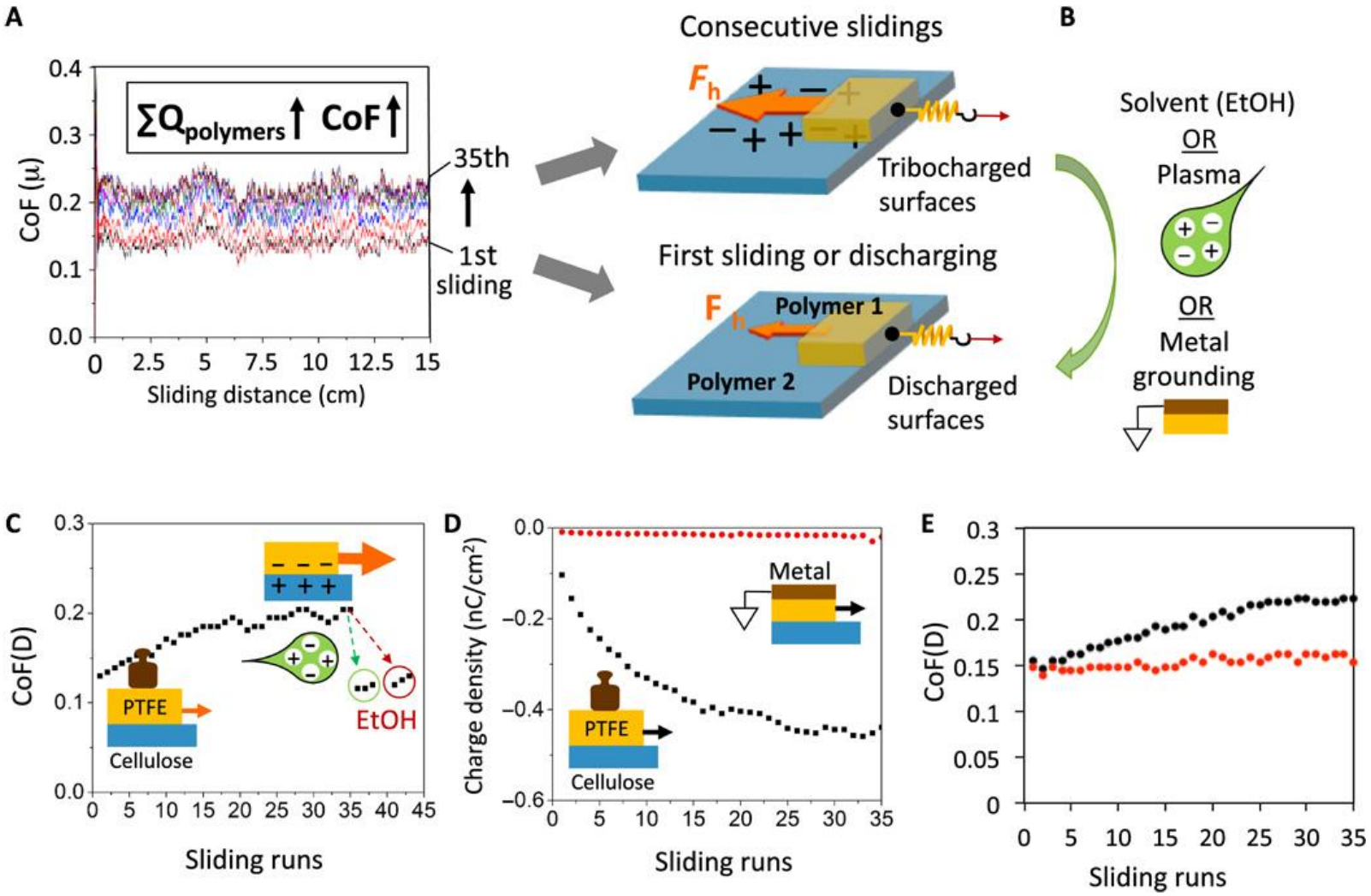
- One-fourth of the global energy losses result from friction and wear.
- Relationship between friction and contact electrification is studied.
- Conventional ways, namely, corona discharging, solvent treatment, or placing a grounded conductor on the backside of one of the shearing materials, to mitigate the charges and its effect on friction.
- Elimination of surface charges can save up to two-thirds of power loss during operation of simple mechanical devices and can reduce wear by a factor of 10.

Experiment #1

A cylindrical wood piece with a polyethylene terephthalate (PET) film base slides on cellulose



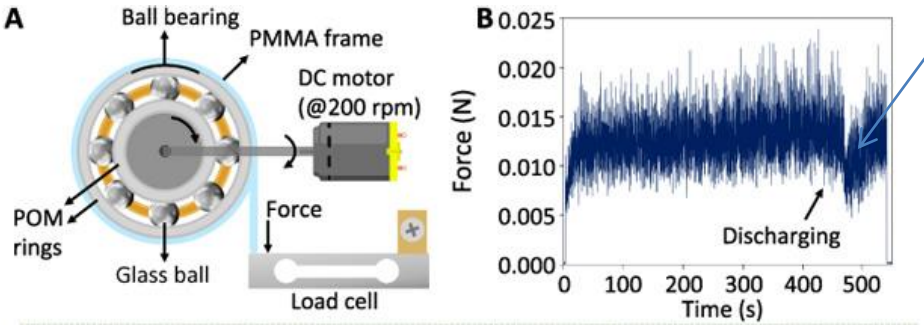
Experiment #2



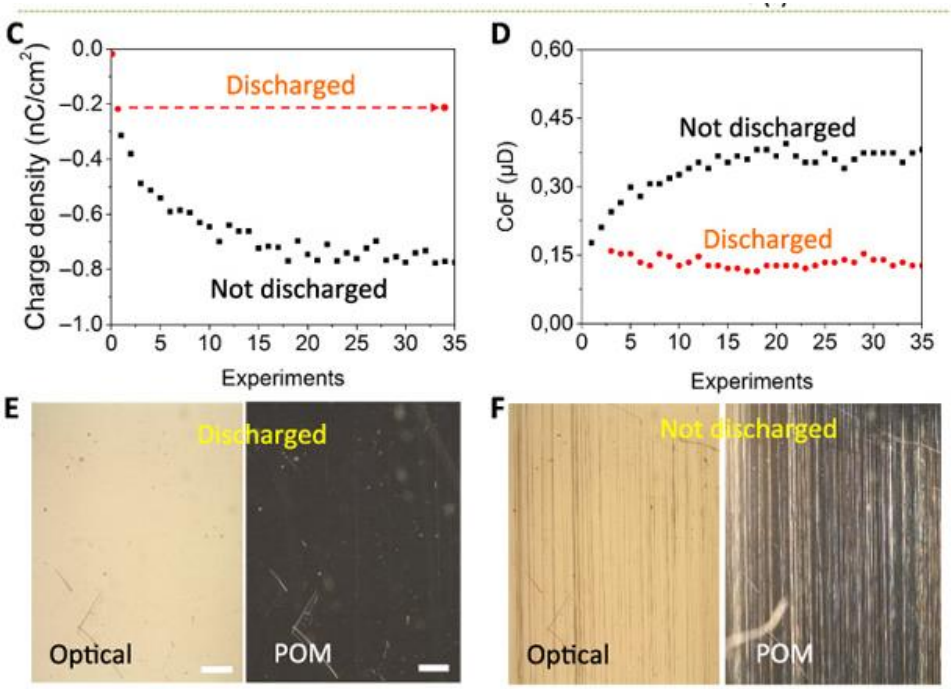
Sliding a PTFE piece horizontally on cellulose

Experiment #3

from 0.0125 to 0.0075 N

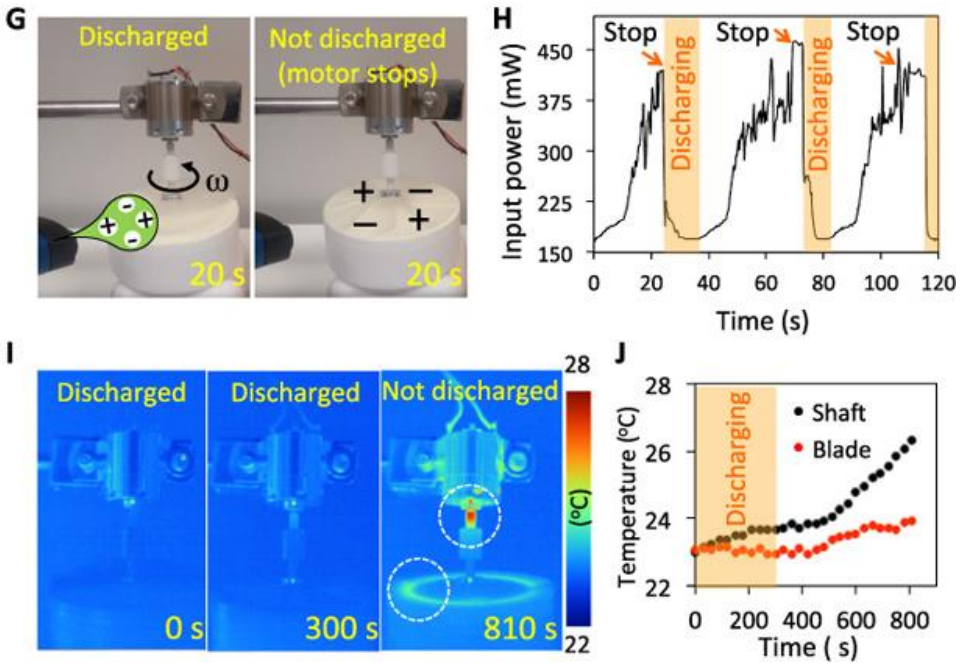


On a ball bearing with inner and outer polyoxymethylene polymer rings and nine glass balls rotated at 200 rpm.



During consecutive runs of PVC pieces on an inclined plane of cellulose

Experiment #4



A 0.2-mm thick PSU blades on the shaft of a DC electric motor made in contact to cellulose surface, the current drawn by the DC electric motor increases from 83 to 220 mA .

Conclusion

Mitigation of static charge greatly reduces the surface wear and friction.

Qualitative relationship b/w CoF and charge density shows a linear dependence in air.

Conventional ways to mitigate the static charge and its effect on friction was studied.

Effects of humidity was also considered.