Mechanical Property Tuning and Surface Texturing toward Enhancing the Performance of Triboelectric Devices

*X. Zhao, J. Song, J. Kim, and Z. Ounaies

Energy harvesting devices based on triboelectric effect have recently emerged as a prominent research area with many rapid developments, in particular in the context of Internet of Things (IoT) where the ubiquitousness of sensors and other devices necessitates supplying power in an effective and efficient manner. The performance of triboelectric devices is affected by the properties of the materials employed; for example, previous studies have illustrated the role of multiple factors such as chemical composition, dielectric permittivity, surface roughness, and mechanical properties.

Therefore, a comprehensive understanding of the relationship between triboelectric output and various factors is important for the development of triboelectric devices. In this work, we focus on the effect of material’s mechanical properties and surface texture on the triboelectric output of polymers. Specifically, the relationship between the triboelectric output and mechanical property is studied using polydimethylsiloxane (PDMS) as a model material, where the mechanical behavior of PDMS is tuned by controlling the crosslinker content and applying a variety of thermal curing profiles.

In addition, the effect of surface texture on the triboelectric output is investigated by changing the shape and size of the patterns fabricated on the contacting surface of another model material system, namely allicin-modified cellulose nanofiber (CNF) films. It is found that the triboelectric output of the different PDMS samples is related to the compressive elastic modulus, such that the PDMS with the lowest compressive elastic modulus yields the highest triboelectric output; in addition, our results indicate that a more flexible material tends to behave more triboelectrically positive. As to surface texturing, the polymer with circular patterns yields the highest triboelectric output. This work contributes to a deeper understanding of the effect of mechanical property and surface texture on the triboelectric behavior of polymers and paves the way to systematically improve the performance of triboelectric devices.

http://www.mri.psu.edu/conferences/usnavy