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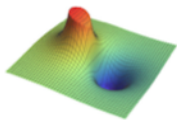

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Fundamental Behaviors of Static Charge Generated by Contact Electrification at the Interfaces of Matter

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Physical laws of electrostatics have been highly developed by physicists via a number of well-known principles and equations. Besides these established theories on electrostatics, however, the fundamental behaviors of static charge in most practical situations are usually far more complex. In particular, the fundamental mechanisms of contact electrification are poorly understood. Experimental results derived from contact electrification of solid surfaces at the interfaces of matter (i.e., solid, liquid, and air) are usually unpredictable, uncontrollable, and counter-intuitive — in many cases, the unpredictability of the results makes the investigations fascinating.

This presentation describes the fundamental behaviors of static charge on solid surfaces at all the interfaces of solid, liquid, and air. For the solid-solid interface, the triboelectric series is found to correlate with the Lewis basicity/acidity of the functional groups on the solid surface [1]. Coupled with the finding that material transfer correlates with charge transfer [2], one possible explanation of contact electrification is due to the combined effects of material transfer and Lewis basicity/acidity. For the solid-liquid interface, results showed that static charge is easily carried away by all types of liquids — including nonpolar insulating liquids [3,4]. This result gives rise to convenient ways of charging liquids, especially the nonpolar insulating liquids that are typically challenging to charge. For the solid-air interface, results showed that the static charge on surfaces can reversibly and controllably exchange between the surface and the surrounding atmosphere and vice versa [5]. This effect produces the fundamental relationship of electrostatics that static charge depends on the shape of the materials [6]. In general, these results challenge the notion of "static charge": the dynamic motion, transport and easily transferrable nature of charge across the interfaces indicate that charge on surfaces generated by contact electrification is not really "static" in nature.

References

[1] Rationalizing the Triboelectric Series of Polymers. *Chemistry of Materials* **2019**, *31*, 1473.
[2] Correlating Material Transfer and Charge Transfer in Contact Electrification. *The Journal of Physical Chemistry C* **2018**, *122*, 16154.
[3] Solid-to-Liquid Charge Transfer for Generating Droplets with Tunable Charge. *Angewandte Chemie-International Edition* **2016**, *55*, 9956.
[4] Charging Organic Liquids by Static Charge. *Journal of the American Chemical Society* **2020**, *142*, 21004.
[5] Reversible and Continuously Tunable Control of Charge of Close Surfaces. *The Journal of the Physical Chemistry Letters* **2017**, *8*, 6142.
[6] The Relationship between Static Charge and Shape. *ACS Central Science* **2020**, *6*, 704.