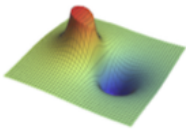
Proceedings of STEP-V
The virtual symposium on Static-Tribo-Electricity of Powder



Date of presentation: 8 July 2023
Step-V#12

Single-contact granular charging experiments: acoustic traps and mosaics

Galien Grosjean
Institute of Science and Technology Austria (ISTA), Austria
E-mail: *galien.grosjean@ista.ac.at*

When grains made of the same material repeatedly come into contact, large buildups of electric charge can occur. Many open questions still shroud this ubiquitous phenomenon, such as the nature of the charge carriers or the causes of the symmetry breaking between nominally identical samples. Using acoustic trapping [5, 6], we investigate single-collision events with a very high level of precision, allowing us to access information that is otherwise lost when working with averaged quantities. For instance, we determine that charging in our system is driven by global differences between samples, as opposed to local surface fluctuations. Those differences could arise from small fluctuations in atmospheric conditions during sample preparation. This is supported by the fact that thorough cleaning can reset the system, while changes in relative humidity can irreversibly affect charging [3]. This points to a mechanism where adsorbates drive charge exchange, perhaps through microscopic amounts of adsorbed water. To model our results, we extend the mosaic framework [1], where donor and acceptor sites on each sample exchange charge, to account for global processes [2, 4]. The result is an analytical model that can continuously transition between same and different-material tribocharging and accurately reproduces our measurements. While this model is agnostic on the nature of the charge donors, it does make experimental predictions which could be tested.

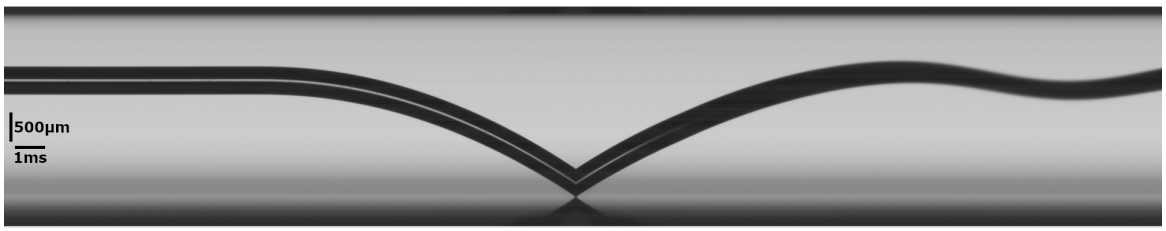
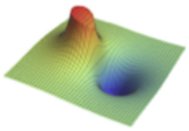


Figure 1: Space-time reslice of a levitated glass sphere colliding with a glass substrate.

References

[1] Apodaca, M. M., Wesson, P. J., Bishop, K. J. M., Ratner, M. A., Grzybowski, B. A. (2010). *Contact Electrification between Identical Materials*. Angew. Chem., Int. Ed., 49(5):946–949. ISSN 14337851. doi:10.1002/anie.200905281.

[2] Grosjean, G., Waitukaitis, S. (2023). *Asymmetries in triboelectric charging: Generalizing mosaic models to different-material samples and sliding contacts*. Phys. Rev. Mater., 7(9):065601. doi: 10.1103/PhysRevMaterials.7.065601.



[3] Grosjean, G., Waitukaitis, S. (2023). *Single-Collision Statistics Reveal a Global Mechanism Driven by Sample History for Contact Electrification in Granular Media*. Phys. Rev. Lett., 130(9):098202. doi:10.1103/PhysRevLett.130.098202.

[4] Grosjean, G., Wald, S., Sobarzo, J. C., Waitukaitis, S. (2020). *Quantitatively consistent scale-spanning model for same-material tribocharging*. Phys. Rev. Mater., 4(8):082602(R). doi:10.1103/PhysRevMaterials.4.082602.

[5] Kline, A. G., Lim, M. X., Jaeger, H. M. (2020). *Precision measurement of tribocharging in acoustically levitated sub-millimeter grains*. Rev. Sci. Instrum., 91(2):023908. ISSN 0034-6748, 1089-7623. doi:10.1063/1.5133049.

[6] Lee, V., James, N. M., Waitukaitis, S. R., Jaeger, H. M. (2018). *Collisional charging of individual submillimeter particles: Using ultrasonic levitation to initiate and track charge transfer*. Phys. Rev. Mater., 2(3):035602. ISSN 2475-9953. doi:10.1103/PhysRevMaterials.2.035602.