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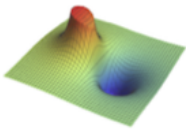

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A model for triboelectrification of rough surfaces

Simon Jantač[a,b,*], Juraj Kosek[a]

[a]University of Chemistry and Technology Prague, Prague, Czechia

[b]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

E-mail: *simon.jantac@ptb.de*

In the fundamental research of triboelectricity, we often rely on atomically flat surfaces. However, such surfaces do not occur in industrial processes. Therefore the applicability of our fundamental understanding of triboelectrification is limited. To counteract this problem, researchers used the Finite Element Method (FEM) to resolve the real contact areas. The FEM calculations are expensive and thus allow only the investigation of small patches; also, the scaling of FEM results are limited only to highly ordered structures. The other way is to use simplified statistical models that are cheap and well-established in the tribology field. The Greenwood-Williamson contact model is one of them, but to extract a close form of the model, many constraints and assumptions must be made.

We decided to develop a new approach inspired by the Greenwood-Williamson model to describe real contact area and use it for the description of triboelectric charging in particle-wall collisions. This approach utilizes Atomic Force Microscope (AFM) to extract the distribution of topological features, then a model of a rough particle is created to precalculate collision results based on simplified contact mechanics using the Monte Carlo approach. This allows the formulation of a simple relation between real contact area and collision velocity. In metal-insulator collisions, saturation charge scales proportionally with contact area; therefore, we can use this relation to directly predict saturation charge at various conditions. The output of the model can be easily implemented in the condenser models.

We partially validated the model for the charging of polyethylene particles with the effect of impact velocity on saturation charge. However, we lack an experimental setup to validate our model in a full range of industrially important conditions. We also extended the model to collisions of non-conforming surfaces and to the systems of various elastic properties and morphologies, but we lack experimental validation in this case.