

How Surface and Substrate Chemistry Affect Slide Electrification

When water droplets move over a hydrophobic surface, they and the surface become oppositely charged by what is known as slide electrification. This effect can be used to generate electricity, but the physical and especially the chemical processes that cause droplet charging are still poorly understood. The most likely process is that at the base of the droplet an electric double layer forms and the interfacial charge remains on the surface behind the three-phase contact line. Here we investigate the influence of the chemistry of surface (coating) and bulk (substrate) on slide electrification. We measured the charge of series of droplets sliding over hydrophobically coated (1-5 nm thickness) glass substrates. Within a series the charge of the droplet decreases with increasing droplet number and reaches a constant value after about 50 droplets (saturated state). We show that the charge of the first droplet depends on both, coating and substrate chemistry. For a fully fluorinated or fully hydrogenated monolayer on glass, the influence of the substrate on the charge of the first droplet is negligible. In the saturated state, the chemistry of the substrate dominates. Charge separation can be considered as an acid base reaction between the ions of the water and the surface. By exploiting the acidity (Pearson hardness) of elements such as aluminum, magnesium, or sodium a positive saturated charge can be obtained by the counter charge remaining on the surface. With this knowledge, the droplet charge can be manipulated by the chemistry of the substrate.

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