

Water drops sliding over arrays of Janus micropillars: A new mechanism of drop charging

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When water drops slide over a smooth hydrophobic solid surface, negative charges are spontaneously deposited at the rear of the drop, and the drops gain a positive charge. This phenomenon is known as slide electrification. Here, we demonstrate an alternative mechanism of spontaneous charge separation in sliding drops. Therefore, arrays of Janus micropillars were fabricated by photolithography. Each micropillar has a hydrophilic top created by reactive ion etching (RIE) and aminopropyltriethoxysilane (APTES) deposition, while the walls and substrate were hydrophobized by perfluorooctyltrichlorosilane (PFOTS). Drops on these arrays show high apparent contact angles, remain in the Cassie state, and still contact the hydrophilic top faces. Sliding drops acquire charge, with polarity and magnitude governed by top-surface chemistry, including $\text{NH}_3^+/\text{NH}_4^+$ formation and PFOTS removal after plasma exposure, and dense NH_2 groups formation from thermally activated APTES vapor deposition. Unlike flat surfaces, high-speed reflection microscopy reveals tiny satellite droplets left on each pillar that evaporate within one second. Consequently, charge separation occurs within the liquid phase between the primary drop and deposited satellites, rather than directly at the contact line.