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Charged Water Droplets can Melt Metallic Electrodes ERIC ELTON, ETHAN ROSENBERG[1], WILLIAM RISTENPART, Dept. Chemical Engineering, University of California Davis — A water drop, when immersed in an insulating fluid, acquires charge when it contacts an energized electrode. Provided the electric field is strong enough, the drop will move away to the opposite electrode, acquire the opposite charge, and repeat the process, effectively 'bouncing' back and forth between the electrodes. A key implicit assumption, dating back to Maxwell, has been that the electrode remains unaltered by the charging process. Here we demonstrate that the electrode is physically deformed during each charge transfer event with an individual water droplet or other conducting object. We used optical, electron, and atomic force microscopy to characterize a variety of different metallic electrodes before and after drops were electrically bounced on them. Although the electrodes appear unchanged to the naked eye, the microscopy reveals that each charge transfer event yielded a crater approximately 1 micron wide and 50 nm deep, with the exact dimensions proportional to the applied field strength. We present evidence that the craters are formed by localized melting of the electrodes via Joule heating in the metal and concurrent dielectric breakdown of the surrounding fluid, suggesting that the electrode locally achieves temperatures exceeding 3400°C.

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