

Spontaneous electrostatic charging during evaporation at solid-liquid and solid-gas interfaces

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Abstract—Electrostatics is an old area of scientific research that lagged behind most other areas of natural sciences and especially chemistry and physics, during the 20th century. The role of interfaces as important sites for electric charge accumulation or exchange is well established in solid-solid, liquid-liquid and liquid-solid systems. However, this is not the case for gas-liquid or gas-solid interfaces. Indeed, the effects of excess charge on the surface tension of water including electrocapillary phenomena for pure water under air were recently published. As seen in the figure (left) below, water with excess charge is the outcome of many different events triggered by electric fields or by interfacial phenomena that produce non-electro-neutral water, either liquid, solid or vapor, due to excess H^+ or OH^- concentration. As interfaces are recognized sites for electrification, we used a very simple apparatus to measure the electrostatic charge during phase transition at liquid-gas and solid-gas interfaces. The experiment consists on recording the electrostatic charge of a water drop on polytetrafluoroethylene (PTFE) during evaporation. This is simply done with a Kelvin probe and an USB microscope. Well-controlled experiments showed that when the drop (NaCl 3% water solution) is positioned on the PTFE surface, a negative potential of -6 V is build-up and it remains pretty stable for roughly 5 hours until the drop has reached half of its value. After that, the negative electrostatic potential starts to increase, passing through zero and reaching $+12$ V when the drop has 33% of its size. Finally, there is a slight electrostatic potential decreasing, reaching a plateau when there is only NaCl crystal on PTFE. This equilibrium electrostatic potential is very stable and did no change even after 21 days of measurement.