Glass under DC potential: Role of atmospheric water on charge build up and dissipation.

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Abstract

Glass electrified under DC potential shows significant deviation of the classic insulator behavior. In experiments where the sample is biased (positive or negative), the surface potential measured by a Kelvin electrode is the same as that applied by the power supply, but the response is delayed under low relative humidity.
When a potential difference is applied to two electrodes on the surface, the surface acquires negative excess charge that also depends on the relative humidity and is interpreted as the result of H^+ ion discharge at the negative electrode.

Introdução

Electrification of dielectrics is an old open scientific problem. There are at least four competing mechanisms, where the charge carriers are electrons, ions or atmospheric ions[1]. The latter are particularly important for hydrophilic surfaces, where it has been show that partition of water ionic clusters influences both charge build up and dissipation. A negative consequence of the current state of (lack of) knowledge in this area is the continuing and widespread accidents that can be tracked to electrostatic discharge. Moreover, many conceivable technologies for power generation and storage, machinery and environmental protection are insufficiently developed due to the lack of sufficient control of electrostatic charge.

Resultados e Discussão

Samples in this work are microscope glass slides mounted within a grounded metal box with humidity control. The samples lay on a polythene film and are connected to the power supply by using copper adhesive tape. The slide connection to the DC power supply is mechanically switched on and of. Potential on glass and on contacting metal is measured by using two Kelvin electrostatic voltmeters. Figure one shows the potential measured as a function of time and relative humidity.

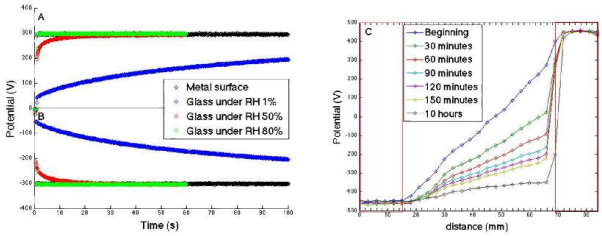

Figure 1. A) Potential over a glass slide as a function of time, when the glass is biased to 300V. B) The same but under -300V bias. C) Potential scanned over a glass surface in between two parallel electrodes, as a function of time. Relative humidity = 80%.

Figures 1A/B show potential build-up on the glass surface that is interpreted considering that surface conduction is sufficient, at least for DC signal transmission over glass.
In another set of experiments, the slide electrodes (rectangles limited by red lines in Fig. 1C) were biased symmetrically to ground, using two separate power supplies. The surface potential was mapped showing the build-up of excess negative charge, with time. This is due to the electrochemical discharge of H^+ ions dissociated from surface silanol groups on the cathode, assisted by the water film. No significant discharge is observed in the anode and this is assigned to the immobility of silicate groups that are firmly incorporated to the glass network[2].

Conclusões

Atmospheric water has a strong effect on glass surface charge build-up under DC bias. Surface potential rises quickly under 80% relative humidity, reaching the applied potential. When a voltage is applied to two parallel electrodes, the glass surface acquires negative potential due to electrochemical reactions.

Agradecimentos

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