Triboelectrification in the Saltation Layer of a Sand Storm

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***Abstract*— Sand particles in a wind-blown sand layer, or 'saltation' layer, get electrostatically charged due to collisions–a phenomenon quite similar to the charging of graupel during thunderstorms. This static charging can cause electric discharge and affect the atmospheric chemistry. Like other tribocharging processes, the basic physics underlying the charging due to collisions between sand particles is yet to be understood. In an attempt to understand the charging process in a saltation layer, we are performing collision experiments in a humidity-controlled environment. In our experimental system, silica particles are colliding with a silica bed at a specific velocity and incidence angle. The charge developed on a silica particle is measured as it is drawn through an image-charge detector. Charges on silica particles are measured as a function of relative humidity, particle size, surface roughness, surface temp! erature, grazing angle, and velocity. We are also performing experiments with chemically modified hydrophobic silica surfaces to investigate the effect of water adlayer in more detail. We found that the most probable charge on a single silica particle decreases systematically with an increase in relative humidity. This result is consistent with atmospheric observations. In another experiment, the surfaces of the silica sand particles were treated with trimethylsilyl chloride to render them hydrophobic. Interestingly, this resulted in a substantial decrease in the charge on the silica particles. A similar result was observed in the case of contact charging between silica surfaces in experiments previously done in our lab. This result motivates us to consider a possible role of water adlayer on the charge separation. In addition to the effect of water adlayer at the interface, the influence of lubricity due to addition of alkyl chains on to the surface is being considered. An! other interesting observation involves the reversal of charge ! polarity on the silica particles from that in the rolling ball experiments which were previously performed in our lab. In rolling ball experiments, silica balls had a positive charge at room temperature, whereas in collision experiments the silica particles have a negative charge. In rolling ball experiments, while both the silica spheres and the silica tube were heated, the charge on the sphere became negative. Strikingly, this charge polarity is the same as seen on silica particles in collision experiments. Since a tremendous amount of local heating is involved in the collisions, it is reasonable to presume a connection between the collision experiment and the rolling ball experiment under heated conditions. More experiments are being pursued to test this hypothesis. With a few additional experiments, we hope to reveal the collisional charging mechanism and identify the factors affecting this process.**