

Mechanism of Contact Charging of Silica

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Abstract— Triboelectric charging is an extensive phenomenon that refers to the charge transfer between two dissimilar surfaces when they come into contact and remain charged when separated. Friction, collision or contact between surfaces can cause triboelectricity. Contact charging of sand particles, essentially silica, is responsible for lightning observed in sand storms and dust devils. Field studies show that updraft of air separates positively charged lighter particles which remain levitated and negatively charged larger particles which settle to the ground. Lightning occurs between the two oppositely polarized parts. Although contact charging has immense importance, basic physics behind the mechanism of charge transfer is not well understood. We have designed experiments to microscopically understand the charge transfer mechanism when two silica surfaces come into contact. Our goal is to investigate effects of relative humidity, temperature, pressure and surface defects on the extent of charge separation. Our findings, so far, indicate a systematic effect of relative humidity on charge separation. Increase in relative humidity decreases the extent of charge separation between two silica surfaces. This has prompted us to propose a mechanism for charge transfer in which water layer adsorbed onto the surface of silica plays an important role. Adsorbed water hydrolyses the terminal silica groups to silanol moiety and more water deprotonates those silanols to generate hydronium ions in the adlayer. When the silica surfaces come into contact, transfer of ions occurs, most likely due to the temperature gradient generated during the contact process and hence the surfaces acquire a net charge after being separated. More experiments are being done to confirm the role of water.