Electrostatic Charging of Particles by Electrodynamic Screens

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***Abstract* — An analysis of different electrostatic charging mechanisms that result from the applied spatially- and time varying electric field on the surface of electrodynamic Screen (EDS) is presented. Transparent Electrodynamic screens (EDS), when laminated on the front surface of PV modules or concentrating solar mirrors, such as heliostats, have the potential to maintain the optical surface of the solar collectors clean by frequently removing dust layer deposited on the surface. Transparent electrodynamic screens consist of rows of transparent parallel conducting electrodes embedded between an ultrathin transparent dielectric film and the front glass cover plate of the PV module or the second surface glass mirrors. When the electrodes are activated by a three-phase, low current (micro-amp level), low frequency (5 Hz), high voltage (1.2 kV) pulses, the particles on the surface become electrostatically charged and are lifted off from the surface by Coulomb repulsion force and swept away from the surface by the traveling electromagnetic wave generated by the electric field. Upon activation of the electrodes, over 90% of the deposited dust is removed. We expound upon different mechanisms of electrostatic charging, acting simultaneously on the particles involved in the operation of EDS including (1) contact charging, (2) tribocharging, (3) corona charging and (4) micro-filamentary discharge (MFD) process causing injection of positive charge carriers to the EDS surface from the positive electrodes. Our studies show that the particles are primarily charged with positive polarity regardless of the dust compositions and size distributions involved. It appears that the micro-filamentary discharge (MFD) process may have the predominant role in charging particles deposited on the EDS surface. We report our experimental data on the charge-to-mass ratio (Q/M) measured for dust particles over a wide diameter range ($4 < dp < 100$ μm) on EDS operation and find the particles are charged with a net positive charge at a high Q/M level and are swept off unidirectional on the EDS film surfce under the action of the applied electric field. The charge injection process was verified by measuring the surface charge on the EDS film as a function of the applied field, with and without the surface dust layer. We will discuss the mechanisms studied with the results of surface charge measurements undergoing micro-filamentary discharge.**