Electrostatic Charging of Particles on Electrodynamic Screens by Low Frequency Electric and Dielectrophoretic Excitations

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***Abstract*— Transparent electrodynamic screens (EDS) integrated with solar panels can be used to minimize loss of power due to the obscuration of the sunlight caused by dust deposition. A transparent EDS consists of set of parallel transparent conducting electrodes embedded within a transparent polymer film. The electrodes, made of Indium Tin Oxide (ITO) having width 100 µm, height 20 µm, with an inter-electrode spacing of 750 to1000 µm, are deposited on a transparent dielectric substrate (e.g. borosilicate glass). When the EDS electrodes are energized by a three-phase pulsed voltage excitation, dust particles are repelled by electrostatic forces and transported away from the surface by the travelling electric field. Uncharged particles, in contact with the polymer surface of the screen acquire electrostatic charge by the contact charging process during their deposition. The alternating electric field induces a dielectrophoretic torque causing a back and forth motion of the particles which increases the charge on the particles by the triboelectric charging process. This charging process continues for a few seconds until the Coulomb force becomes strong enough to repel the particles from the surface. When the charged particles are lifted off from the surface by the vertical component of the field, the travelling wave component propels the dust to the edge of the screen. We discuss possible mechanisms involved in particle charging during their generation, deposition, and their interaction on the surface of the EDS. An analysis of the electrostatic and dielectrophoretic forces involved in charging the particles in a divergent, nonuniform electric field of low frequency is presented with experimental data on the size and charge distributions. Effects of particle conductivity on the operation of the EDS are briefly discussed. The forces of adhesion of the particles on the EDS surface is compared to the removal forces as a function of particle size. Dust removal efficiency of the EDS for particles of different physical properties is presented.**