Electrostatic charging mechanisms for dust layer deposited on the surface of Electrodynamic Screen (EDS): Relevance to Self-Cleaning Solar Collectors

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***Abstract*— The kinetics of particle on the surface of electrodynamic screen (EDS) influenced by the multi-phase electric field generated by the electrodes driven by the applied AC voltage have been investigated by many researchers for different applications. Each application involves particles of specific size range and the electrode geometry designed to meet the requirements of the desired particle motion. Particles of diameters from submicron to larger than 100 μm are involved with different chemical compositions. Corresponding to the particle size in each specific case, the electrode dimension varies from submicron to millimeter scales. In most studies, the particles are assumed to be electrostatically charged having sufficiently high magnitude for the desired particle motion. Analysis of the charging processes for uncharged particles and continuous charging of particles required for removal of deposited atmospheric dust on the EDS surface have not been well documented yet. It is not clear how the particles of different conductivities get charged in contact with the dielectric film encapsulating the electrodes activated by the applied voltage. In this paper we discuss possible particle charging mechanisms including contact charging, tribocharging facilitated by the electro-rolling of particles by dielectrophoretic (DEP) torque, local dielectric breakdown initiated micro-discharge (DBD) from the electrode edges allowing charge injection and leakage of accumulated charge from the EDS dielectric surface. Our current application involves atmospheric dust particles depositing on the EDS surface with a wide size distribution, different chemical compositions, and exposures to different ambient temperature and relative humidity. A brief discussions on the charging mechanisms is presented for dust particles involving (1) contact charging process based on the surface states of atoms in contact and the density of surface states, (2) analysis of the DEP torques that causes oscillation or rolling of particles on the EDS surface, (3) induction charging process for conductive particles, and (4) charge injection process by DBD initiated micro-discharge. Experimental data on the charging characteristics of dust samples obtained from different desert sites and classified under different size ranges are presented. The relationship between the charge-to-mass ratio of particles and the dust removal efficiency of the EDS in cleaning solar mirrors and solar panels is discussed.**