Modeling of Trajectories in an Electrodynamic Screen for Obtaining Maximum Particle Removal Efficiency

Mark N. Horenstein, Malay Mazumder, Robert Sumner, Jeremy Stark, Omar Saddar
Boston University

***Abstract*— The electrodynamic screen , also known as the "electrostatic curtain", was first proposed in the early 1970's by Senichi Masuda, a legendary pioneer in electrostatics. The electrodynamic screen (EDS) provides a method for the efficient removal of particles from the surface of an insulator. A low-frequency surface-traveling wave of electric field, formed by imbedded or deposited interdigitated electrodes, sweeps deposited particles laterally, thereby removing them the surface. The EDS has been incorporated by NASA into planned solar collectors for future Mars and Moon missions, and it has also been proposed as a method for removing dust from the surfaces of earth-based solar collectors, especially photovoltaic panels.**

Desert environments in the arid and semi-arid regions of the world are ideal for large-scale solar installations, because these areas have strong, abundant sunlight. Deserts, however, also provide an ample supply of dust which inevitably will collect on the solar panels, thereby obscuring solar flux. The dearth of water in deserts makes washing unfeasible, thus exacerbating the problem. Experiments have shown that just 2 milligrams per cm2 of fine dust on a solar panel can reduce its output by nearly 30%. At 8 mg/cm2 dust deposition, output is reduced to just 10% of that obtainable from a clean panel. Dust is not particularly glamorous, but it is a solar panel's nightmare. If the dust problem is left unsolved, it will likely be a "show stopper" that will make long term, large-scale solar power impossible.

We are developing EDS technology for the automatic and continuous removal of dust from solar panels without requiring water or moving parts. Our goal is a robust solution that can withstand decades of desert climate, hence materials and electronics are key elements of the problem. One of our tasks is the modeling of EDS particle trajectories for particles of different diameters likely to be found in desert environments. We seek to find the values of electrode spacing, excitation frequency, and voltage magnitude that yield maximum particle removal efficiency. The optimum values of these parameters will be different for particles of different diameter and charge. We also seek to compare of our modeled trajectories with observations from laboratory experiments so as to validate the calculations. Another task is the development of simplified, low-power, low-cost drive electronics and a scalable, mass-production method for depositing transparent surface electrodes on large glas! s panels. This paper discusses the current state of our research efforts.