Evaluation of the Triboelectric Sensors in the Mars Environmental Compatibility Assessment Electrometer

The Mars Environmental Compatibility Assessment (MECA) Electrometer was designed jointly at the Jet Propulsion Laboratory and at the Electromagnetic Physics Laboratory at the Kennedy Space Center to be a flight instrument on a future unmanned Mars mission. The MECA/Electrometer was designed primarily to characterize the electrostatic properties of insulating materials that would come into contact with the soil of Mars. The materials were selected based on their use in previous space missions. The five insulators chosen for the MECA/Electrometer were: Fiberglass/Epoxy, Polycarbonate (known as Lexan™), Polytetraflouroethylene (Teflon™), Rulon J™, and Polymethylmethacrylate (Lucite™ or PMMA).

The triboelectric sensor array consists of five (6.35 mm diameter) circular patches of the insulating materials placed above metal electrodes. The five individual electrodes are connected to independent electrometer circuits. The five outputs are collected via a serial connection to a controlling computer. The tribosensors are housed inside the MECA/Electrometer, whose case is made of titanium of volume ~50 cm^3 and total mass ~50 g. The power consumption is <250 mW. Figure 1 is a picture of the MECA/Electrometer. Figure 2 is a simplified representation of the circuitry for one tribosensor. Figure 3 shows a typical output in a low pressure CO_2 atmosphere.

The five circular patches shown in Fig. 1 are the five types of insulators used in this project. Below the patches are the electrometer's circuitry that measures the amount of electric charge that develops on the insulator surfaces after the electrometer is dragged through the Martian soil simulant. The two openings shown above the five insulators in the electrometer photo are the local electric field sensor (ELF) on the left, and the ion gauge (IG) on the right. The temperature sensor is a dedicated integrated circuit chip that is mounted inside the case and is not shown in the photo of the MECA/Electrometer.

A thorough evaluation of the sensitivity of the tribosensors was performed in our laboratory. We determined that the gain in the current electrometer circuitry should be programmable to compensate for a variety of surface conditions that might be encountered on Mars.

Key Accomplishments:

- The triboelectric sensors were tested with Martian soil simulant in dry air and under a low pressure CO_2 atmosphere.
- The gain of the tribosensors was measured to be 0.25 nC/V as measured at the output and found to be too low to measure the maximum charge that can accumulate on the materials.

Key Milestones:

- Enhancements to this instrument are planned.

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File: "Electrometer 1a.jpg"

Figure 1

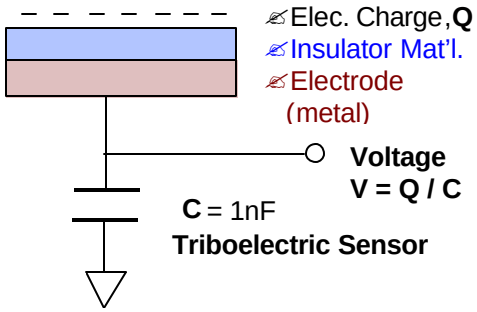

Figure 2

File: "Insulator Charging with Martian Simulant.xls"

Figure 3