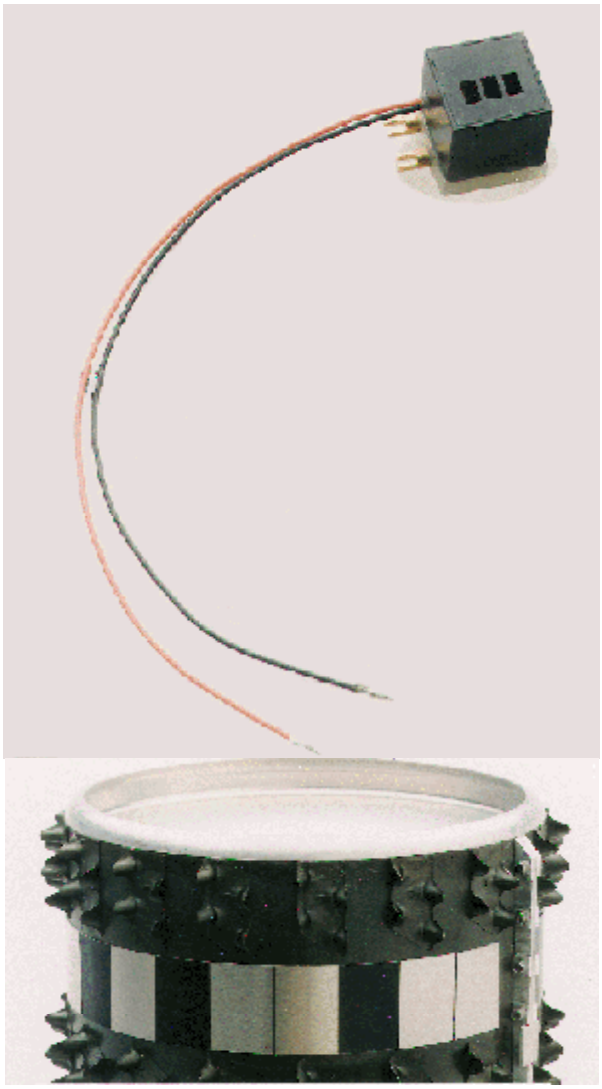
Mars Pathfinder: The Wheel Abrasion Experiment



Left (or top): Photodetector for Lewis' Mars Pathfinder Wheel Abrasion Experiment (WAE). Right (or bottom): Nickel abrasion samples from wheels

NASA Lewis Research Center's Wheel Abrasion Experiment (WAE) will measure the amount of wear on wheel surfaces of the Mars Pathfinder rover. WAE uses thin films of Al, Ni, and Pt (ranging in thickness from 200 to 1000 angstroms) deposited on black, anodized Al strips attached to the rover wheel. As the wheel moves across the martian surface, changes in film reflectivity will be monitored by reflected sunlight. These changes, measured as output from a special photodetector mounted on the rover chassis, will be due to abrasion of the metal films by martian surface sand, dust, and clay. Since fine dust and clay particles are expected to adhere to the wheel and rover surfaces, the first WAE measurements from Pathfinder will provide a baseline against which dust and clay

contributions can be calibrated for the remainder of the experiment. All additional changes in reflectivity will be assumed to be due to metal abrasion during martian surface operations.

During surface operations, the rover will move about the landing site on a set of six independently driven wheels. Twice each martian day, all the rover wheels, except the WAE test wheel, will be locked to hold the rover stationary while the test wheel is spun and digs into the martian regolith. These tests will provide wear conditions more severe than simple rolling.

Concomitantly, ground tests will be conducted on Earth with an identical wheel in simulated martian surface conditions. These tests will use different sands and clays to simulate the martian regolith. Slip tests, analogous to those on Mars, will be conducted in these simulations. Statistical analyses of the test results will be compared with similar analyses of Pathfinder data to determine which simulants behave most like the martian surface. Conclusions will be drawn about the likely nature of the martian surface and its effect on wear surfaces.

Initial tests have already been run to demonstrate the feasibility of the concept, and to gain rough estimates of surface abrasion. These initial tests also have produced an interesting result: As the rover moves across the dry martian surface, it will accumulate an electrical charge. This charge appears to be the primary reason for the fine dust and clay adhesion. After making some rough predictions of rover charging, we conducted ground tests using a noncontacting, capacitive probe to monitor wheel electrical potential. These tests have produced surface voltages in excess of 100 V, large enough to cause concern about electrical discharge through the martian atmosphere from rover surfaces. Additional tests with small discharge points have shown that it is possible to mitigate these charging effects to some extent, and to reduce the probability of unwanted electrical discharge. As a precaution, Lewis recommended a set of discharge points, and these points were included by the Jet Propulsion Laboratory on the Pathfinder rover antenna base. WAE involves a heavy commitment on the part of both the Space Environment Effects Branch and the Photovoltaics Branch at Lewis.