Solar Array Panels With Dust-Removal Capability

Inexpensive, low-power piezoelectric buzzers would be built in.

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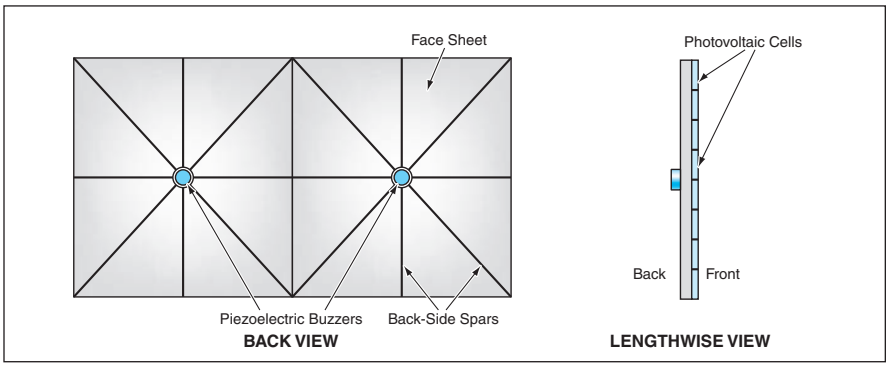
It has been proposed to incorporate piezoelectric vibrational actuators into the structural supports of solar photovoltaic panels, for the purpose of occasionally inducing vibrations in the panels in order to loosen accumulated dust. Provided that the panels were tilted, the loosened dust would slide off under its own weight. Originally aimed at preventing obscuration of photovoltaic cells by dust accumulating in the Martian environment, the proposal may also offer an option for the design of solar photovoltaic panels for unattended operation at remote locations on Earth.

The figure depicts a typical lightweight solar photovoltaic panel comprising a backside grid of structural spars that support a thin face sheet that, in turn, supports an array of photovoltaic cells on the front side. The backside structure includes node points where several spars intersect. According to the proposal, piezoelectric buzzers would be attached to the node points. The process of designing the panel would be an iterative one that would include computational simulation of the vibrations by use of finite-element analysis to guide the selection of the vibrational frequency of the actuators and the cross sections of the spars to maximize the agitation of dust.

Although the basic concept of the proposal is a straightforward extension of a common household cleaning practice, the engineering implementation of the proposal would not be trivial. The following are some of the engineering issues that must be addressed:



Piezoelectric Buzzers would be mounted at nodes of a grid of spars that support a solar photovoltaic panel.

- Compact, low-power, inexpensive piezoelectric buzzers are commercially available. They may or may not be suitable for use as the piezoelectric actuators to implement the proposal. Because typical commercial buzzers operate in the kilohertz frequency range and the natural vibrational frequencies of typical solar photovoltaic panels are lower, it may be necessary to build lower-frequency piezoelectric buzzers.
- It may be necessary to cover panels with flat, transparent sheets or else redesign the panels to eliminate recesses or protrusions that could retain dust or prevent dust from sliding off during vibration.
- The expected rate of accumulation of dust must be taken into account in assessing the effectiveness of a dust-removal design.
- Tests must be performed to determine the interdependences among tilt angles required for interception of solar radiation, the amounts of agitation required at various vibrational frequencies and amplitudes to reduce obscuration by dust to an acceptably low level at those tilt angles, and the differences in among the rates of removal of dust particles of different sizes and types.
- Care must be taken to ensure that the energy recovered by removing dust that obscures the solar photovoltaic panel exceeds the energy expended in shaking the dust off. This entails consideration of buzzer power levels and agitation times.
- Care must also be taken to ensure that the dust-removal design does not adversely affect equipment other than the solar photovoltaic panel.

This work was done by Stephen Dawson, Nick Mardesich, Brian Spence, and Steve White of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

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