



## Fluorescence-Based Sensor for Monitoring Activation of Lunar Dust

This sensor also is suitable for assessing safety and health in the cement and fly ash industries.

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This sensor unit is designed to determine the level of activation of lunar dust or simulant particles using a fluorescent technique. Activation of the surface of a lunar soil sample (for instance, through grinding) should produce a freshly fractured surface. When these reactive surfaces interact with oxygen and water, they produce hydroxyl radicals. These radicals will react with a terephthalate diluted in the aqueous medium to form 2-hydroxyterephthalate. The fluorescence produced by 2-hydroxyterephthalate provides qualitative proof of the activation of the sample. Using a calibration curve produced by synthesized 2-hydroxyterephthalate, the amount of hydroxyl radicals produced as a function of sample concentration can also be determined.

There are five main components to the sensor unit: cuvette holder, quartz cuvette, power/control electronics board, software, and a data acquisition board. The quartz cuvette holder will be made of an optically opaque material in order to decrease the possibility of scattered light. An ultraviolet LED producing light in the range of 310–330 nm, and a Si photodiode detector, will be mounted to the walls of the flow cell holder directly opposite one another to form the optical axis.

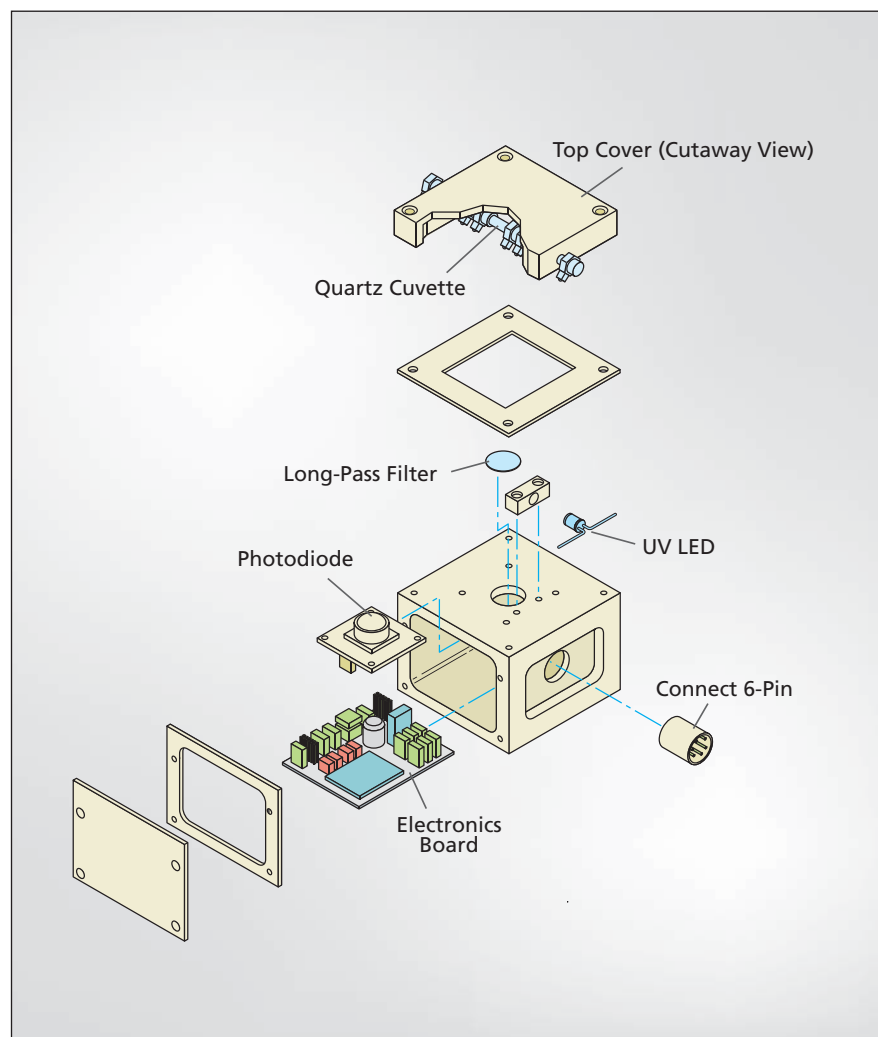
There are two possible configurations for the sample cuvette. First, test solution could be introduced into a standard, capped quartz cuvette. After testing, the cuvette could be removed and cleaned prior to further testing. Alternatively, a flow-through quartz cuvette could be used. After monitoring the fluorescence intensity of the test solution, the solution can be removed by pumping or other methods.

The power/control electronics board will provide power to the LED and the photodiode, control the LED, and amplify the analog output of the photodiode. Power will be provided by a DC–DC converter, filtered through an LC circuit, and fed to linear voltage regulators to generate clean, stable, positive and negative voltages.

The software is a virtual instrument written in LabVIEW v.6i. From the virtual instrument, the time of illumination can be controlled, as well as data acquisition parameters such as scan rate. In addition, the virtual instrument will apply a user-set calibration curve to the data to obtain the hydroxyl radical concentration. All of the data collected, as well as the calculated hydroxyl radical concentration, will be plotted on the virtual instrument and stored automatically in a text file with a time and date stamp.

A National Instruments data acquisition board will be installed in a personal computer running Microsoft Windows XP. The analog output from the sensor will be fed to the data acquisition board, where it will be digitized. The data will be collected using the virtual instrument running LabVIEW.

For terrestrial activation studies, a small amount of sample will be placed into a mortar and ground using a pestle for 10 minutes. At approximately 2-minute intervals, the sides of the mortar



A possible design for the proposed Lunar Dust Activation Sensor.

should be scraped in order to ensure that all material is experiencing consistent grinding. At the completion of grinding, or during testing in the lunar environment, a portion of the activated material will be added to a solution consisting of disodium terephthalate diluted in phosphate-buffered saline (PBS) at a concentration of 10 mM. The concentra-

tion of the sample in solution should be at least 1 mg/mL in order to provide sufficient fluorescence intensity. After allowing the sample to interact with the solution for 30 minutes, the mixture will be filtered using a 0.2-micron filter. The filtered solution will be placed in the quartz cuvette, and emission spectra will be obtained using an excitation wave-

length of approximately 324 nm. The emission spectra will be compared to the calibration curve made using pure 2-hydroxyterephthalate.

*This work was done by William T. Wallace of Universities Space Research Association and Antony S. Jeevarajan of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24446-1*

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## Aperture Ion Source

**The aperture ion source has application in commercial mass spectrometers.**

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The aperture ion source was conceived to eliminate distortion in measurements of angular distributions of neutral atoms and molecules that require electron-impact ion sources. The approach simplifies the coupling between ion source and spectrometer while providing virtually distortion-free angular distributions and improved accuracy in the dimensions of the ionization region. Furthermore, it virtually eliminates the volume occupied by the ion source.

The basic idea is to place the ionization region in the aperture to the energy-angle analyzer or mass spectrometer. Electron impact ionization of neutrals prior to analysis is used here as in conventional ion sources. Implementation of the idea embeds the ionizing electrons in a very narrow space immediately above the spectrometer entrance aperture, leading to improved performance over the present extended ion source configuration. In order to ensure a field-free ionization volume, the ionization space is defined by two plates with identical apertures, the central plane between the two serving as the object plane for the spectrometer. Therefore, the effective position of the en-

trance aperture to the spectrometer lies in the middle of the ionization region. One of the goals is to provide an easy way to specify the position and dimensions of the ionization region. Thus, the smaller the ionization region, the easier the specification of the ionization region, and if done properly, the smaller the fraction of unused electrons in the electron beam. Making the ionization region as small as possible should also enhance ionization efficiency. This is actually borne out by a calculation comparing the ionization efficiencies of the present scheme to that of the aperture ion source.

The aperture ion source would operate as follows. One of the four cathodes is activated to emit ionizing electrons toward the ionization region. A collector just ahead of the diametrically opposite unused cathode registers the ionizing electron current. A fraction of the neutral atoms and molecules passing through the apertures is ionized and proceeds on to the interior of an energy-analyzer to give the energy-angle distribution of the original neutrals.

In addition to simplifying and enabling distortion-free measurement of

angular distributions of neutral atoms and molecules, this innovation offers a drastic reduction in ion source volume with improvements in ionization efficiency. This innovation also lends itself to mounting two, four, and possibly eight cathodes around the aperture to provide two, four, and eight-fold redundancy to improve reliability.

The formulation process of this idea showed that the aperture ion source offers higher efficiency over conventional ion sources that ionize the neutral gas at some distance from the entrance aperture of the spectrometer. In addition, it offers well-defined ionization volume for careful quantitative analysis using mass spectrometers. Most commercial mass spectrometers use such electron impact ionization ion sources with issues of operation downtime due to cathode replacement. The cathode redundancy that comes with this innovation would reduce downtime by at least a factor of four.

*This work was done by Fred Herrero of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16145-1*