PHOTOCONDUCTIVITY IN LUNAR MATERIAL. Román Alvarez, Instituto de Geofísica, UNAM, México 20, D.F.

Electrical determinations on various lunar samples have been usually made in the dark (i.e., in the absence of solar radiation). However, solar radiation is known to produce photoelectrons at the lunar surface; the question arises as to whether the electrical conductivity of surface material is altered, and in what proportions, owing to the effect of solar radiation.

Photoconductivity changes have been determined for sample 15498,38 at initial temperatures of 100° and 295°K and vacuums ranging from 10^{-7} to 10^{-8} torr. The sample has dimensions of 5 x 6 x 15.7 mm and weighs 1.31 g ; it is a breccia previously analyzed in (1). Four independent sources of radiation were used to simulate solar radiation at the lunar surface: two UV sources (235 and 365 nm wavelengths), each delivering approximately 600 μ watts/cm^2 at the sample's surface, plus a source of visible radiation and a source of infrared radiation, the former delivering approximately 1522 μ watts/cm^2 at the sample's surface and the latter 13600 μwatts/cm^2. Experiments were made using a single radiation source or various source combinations.

Temperatures reported herein refer to initial sample temperatures; in the case of UV irradiation no appreciable heating takes place on the sample surface. Visible or infrared radiation produce heating that typically results in surface temperatures of approximately 385°K in 15 min periods when starting at 295°K. We have not determined temperature increments when starting at 100°K.

Figure 1 shows the sample's response to UV excitation. Wavelengths of 235 and 365 nm were used at temperatures of 100° and 295°K. A typical photoconductivity effect is observed when illuminating with short-wave UV light (235 nm); it consists of an instantaneous conductivity increase of two orders of magnitude. A similar decrement is observed when switching the source off. When illuminating with long-wave UV light (365 nm) a small decrease in conductivity is observed which may correspond to the seldom observed phenomenon of negative photoconductivity (2). Little change in the response occurs between temperatures of 100° and 295°K.

Figure 2 shows the response of the sample to various combinations of the visible, infrared, and UV sources, at temperatures of 100° and 295° K. The surface conductivity increased five orders of magnitude when the four sources were on for 22 min; conductivity decreases immediately after switching off the sources. After an initial transient of about 5 min this response follows a straight line in the semilog-plot; from minute 17 on a second straight line is defined. The decay is also characterized by two straight lines followed by a curve.

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The straight segments correspond to trap-controlled photoconductivity (e.g., (3)) described by $\sigma = \sigma_0 \exp \pm (t/\tau)$, where σ represents conductivity, t time, and τ is known as the response time of the photoconductive process. Apparently various kinds of traps, with different response times, are involved in such a process. Similar response times can be defined for excitation with visible or infrared radiation only. Table 1 summarizes the response times for the various plots inf Figure 2. Infrared radiation yield the largest response times when the initial temperature is 295°K; however at 100°K the response times decrease approximately three-fold.

The present experiments suggest that solar radiation may increase the conductivity of some surface material (1-2 mm depth) up to seven, or perhaps more, orders of magnitude. This observation is based on the fact that the variation of five orders of magnitude, in Figure 2, occurred in only 22 min and that it appears to be far from reaching equilibrium.

REFERENCES

(1) Mason, B., Mineralogy and petrology of polymict breccia 15498, in The Apollo 15 Lunar Samples, ed. J.W. Chamberlain and C. Watkins, p. 137, LSI, Houston, 1972.

(2) Bube, R.H., Photoconductivity of Solids, p.404, John Wiley, 1960.

(3) Kittel, C., Introduction to Solid State Physics, 3d. ed., p. 550, John Wiley, 1968.

TABLE 1

RADIATION	TEMP (°K)	ON $+\tau$ (sec)	OFF $-\tau$ (sec)
VISIBLE	295	65	60,190
INFRARED	295	360	300
	100	95	110
VIS + IR	100	—	90
VIS+IR+UV(235+365)	295	120,225	60,110

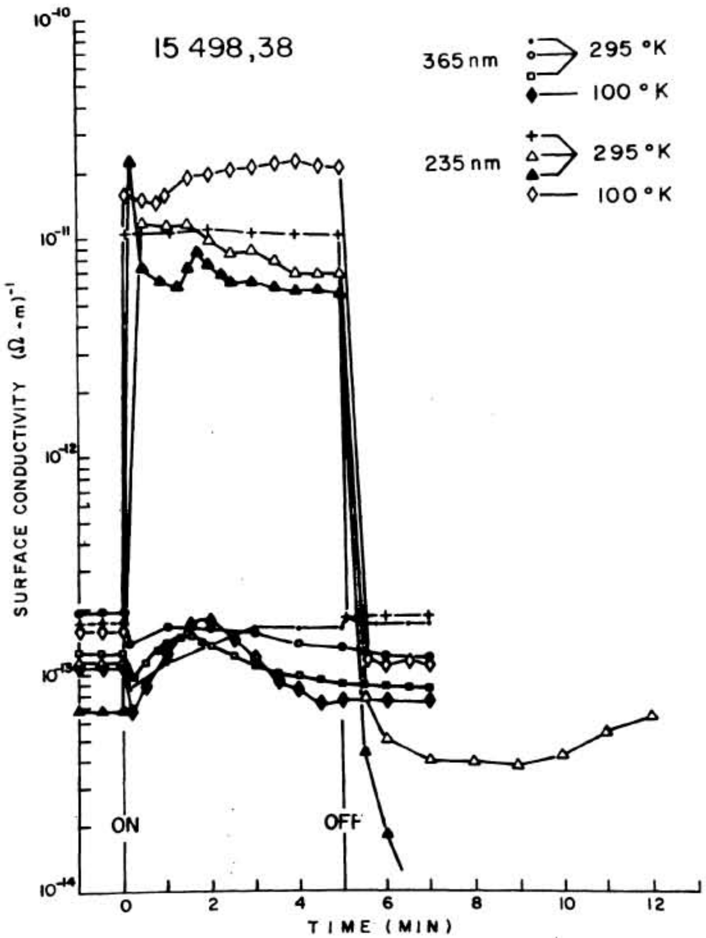

Fig. 1 Photoelectric effect in sample 15498,38. UV sources of 235 and 365 nm were used

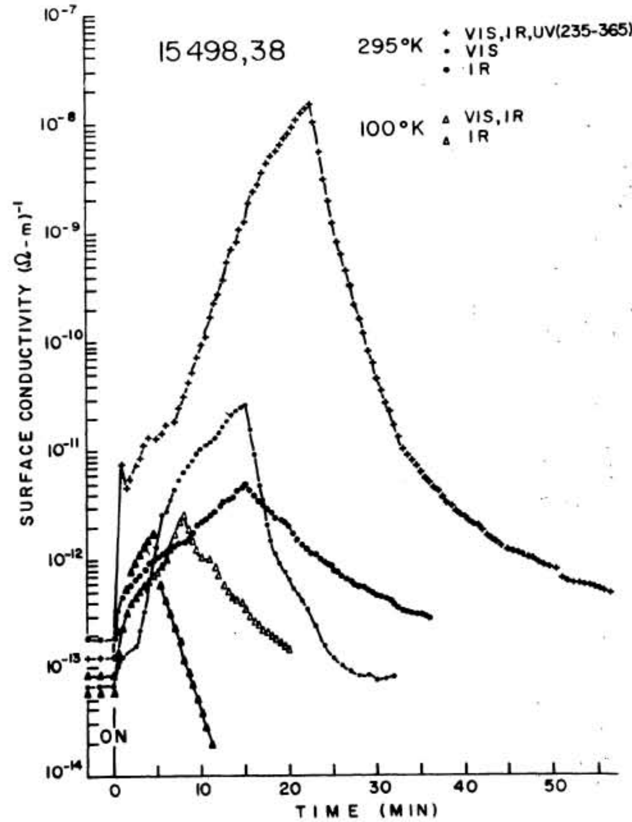

Fig. 2 Photoelectric effect controlled by traps obtained when combinations of visible, IR, and UV sources were used.