
The possibility of the existence of an appreciable concentration of low energy electrons above the lunar surface due to photoemission and secondary electron emission processes has previously been considered theoretically by a number of authors. Direct evidence for the photoelectron component has been provided by the charged particle lunar environment experiment (CPLLE) set up during the Apollo 14 mission. The low energy electron spectrometer showed quite clearly an electron flux due to solar irradiation in the energy range from 200 down to 35 eV. We have undertaken measurements of the yield and the energy distribution of photoelectrons due to solar irradiation, together with the diffuse reflectance, for sample 14259.116. Data were taken in the range from the photoelectric threshold near 2500 Å to 500 Å wavelength, corresponding to a photon energy range of 5 eV to 20 eV. Future measurements using a synchrotron light source will extend this data up to about 100 eV and allow direct comparison with the CPLEE data taken in the region of overlap. Calculations have been performed on the basis of those data, which give the density and energy distribution of the electrons in the lunar photoelectron layer. Together with data on the secondary electron emission due to solar wind particles a complete description may be given of the low energy electron layer and the electrostatic potential of the sunlit lunar surface.

The samples were handled in a dry nitrogen atmosphere of less than 10 ppm impurities during sealing into the ultrahigh vacuum chamber. Both photoelectric yield and the electron energy distributions were measured using a hemispherical collector. The resolution of the electron energy analyzer was 300 mV.

Figure 1 shows preliminary results on the photoelectric yield of the sample in the wavelength range 500 to 2500 Å. The yield is found to be about 7% in its maximum at 900 Å wavelength. This yield is much lower than expected for insulating materials, which reach yields of 30% and higher. The lower yield is probably due to the fact that the material is in the form of a fine powder, thus increasing the probability of reabsorption of a photoemitted electron. For an insulator one would also expect the yield to increase further for higher photon energies between 12 and 20 eV. Instead a decrease is observed, dropping to 1.2% at 584 Å wavelength (21.2 eV photon energy). The measured yield is even lower than that of common metals, which typically reaches peak values of about 10%.

A set of photoemission energy distribution curves is shown in Fig. 2 as measured with different photon energies. Those curves show a high contribution of low energy electrons, while the number of electrons emitted with the highest possible energies, namely photon energy minus work function, is small. The average electron energy therefore will be small compared to the photon energy.
PHOTOEMISSION FROM LUNAR SURFACE FINES.

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Fig. 1 Photoelectric yield per incoming photon of lunar sample 14259.116.

Fig. 2 Energy distribution of photoelectrons emitted from lunar sample 14259.116 for various photon energies.
Computer calculations have been performed to study the properties of the lunar photoelectron sheath on the basis of the data given in Fig. 1 and 2. The results give the saturation photoelectron flux as \(2.8 \times 10^{13}\) electrons/m\(^2\) x sec or 4.5 \(\mu A/m^2\). This is an order of magnitude less than for aluminium, due partly to the low yield and partly to the high work function of 5 eV. The density of electrons in the sheath is calculated to be 130 per cm\(^3\) at the surface, and the shielding length 78 cm.

A direct comparison with the data measured by the CPLEE\(^6\) on the lunar surface is not possible with the present measurements due to the limitation in light energy used. However, one can say that if these results are typical, the lunar photoemission is small compared to that of common materials\(^8\), and the average energy is very low. Therefore care has to be taken in the interpretation of low energy electron measurements taken on the lunar surface, since a considerable amount of the measured electrons might be due to contamination of the local photoelectron sheath by the instrument itself.

References: