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Photoelectric Charging by Ultraviolet Light of a Lunar Dust Simulant in a Microgravity Environment

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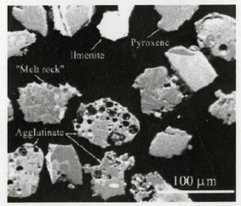
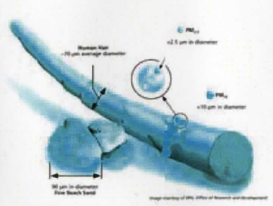
Abstract

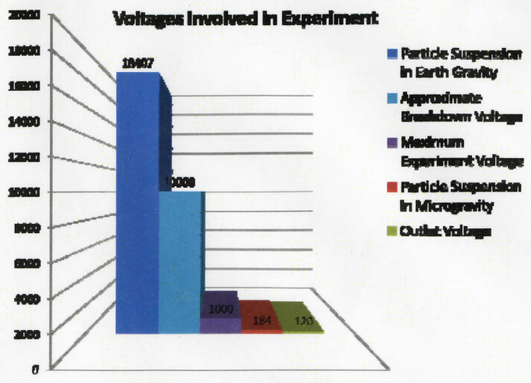
A microgravity experiment to test the electrostatic behavior of a lunar dust simulant being charged through the photoelectric effect will expand understanding of the charging characteristics of dust particles and may lead to a possible mitigation solution. With a design based upon Robert Millikan's oil-drop experiment, this experiment is designed to observe the interactions of a lunar dust simulant without the conflicting effect of a dominant gravitational force. The dust particles will be charged by means of a lamp capable of photon energies necessary to emit electrons by the photoelectric effect. In the presence of an axial electric field, the photo-electrons and charged dust will be attracted to opposing sides of a capacitor and the net charge over time as well as physical trajectories of the particles can be determined.



Courtesy of NASA


Courtesy of EPA, Office of Research and Development

Although this experiment is not designed to provide a dust mitigation strategy for lunar regolith, an increased understanding of the charging properties of silica by means of the Get Away Special Team's experiment benefits the scientific community.



Experiment

One of the unexpected obstacles of the Apollo Missions was the presence of abrasive and adhesive lunar dust. Due to such factors as plasma electrons, bombardment from solar winds, and photoelectrons, the lunar dust (regolith) is charged. The purpose of this experiment is to better understand the charging of a lunar dust simulant due to an easily reproducible means of charging, the photoelectric effect.

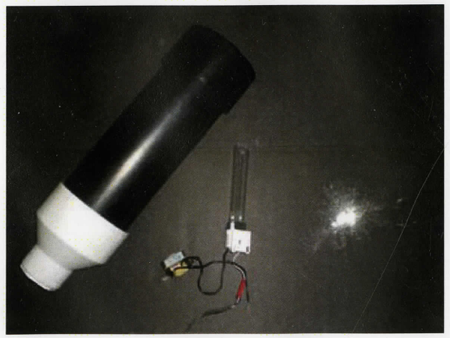
Test Objectives:

1.To determine the net charge acquired by silica dust particles over time evolution due to electron emission from the photoelectric effect, under controlled experimental conditions.
2.To qualitatively observe the interactions between particles of a charged lunar dust simulant in microgravity.
3.To determine the effect of particle size in relation to net charge acquired.

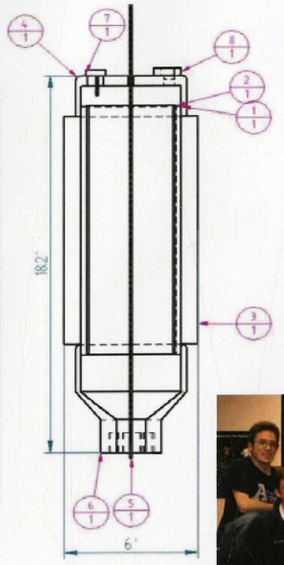
***Hypotheses*:**

1.Silicon dust particles will exhibit a charging effect when exposed to ultraviolet light containing sufficient minimum photon energy corresponding to the work function for the compound.
2.The rate of charging over time evolution will be constant due to the photoelectric effect being almost instantaneous, but the rate of acceleration of the particles will increase as greater charge is accumulated.

Experiment Apparatus:



1	ABS Tube
2	Capacitor Wall
3	Faraday Cage
4	Top Tube End
5	Grounded Wire
6	Bottom Tube Reducer
7	UV Lamp
8	Camera

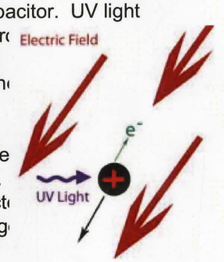


Need for Microgravity:

1.Experiments on earth would require an unsafe voltage to balance the force of gravity with an electromagnetic force
2.Microgravity environments better model conditions of dust interaction on lunar , Martian, and other sub-earth-gravity environment surfaces

Procedure:

Upon achievement of microgravity, BK7 lunar dust simulant is introduced into the charged axial capacitor. UV light irradiates the dust, causing the electrons to be emitted. The positively charged dust is attracted to the negative plate of the capacitor, while the electrons are attracted to the positive wire. The electrons received on the wire register a current measured by the ammeter. The positively charged dust is expected to interact with itself and video footage will be taken to be later analyzed in determining particle trajectories.



Several experimental runs will be performed with a variety of voltages, light energies, and particle sizes

Light Energies	Voltage			
	50% (100 V)	100% (200 V)	300% (600 V)	500% (1000 V)
> 5eV (unfiltered)	2µm 18µm 60µm	2µm 18µm 60µm	2µm 18µm 60µm	2µm 18µm 60µm
Visible control	18µm	18µm	18µm	18µm
< 5eV (filtered)	2µm 18µm 60µm	2µm 18µm 60µm	2µm 18µm 60µm	2µm 18µm 60µm
Visible control	18µm	18µm	18µm	18µm

Results:

Unfortunately due to budget constraints, NASA was unable to allow the normal number of proposals to be accepted, meaning the experiment wasn't performed.

Acknowledgements

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