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OPTICAL EFFECT OF THE CONTAMINATION OF INFRARED WINDOWS BY THE OUTGASSING OF MATERIALS IN OUTER SPACE

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SEMI-ANNUAL STATUS REPORT
FOR THE PERIOD ENDING JANUARY 1, 1975

RESEARCH GRANT NGR 43-021-002

E. Silberman, Principal Investigator

at

FISK UNIVERSITY
NASHVILLE, TENNESSEE 37203

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NASA Scientific and Technical Information Facility
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Gentlemen:

Enclosed are two copies of our Semi-Annual Status Report for NASA Research Grant Number NGR 43-021-002, entitled, "Optical Effect of the Contamination of Infrared Windows by the Outgassing of Materials in Outer Space."

Sincerely yours,

E. Silberman
Principal Investigator

NASA Interim Report

I. SUMMARY OF OBJECTIVES

Research objectives were modified somewhat during the reporting period due to changes in the overall emphasis of contamination research by the coordinating technical advisor at NASA-Marshall Space Flight Center. Rather than a compillation of infrared spectra of possible contaminants of spacecraft optical surfaces, the research will be aimed at greater understanding of the kinetics of outgassing materials and surface adsorption.

In particular, the composition and evaporation rate of the outgassing of a space vehicle thermal control paint (S-13G) as a function of temperature were to be studied.

II. WORK COMPLETED AND PRESENT STATUS

A. INSTRUMENTATION

The principal activity during the reporting period has been to design, construct and test a modification of the contamination chamber described in the previous interim report. This modified chamber now includes an accessory sub-chamber in which the samples are heated while any outgassing products are directed to the temperature controlled infrared transmitting window located in the main chamber. The products collected can then be identified through their measured infrared spectra. An important feature of the system is that the entire process, i.e., outgassing, collection of products, UV irradiation (if desired), and infrared measurements, can be carried out without removing the deposition window from the evacuated chamber.

A diagram of the system is included as Figure 1. The paint sample, deposited on an aluminum foil, is held by a copper ring against a flat plate which may be heated by resistance wire to any temperature up to 200°C. A cone-shaped baffle, which may be independently heated, is designed to prevent the outgassing products from collecting on the outer wall of the sub-chamber. The outgassing products are therefore guided to the cooled infrared transmitting window in the main chamber. The temperature of the infrared window may be varied from 20 to 300°K. Temperatures of the sample plate and baffle are measured by copper-constantan thermocouples. The infrared window temperature is measured with an iron-doped gold vs constantan thermocouple. By using an ion pump, a vacuum of 2×10^{-6}Torr or better can be maintained throughout the system. When the cryogenic refrigerator of the main chamber is in operation, pressures fall to below 10^{-7}Torr.

Only a small quantity of material is expected to be outgassed from the paint samples, so special care was taken to eliminate other sources of outgassing products within the chamber. The heating wire used to control the sample and baffle temperatures is insulated by MgO covered with an Inconel sheath, since any organic insulation would be a potential source of unwanted contamination. Except for the "O" ring seals, the sub-chamber is made entirely of metal.

B. EXPERIMENTAL

1. Several samples of S-13G thermal control paint have been tested to determine if heating to moderate temperatures causes them to release outgassing products which can be collected on a cooled cesium iodide window for identification by IR analysis. As expected,

even with careful attention to keeping the various metal surfaces of the contamination chamber clean, outgassing of surfaces other than the sample itself was a problem. Only after the surfaces were preconditioned by baking them in a vacuum, the residual contaminants were gradually eliminated.

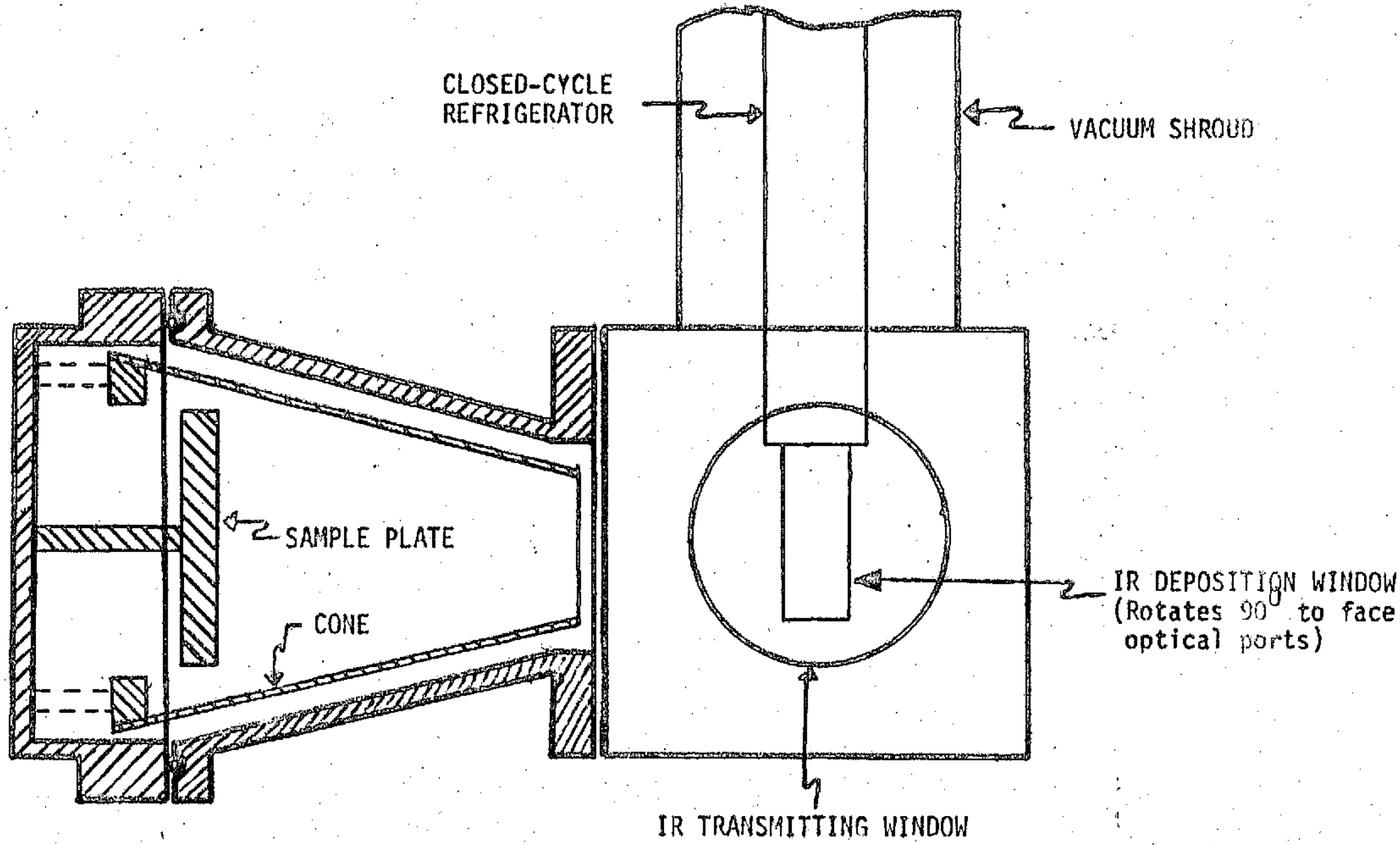
Comparison of the deposits collected with and without the S-13G paint in the sample holder showed bands possibly due to outgassing products of the paint at: $810cm^{-1}$ $1030cm^{-1}$ $1170cm^{-1}$ $1312cm^{-1}$ $1010cm^{-1}$ $1090cm^{-1}$ $1265cm^{-1}$ $1425cm^{-1}$ $1495cm^{-1}$

The strong absorption due to the ZnO in the paint would fall at $450cm^{-1}$. The bands at $810cm^{-1}$, $1010cm^{-1}$, $1090cm^{-1}$, and $1265cm^{-1}$ are due to the RTV binder. At this point we have not established the composition of the remaining out-gassing products but a search of standard spectra that may clarify the problem is under way.

III. WORK IN PROGRESS

Further experiments are planned to identify the S-13G paint outgassing products and to reliably distinguish between those and condensates not related to the sample itself. Once this is done, a systematic study will be made of the rate of outgassing and the compounds released by the paint as a function of its temperature. Also, the fraction of the outgassing products that actually stays on the deposition substrate for a measurable length of time will be measured as a function of substrate temperature.

A graduate student is working on the optical measurement of the deposit thickness and the spectral corrections due to the thin film effect.



LOWER PART OF CONTAMINATION CHAMBER SHOWING SAMPLE ACCESSORY (Approximately Full Scale)