BIF-107-50247-69
Copy 1 of 2
Page 1
3 pages total

To: G. D. Mc Ghee

16 June 1969

Subject: Flash Cleaning of Optical Surfaces in Vacuum

From: J. S. Thompson

The problem of cleaning optical surfaces in a vacuum, gravity-free environment has received some attention recently. Dr. James G. Baker suggested that a cleaning action may result from irradiation of the surfaces at high power and energy levels with an Edgerton flash lamp.

Following this suggestion the Laboratories Division of the Aerospace Corporation set up an experiment to "calibrate" its feasibility. The attached pages are a report on their results.

While their report is discouraging, their funds and time were limited, and they were unable to do more than examine the original, unadorned proposal. At these photon flux densities it seems quite probable that photoelectric emission must be occurring. If these electrons were swept away by an electric field it would leave a net positive charge on the contamination (assumed to be a dielectric). Raising the potential of the substrate at this point may aid in the removal of the contamination.

While this may prove to be impracticable it is suggested, mainly, to indicate that one need not consider the issue closed.

James S. Thompson
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JST:im

Attachment: Edgerton Flash Cleaning of Optical Surfaces; 2 pages

cc: R. Belt

EDGERTON FLASH CLEANING OF OPTICAL SURFACES

A helical xenon flash lamp was mounted in an aluminum block housing. The inside surface of the aluminum block was polished. An opening in the block provided a diffuse source of radiation. The energy input to the lamp could be controlled by the charge on the capacitor power supply; however, the maximum charge was used for all experiments.

Sample reflective surfaces were mounted inside a vacuum chamber, and the radiant flux was introduced through a fused silica window. A transient thermopile was used to measure the incident energy. Absorbed energies were calculated from the incident energy, lamp spectrum, and the sample spectral reflectance. Radiant energy pulses were of the order of 0.001 second.

The reflecting surfaces were coated with F-50 silicone oil, F-50 silicone oil with an absorbing dye, and F-50 silicone oil with a black pigment. Thicknesses of between 0.2 and 30 μ were obtained. A free-standing polymer film was also irradiated. The use of a dye pigment increased the absorbed dose without changing the incident energy.

For the pigment-free oils, absorbed doses of under $5 \times 10^{+3}$ joules/cc had no effect. Some oil removal for the thicker films was obtained with absorbed doses of $1 \times 10^{+4}$ joules/cc. The efficiency decreased with the film thickness.

For the pigmented oils absorbed doses of approximately $3 \times 10^{+4}$ joules/cc resulted in partial removal; however, some decomposition of the oil was also produced which resulted in a carbonaceous layer on the surface. For these carbonaceous deposits, even absorbed doses of $25 \times 10^{+4}$ joules/cc had little effect.

An analysis indicated that incident energies of 50 joules/cm^{-2} would melt a thin aluminum layer. By placing an aluminized mirror within the flash lamp in air, where approximately 100 joules/cm^2 was obtained, the aluminum was removed.

The critical parameters for the successful removal of surface contamination by a flash lamp appear to be:

1. energy necessary for removal or evaporation of film,
2. energy delivered to the film by optical means,

3. heat loss to the substrate, and
4. damage threshold of mirror.

The first factor depends on the nature of the film, i. e., polymer, inorganic or carbon deposits. The second factor depends on the matching of the absorption spectrum of the deposit and the lamp's radiant spectrum and power level. The third distinguishes between thin and thick films. It is our opinion that this method will not serve as a general method of clearing contaminated surfaces. The method will become very inefficient for thin contamination layers and, because of chemical reactions, it may introduce more problems than it solves.