NASA TECH BRIEF

Ames Research Center

Optical Bonding Agents for Severe Environments

Available optical cements were found unsuitable for use as bonding agents for the calcite analyzing prism of the photopolarimeter for the Pioneer F/G mission. They could not resist forces induced by differential expansion of mated parts over a wide temperature range. Moreover, the characteristics of ordinary cement change when it is in a vacuum or in the high energy radiation environment of space.

The calcite prism is formed of three elements; the fast axes of each element are mounted orthogonally. Since the thermal expansion coefficients of calcite are $-6 \times 10^{-6} / ^\circ C$ perpendicular to the optical axis and $+25 \times 10^{-6} / ^\circ C$ parallel to the axis, the bonding agent must remain flexible to prevent the development of thermally induced stresses over a wide temperature range.

Previous experience with silicone elastomers as bonding agents suggested that their suitability for this application should be investigated. Hence, the following elastomers were tested: General Electric RTV 655, Dow Corning (DC) XR-63-488, DC 93-500, DC 182, and DC 184.

Dynasil fused silica disks, bonded with these agents, were subjected to hard radiation (10-MeV electron and 142-MeV proton bombardment) and no changes were detected in the optical transmittances before and after bombardment. The applicability of these materials for space was checked by determining loss of weight when maintained in a vacuum at an elevated temperature. All but one of these materials exhibited about 1% loss of weight after 2 days at 90° C and 1×10^{-6} torr ($1.3 \times 10^{-4} N/m^2$).

The DC 93-500 exhibited less than 0.5-percent weight loss. The results of thermal-shock cycling tests using DC 93-500 and XR-63-488 indicated that both of these materials were satisfactory bonding agents for calcite faces with orthogonal axes, and for calcite to aluminum. Vibration and acceleration tests were applied to the DC 93-500 specimen; the results were satisfactory. Therefore, the DC 93-500 material was selected as the best material for this particular task. It was noted that some of the others tested are suitable for applications where outgassing is permissible. When curing problems were encountered with DC 93-500, it was found that DC XR-63-488 is a satisfactory substitute.

The low refractive index and low adhesive strength of these elastomers were not determining factors in this application.

Reference:

Pellicori, S. F.: Optical Bonding Agents for Severe Environments. Applied Optics, 9, 2581 (1970).

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
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No patent action is contemplated by NASA.

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