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DEVELOPMENT OF MATERIAL SPECIFICATIONS AND QUALIFICATIONS OF POLYMERIC MATERIALS FOR THE JPL SPACECRAFT MATERIALS GUIDEBOOK

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I. Scope

This report covers the work performed during the period April 10 to May 10, 1965, on "Development of Material Specifications and Qualifications of Polymeric Materials for the JPL Spacecraft Materials Guidebook."

The over-all objective of this program is to provide assistance to the JPL staff members in the development of specifications and procedures for polymeric spacecraft materials. This includes definitions of properties, tests, and environments which are sensitive and meaningful, and collection of pertinent property, environmental, and materials data for use in specifications. Of particular importance to this program are the outgassing characteristics of various polymeric materials. The classes of materials to be examined were selected by the JPL cognizant engineers.

Current studies are concerned with the outgassing characteristics of liquid and paste silicones and the effects of different postcuring procedures.

II. Work Accomplished

Previous tests on the RTV silicone materials have shown that they are unsatisfactory for spacecraft use because of the large amounts of condensable oils evolved on heating in a vacuum. At the request of Mr. Hugh Maxwell we have investigated altervative processing routes which might improve the outgassing characteristics of these materials.

Experimental: Four representative silicone potting compounds, RTV's 615, 11, 60, and 560 were given a "space-postcured" treatment by heating the samples to 150°C under a vacuum of 10^{-5} mm Hg for 24 hours. The samples began to give off large amounts of clear oil when the bath temperature reached 130-140°C. After twenty-four hours, oil evolution had apparently ceased and the postcured test specimens were removed from the vacuum system. The samples were weighed and then exposed to air for three days before thermal-vacuum treatment. There was a slight increase in weight due to absorption of water and gases on the surface

of the test specimens. As an approximation, the amount of adsorbed material may be subtracted from the total weight loss during vacuum postcuring to give the weight percent of condensable oil removed by the treatment. (See Table I).

Table I

Silicone RTV	Original Wt. untreated sample	Weight after post-curing	% wt Lost	Wt after 3 days in air	% wt Gained	Over-all wt loss %
615	4.68625	4.61465	1.53	4.61595	0.03	1.50
11	5.68011	5.61990	1.06	5.62569	0.08_5	0.97_5
60	5.65682	5.59112	1.16	5.59573	0.08	1.08
560	4.61445	4.47032	3.12	4.47225	0.06	3.06

These test specimens were then submitted to thermal vacuum treatment under the usual conditions, i.e., 150°C/5 x 10^{-6} mm Hg. There was no detectable oil evolution from any of these samples; for this reason the "space postcure" seems the most successful method for pretreatment of the silicone RTV compounds. A summary of the methods tried is given in Table II; Fig. 1 illustrates the full weight loss curves for RTV 60 treated by each of these methods. However, it must be kept in mind that this type of postcuring may not be suitable for all end-uses of those materials. A more suitable method for some uses might be changes in resin formulation involving, for example, a new carrier for the catalyst (other than silicone oil) or a new catalyst.

Table II

% WEIGHT LOSS OF MATERIALS
(≈45 hrs at 150°C/10^{-6} mm Hg)

Silicone	Standard cure	Standard cure (0.5% catalyst)	Postcured in air*	Vacuum postcured**
60	1.6	1.4	0.8	0.3
560	3.3	3.3	1.6	0.4
11	2.7	2.2	1.2	0.5
615	1.9	---	---	0.5

*Material postcured using JPL recommendations (in air, 150°C x 24 hr)

**Material postcured using SRI recommendations ("space postcured")

Report Preparation: A special report including all data obtained on the "Epon" adhesives under thermal vacuum conditions is nearing completion; work on a similar report convering the RTV silicones is in the rough draft stage.

Analytical Services Department: R. F. Muraca reports that, "Construction is well underway for the vacuum apparatus designed for standardized determination of the weight loss of polymers for materials specifications. The basic console has been completed and the vacuum pumps and central manifold have been received. Fabrication of glassware has begun, and it is anticipated that the system will be in operation before the end of the next working period."

III. Future Work

Work on determining the outgassing properties of the various fluorocarbon polymers has begun, and the data for these should be available for the next monthly report. After that time, further work will be transferred from the Polymer Sciences Department to the Analytical Services Department, in accordance with the change in emphasis requested by JPL, until such time as more basic studies again become desirable.

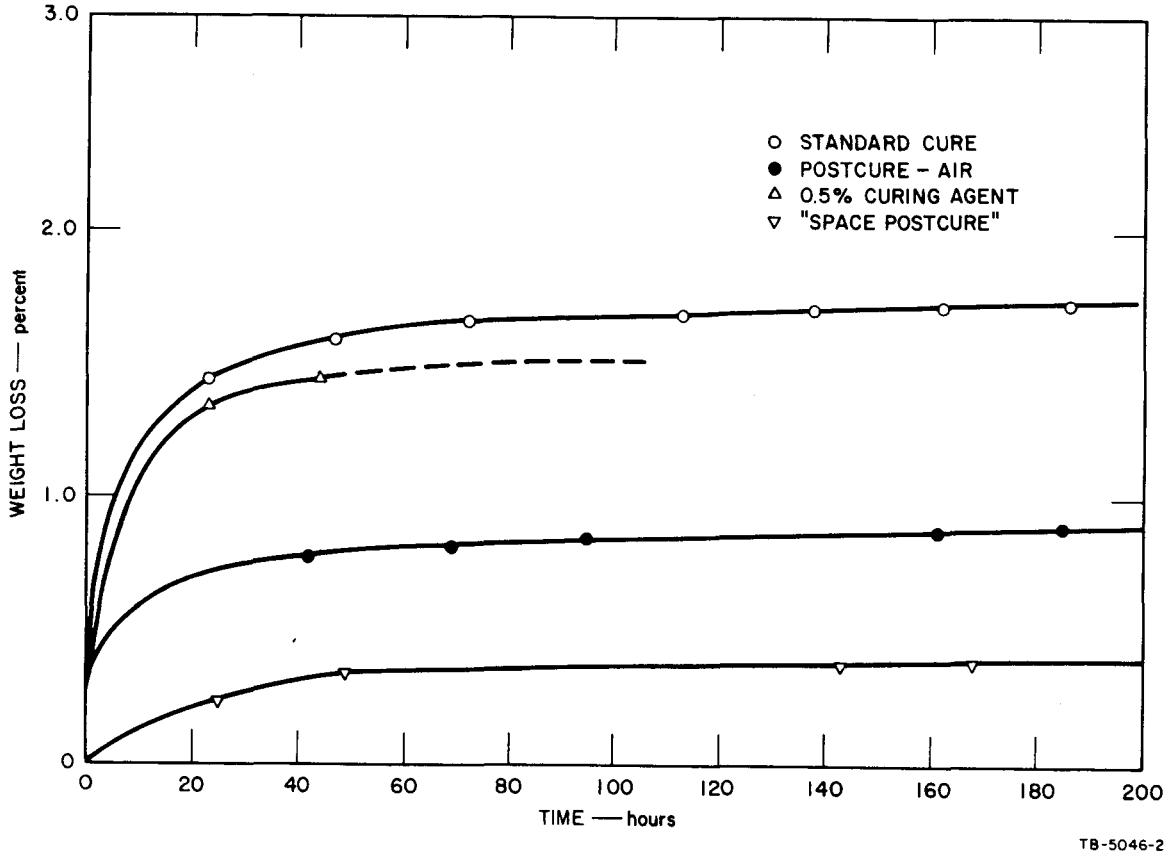

FIG. 1 EFFECT OF VARIOUS PRETREATMENTS ON THE OUTGASSING CHARACTERISTICS OF RTV 60 AT 150°C × 10^{-6} mm Hg