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THERMAL TESTING OF ALUMINIZED MYLAR

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TABLE OF CONTENTS

TECHNICAL MEMORANDUM

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INTRODUCTION

Physical properties such as tensile strength and thermal stability are extremely important when evaluating the value and durability of various materials. In this study, aluminized Mylar (Al-Mylar) film was tested for thermal stability. Tensile strength as a function of temperature was measured to indicate thermal stability. The samples were heated using a vacuum oven maintained at a nominal pressure of 1×10^{-2} torr.

Al-Mylar possesses a wide range of physical properties. The material is used in everything from aircraft to loudspeakers. Besides having high thermal stability, Al-Mylar is also chemically resistant. It is hoped that the information from this study will provide more information about the value of these materials in space environments.

SUMMARY

The Al-Mylar was cut into 5- by 1-in strips and placed in a vacuum oven for 1 week at various temperatures. Two strips were placed in the oven at a time. Before placing them in the oven, the materials were cleaned thoroughly with alcohol. The two strips rested on an aluminum plate and were held in place by two thin aluminum bars placed on the ends of the strips. The samples were heated at 50° intervals ranging, from 50 to 300 °C. The tensile strength of the Al-Mylar was measured after the 1-week intervals.

BACKGROUND INFORMATION

Mylar film is transparent, tough, and flexible. The material exhibits properties such as low water absorption; dimensional stability; resistance to oils, fats, and many chemicals; and has a very low permeability to gases and odoriferous substances. O and S are two types of Mylar; O is highly transparent; and S is slightly opaque, has improved slip or handling characteristics, and is available in several widths and gauges. The material has a variety of applications, with the most prominent being electrical. For example, the 100-gauge film is suitable for electrical capacitors, electrical motor slot-liners, and for other insulation applications involving cables, coils, and transformers. The material is free from plasticisers or other additives; therefore, metallization by the vacuum process is easy. Mylar was also used as the construction material of the American communications satellite, Echo I of 1960, in the Stratoscope balloon telescopic system, and the Ranger lunar surface exploration vehicles.[1]

The chemical name for Mylar is polyethylene terephthalate which is a saturated polyester. The name, Mylar, is a trade name for the material used by Du Pont, the primary manufacturer of Mylar in the U.S. Polyethylene terephthalate film has a high thermal stability. Over the temperature range of –20 to

80 °C, the physical and mechanical properties of Mylar show little change. The film retains useful properties ranging from 150 to 175 °C, and no embrittlement occurs at temperatures as low as –60 °C. The film remains flexible at temperatures as low as –50 °C.[2]

EXPERIMENTAL RESULTS

Visually and structurally, there were no observable defects at temperatures below 200 °C. At that temperature, however, the aluminized Mylar lost some of its luster and began to wrinkle and become brittle. The streaking and embrittlement of the Al-Mylar increased with temperature.

The tensile strength (measured in lb/in^2) of Al-Mylar at the various temperatures was measured, and the information from the average of two samples was compiled into a line graph (fig. 1). The tensile strength of the Al-Mylar was calculated using the following formula:

$$\text{max load (lb)}/(b' \times a)\ \text{in}^2 \ ,$$

where a is the thickness of the Al-Mylar strip, and b' is the calculated width of the strip. The calculated width, b', was found by:

$$b' = b - hc \ ,$$

where b is the measured width of the Al-Mylar, c is the hole diameter, and h is the number of holes in the strip. The value, b', was used as the width because the Al-Mylar strips contained holes which reduce the total cross-sectional area of the material. The temperature, calculated width, max load, and tensile strength of the samples are provided in table 1.

CONCLUSIONS

Conclusions were drawn based on structural degradation of Al-Mylar after it was removed from the vacuum oven. In addition, the tensile strength of the material was measured and the information plotted, with tensile strength as a function of increasing temperature (fig. 1). Overall, the goal is that the information obtained will help determine the usefulness of Al-Mylar at various temperatures.

The results obtained from the thermal tests confirmed that the materials are thermally stable within certain temperature ranges. With regard to tensile strength, the data collected indicate that there is a peak in tensile strength at 200 °C; however, statistical error analysis reveals that this peak is within the margin of error. In the range of 50 to 200 °C, statistical analysis indicates that the tensile strength of Al-Mylar does not change, but Al-Mylar definitely degrades considerably beyond 250 °C.

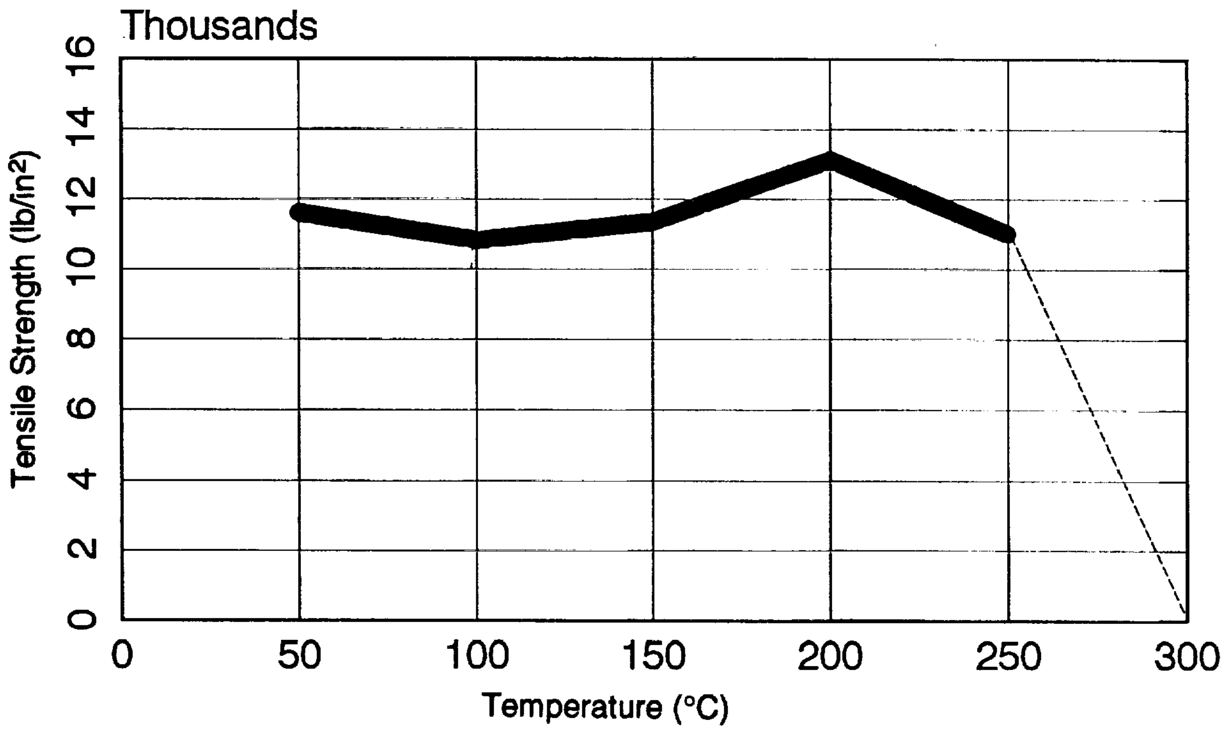

Figure 1. Tensile strength of Al-Mylar at various temperatures.

Table 1. Data of Al-Mylar samples.

Sample Number	Temperature (°C)	Calculated Width (in)	Max Load (lb)	Tensile Strength (lb/in^2)
50.1	50	0.7090	3.693	12,018.3
50.2	50	0.7535	3.660	11,207.5
100.1	100	0.7065	3.410	11,136.6
100.2	100	0.6935	3.167	10,536.9
150.1	150	0.7055	3.445	11,266.9
150.2	150	0.7570	3.748	11,423.9
200.1	200	0.6570	3.952	13,879.1
200.2	200	0.7125	3.968	12,849.8
250.1	250	0.7330	3.618	11,388.7

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1. Goodman, I., and Rhys, J.A.: "Polyesters-Saturated Polymers." Volume I, American Elsevier Publishing Company, Inc., New York, NY, 1965.

2. Bjorksten Research Labs: "Polyesters and Their Applications." Reinhold Publishing Company, New York, NY, 1956.

APPROVAL

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The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

P.H. SCHUERER
Director, Materials and Processes Laboratory

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13. ABSTRACT *(Maximum 200 words)*

This report summarizes the effect of heat on aluminized Mylar film. With the report, a summary of the procedure used in testing the material, background information describing the physical properties of the material, and the experimental results of heating the material at various temperatures are included. This study reveals that aluminized Mylar film is thermally stable within the temperature range of 50 to 200 °C. The information compiled in this report will be used to determine if aluminized Mylar can be useful in space applications.

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