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Elastic Modulus of Mylar Sheet*

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Synopsis

High precision stress-strain curves were determined from representative Type A Mylar sheets in several commercially available thicknesses. A representative value for Young's modulus was found to be 0.76×10^6 psi. Measured values were from 0.60 to nearly 0.78×10^6 psi with the maximum value occurring at 0.005-in. thickness.

Introduction

The purpose of this investigation was to determine accurately the tensile elastic modulus of commercially available thicknesses of Type A Mylar. It was found that elastic modulus is a function of material thickness.

Model Fabrication

The test specimens were cut from $8^1/_2 \times 11$ in. sample sheets of Type A Mylar supplied by E. I. du Pont de Nemours and Company, Inc. They were 1 in. wide and 6 in. long in each of the following nominal thicknesses: 0.00075, 0.001, 0.0015, 0.003, 0.0075, and 0.010 in. All specimens were cut with the 6-in. lengths parallel to the $8^1/_2$ in. sides of the sheets.

The thickness of each test section was measured at a minimum of ten different locations. The average was taken as the effective model thickness.

Experimental Procedure

The tensile testing machine consisted of a high pressure gas supply, a pressure console, and a pneumatic loading cylinder on a special constant load testing machine which provided precise measurement and control of the load throughout the test.

The laboratory's dual objective micrometer[1] was used to measure the motion of two gage marks on the specimen as it was loaded. To obtain a small but visible gage mark, each specimen was covered with a coating of opaque china marking crayon across which were scribed two hair-lines at a spacing of 2.61 in. by using a reference gage block. The scribe lines did

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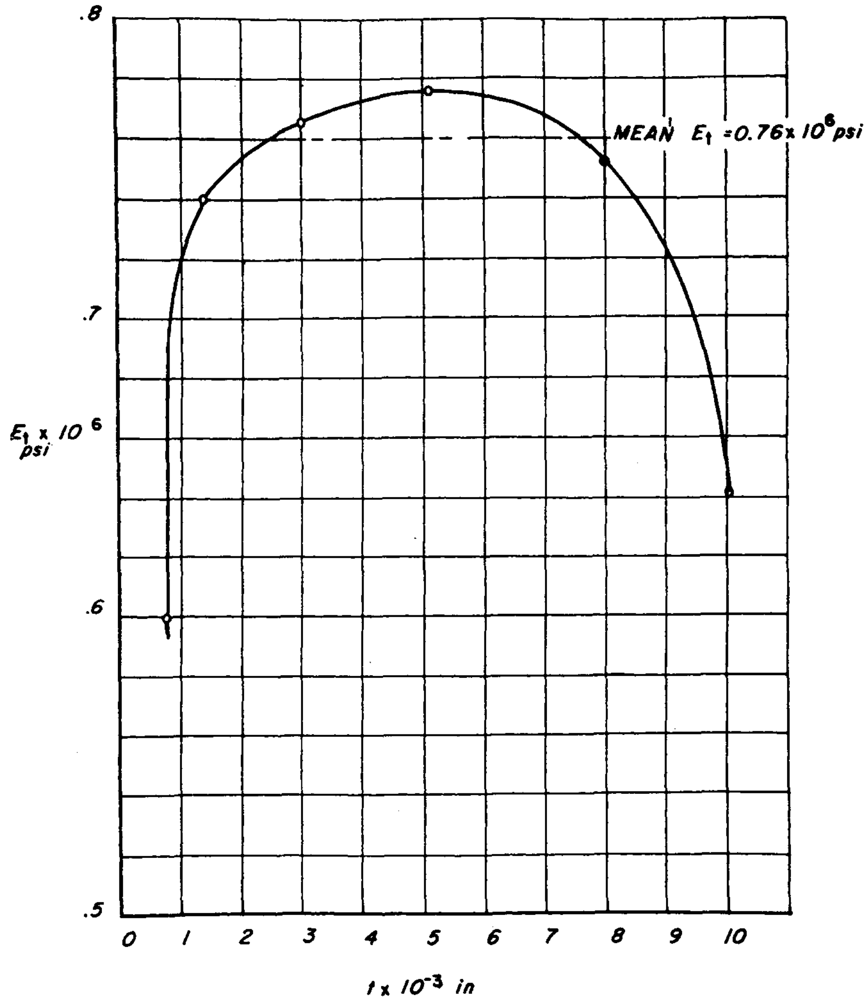

Fig. 1. Elastic modulus of Mylar as a function of sheet thickness.

not scratch or damage the surface of the Mylar. A light illuminated the specimen from the rear.

The micrometer was rigidly mounted to the testing machine frame. It was adjusted so that both gate marks were in focus at the same time, which meant that the microscope was normal to the specimen. With the particular distances that were used this gave a 3.5 × magnification, and as a result the strain was obtained from eq. (1):

$$\begin{aligned} \epsilon &= \Delta L/L \\ &= (I\text{-}F)/[(2.54)(3.50)(2.61)] \qquad (1) \\ &= 0.0431(I\text{-}F) \end{aligned}$$

where I is the initial separation of gage marks (in millimeters), F is the separation of gage marks at any particular stress (in millimeters), 2.54 denotes the centimeter-to-inch conversion, 3.50 is the magnification of micrometer, and 2.61 in. is the gage length.

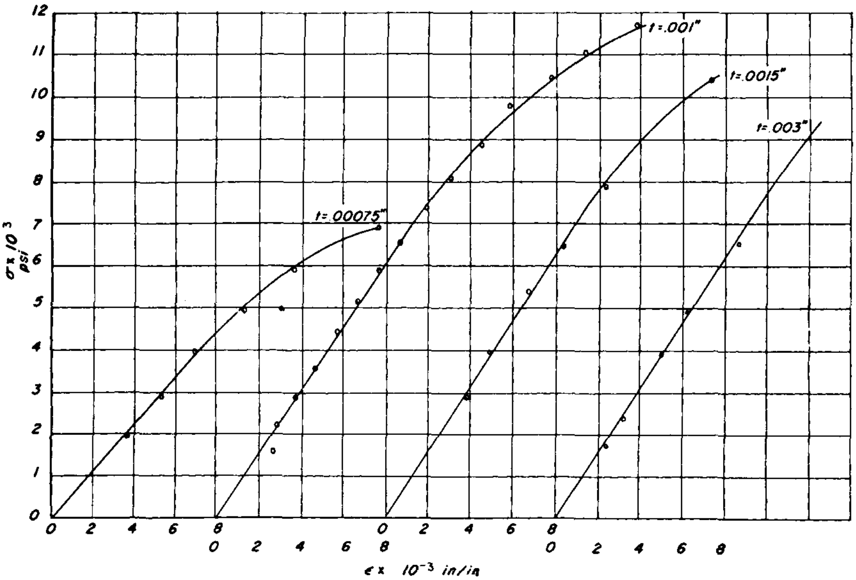

Fig. 2. Stress–strain curves of Mylar for sheet thickness between 0.00075 and 0.003 in

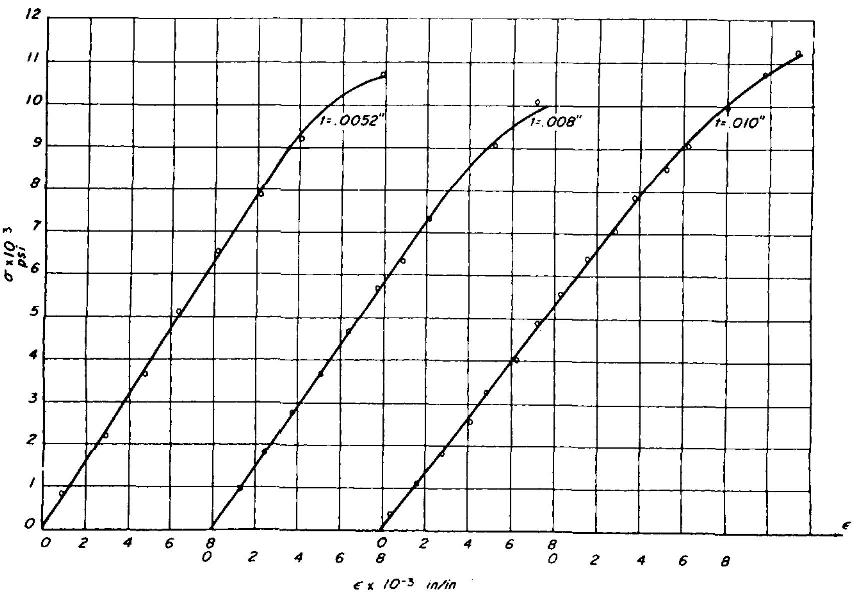

Fig. 3. Stress–strain curves of Mylar for sheet thickness between 0.0052 and 0.010 in.

During each test the specimen was loaded to a predetermined stress and then the relative separation of the gage marks was read on the reticle of the filar eyepiece in the micrometer. This procedure was repeated at small increments of stress to obtain the stress-strain curve for each thickness of Mylar.

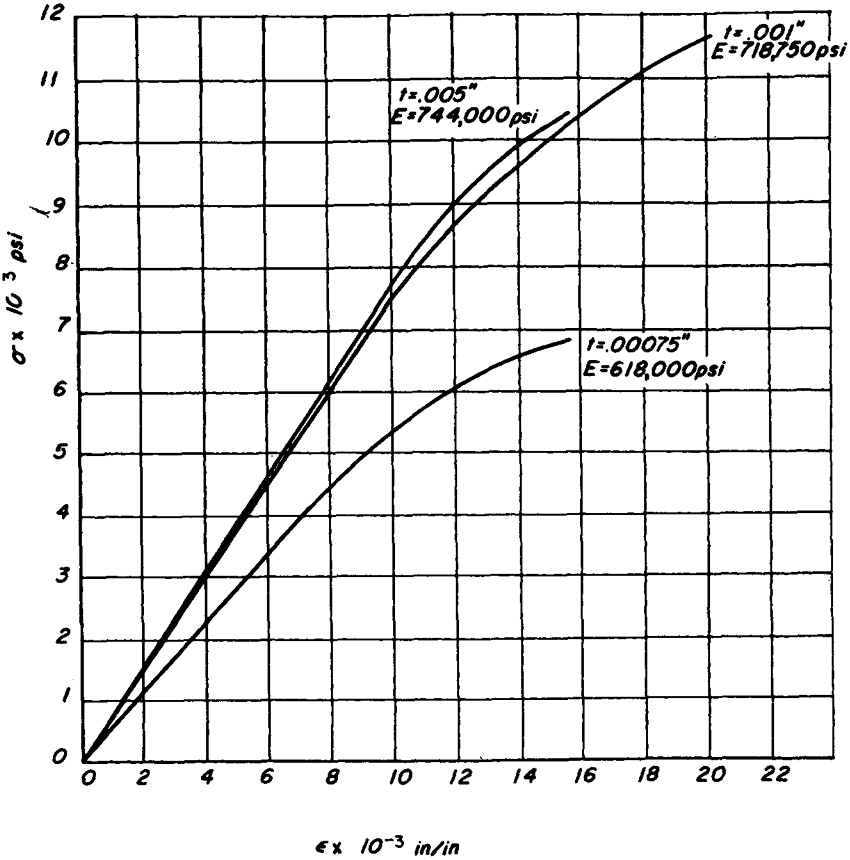

Fig. 4. Summary of stress-strain curves for Mylar sheet.

The length of time to obtain all the data for any given thickness was approximately 10 min. Throughout the testing period the temperature in the laboratory remained at about 75°F. At least two tests were made for each thickness to insure accuracy. The elastic modulus E was obtained from the slope of the straight line portion of each stress-strain curve.

Discussion of Data

A plot of tensile modulus versus thickness is made on Figure 1. The individual stress-strain curves for each thickness are plotted in Figures 2–5.

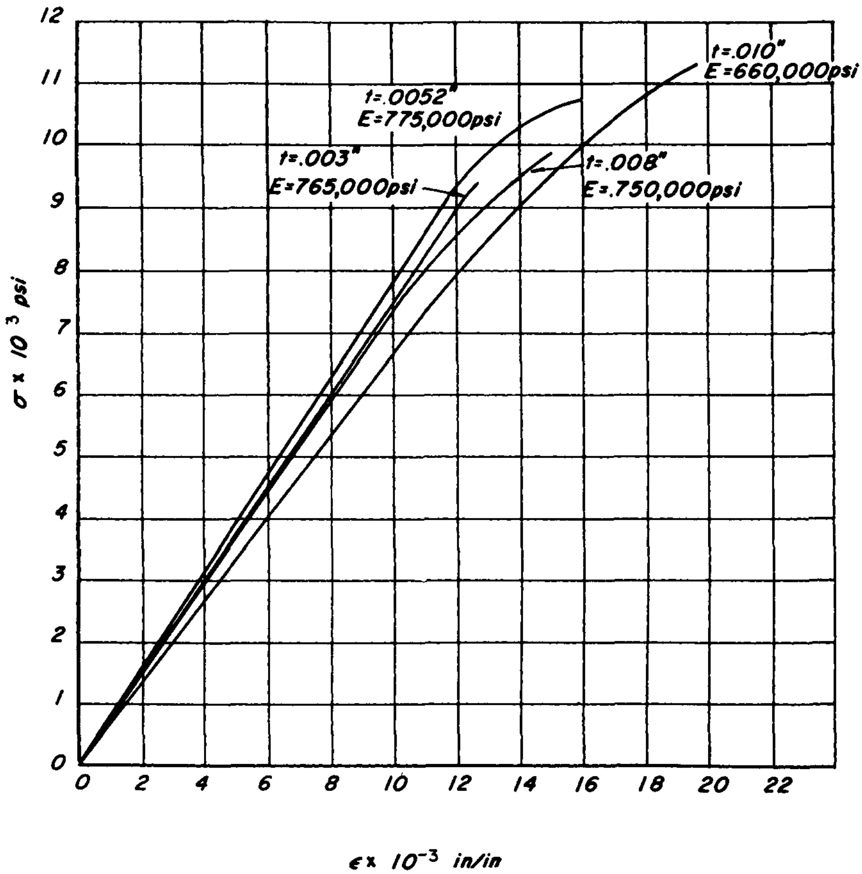

Fig. 5. Summary of stress–strain curves for Mylar sheet.

It is indicated in Figure 1 that the tensile modulus of Mylar is not a linear function of thickness. Below $t = 0.0015$ in. and above $t = 0.008$ in. the modulus drops off very rapidly. In the intermediate thickness range a variation of $\pm 2\%$ from a mean of 0.76×10^6 psi was found. The maximum modulus was found to be 0.775×10^6 psi. For general purposes the mean E, 0.76×10^6 psi, should be sufficiently accurate for the range of $t =$ 0.002–0.008 in. Where high accuracy is important it is advised to run a stress–strain test on a sample from the sheet that will be used.

Reference

1. Papirno, R., A. C. Gilbert, and H. Becker, *Rev. Sci. Instr.*, **27**, 854 (1956).

Résumé

On a étudié avec beaucoup de précision la courbe de tension-élongation de feuilles de mylar (type A). On a utilisé des feuilles d'épaisseur variable qu'on pouvait obtenir commercialement. La valeur la plus probable du module de Young a été trouvée égale à

0.76 × 10^6 psi. Les valeurs mesurées varient de 0.60 jusqu'à 0.78 × 10^6 psi, la valeur étant maximum à une épaisseur de 0.005 inch.

Zusammenfassung

Spannungs-Dehnungskurven hoher Genauigkeit wurden für repräsentative A-Mylar-Filme in einigen handelsüblichen Dicken bestimmt. Als repräsentativen Wert für den Young-Modul ergab sich 0,76 × 10^6 psi. Die Messwerte lagen im Bereich von 0,60 bis nahezu 0,78 × 10^6 psi, wobei der Maximalwert bei 0,005 Inch Dicke auftrat.

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