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A New Method for Determining Effective Tensile Gage Length

It has been shown by a photographic method that crosshead displacement can be used to calculate the elongation for a dumbbell specimen in tensile extension by using an effective gage length.[1] We wish to report here a convenient method for determining this effective gage length from tensile data at different crosshead speeds *without actually measuring the gage length* and to show that this method can be applied to dumbbell specimens as well as specimens of film strips.

It has been shown[1] that at constant temperature the true stress αS, measured at different strain rates R, is related to experiment time t in the following manner

$$\alpha S/R = f(t) \quad (1)$$

where α is the extension, S the stress based on the original cross-sectional area of the specimen, and $f(t)$ a function of t. By definition

$$\alpha = 1 + \gamma = (L_e + D)/L_e \quad (2)$$

$$R = V/L_e \quad (3)$$

where γ is the elongation, L_e the effective gage length, and V and D are the speed and displacement of the crosshead respectively. Substitution of (2) and (3) into (1) and transposing gives

$$D = f(t)V/S - L_e \quad (4)$$

When the crosshead displacements at constant value of time t are plotted against the ratios of crosshead speed V to apparent stress, the result will be a straight line, since $f(t)$ is a function of t only. The intercept of this line with the ordinate will give the value of $-L_e$. Since L_e does not change with t, all lines of constant t should converge to the same $-L_e$ on the ordinate.

An example of this kind of D vs. V/S plot is reproduced in Figure 1. Figure 1 is based on tensile data obtained from specimens of rectangular strips of a commercial polyisobutylene (Vistanex 120) at 24°C. and using crosshead speeds of 5 to 50 in./min. with an initial jaw separation of 1 in. The actual isochronic lines do not intercept the D axis at the same point of $-L_e$. However, the variation is within experimental error. The isochronic lines shown in Figure 1 were drawn through the average of $-L_e$ which is 0.93 in. for 1 in. jaw separation to compare with the experimental points which are shown as dots. The excellent agreement shows that this method is adequate for the determination of effective gage length. Another experiment on the same

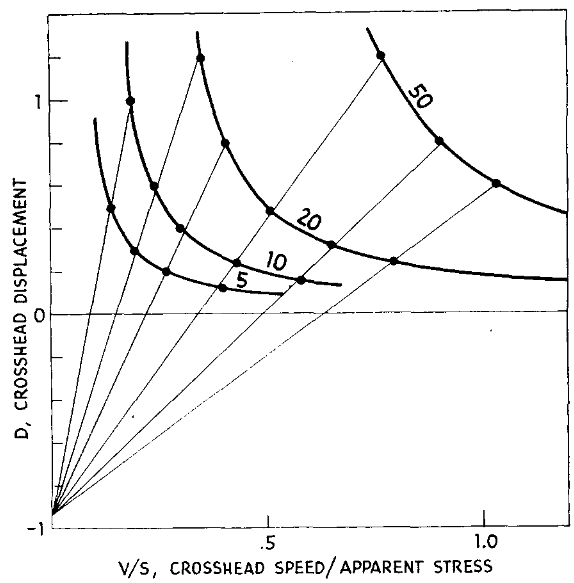

Fig. 1. The D vs. V/S curves for a polyisobutylene. The numerals indicate the crosshead speeds in in./min.

material but with a jaw separation of 2 in. gives an effective gage length of 1.85 in.

This method was applied to the stress-strain data on NBS polyisobutylene obtained[1] with dumbbell specimens, to which an effective gage length correction had been already applied. For this case eq. (4) can be modified to

$$\gamma = f(t)R/S - 1$$

The intercept of isochronic lines should, therefore, be -1, instead of $-L_e$. This was the actual result. Therefore, this method is applicable to dumbbell specimens as well.

In the region of small crosshead displacement where the hyperbolic D vs. V/S curve is almost flat, a small experimental error would cause a considerable error in L_e. At the other end of the curve, i.e., at large displacement, eq. (1) may not hold. The application of this method for determining effective gage length is probably, therefore, limited to a region from 20 to 120% nominal elongation.

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Reactions of Primary Amines with Epoxides

The advent of epoxy resin technology has created considerable interest in the reactions of amines with epoxides.[1] The reactions of ammonia and primary amines with epoxides are competitive consecutive processes and present con-