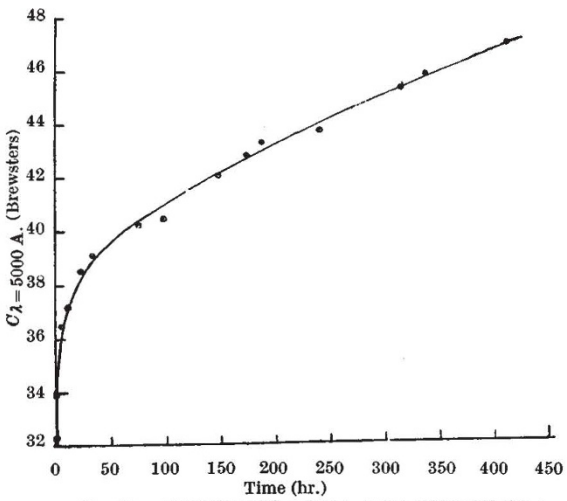
Photo-elastic Creep in 'Catalin 800' and *CR* 39

During the course of an investigation on the variation with wave-length λ of the stress-optic coefficient C_λ of 'Catalin 800' (a glass-clear phenol-formaldehyde resin) and of *CR* 39 (a condensed allyl ester), it has been found that C_λ depends upon the time allowed to elapse between the application of the load and the measurement of the resultant birefringence, the effect being due to the so-called photo-elastic creep in the loaded specimens. The two specimens, one of 'Catalin' and the other of *CR* 39, were both strained by a tensile force applied by a simple loading machine working on the lever principle, and the stress-optic coefficients were determined by the modified form of Filon's method[1], using a spectrograph instead of the usual spectrometer.



○—○—, Experimental points; curve computed from $C_\lambda = c_0' + c_1'\{1 - \exp(-kt^{1/3})\} + c_2't$

From the spectrogram formed by plane-polarized parallel light which has passed through a narrow limited section of the strained specimen, C_λ for a given wave-length can be deduced. From a series of such spectrograms, taken at intervals of time, t, after loading, values of C_λ for $\lambda = 5000$ A. were calculated, and plotted against t. Equations were fitted to the curves.

For 'Catalin' the results agree with those of Mylonas[2], the relation between C_λ and t being

$$C_\lambda = c_0 + c_1 t^{0.3}, \qquad (1)$$

where c_0 and c_1 are constants. The maximum duration of the test was 24 hours, though Mylonas, who originally suggested (1), used tests of duration less than one hour. For periods of continuous loading up to one hour, the experimental results agree with (1) to within 1 per cent, and for periods of 24 hours to within 5 per cent. c_0 and c_1 vary considerably from test to test, appearing to depend upon the history of the specimen. (A similar effect has been observed by previous investigators but for other materials.) Since the same value of load was used throughout, the dependence, if any, of c_0 and c_1 on the stress could not be ascertained.

For *CR* 39 more detailed results were obtained, but, as for 'Catalin', for one value of load only. The 'creep'-rate was not as rapid as for 'Catalin'. For short-period loadings, C_λ and t are related exponentially, but for long-period loading (over a range of 400 hr.) a better fit to the experimental results is given by

$$C_\lambda = c_0' + c_1'[1 - \exp(-kt^{1/3})] + c_2't \qquad (2a)$$

for $\lambda = 5000$ A., where c_0', c_1' and c_2' are constants and t is in hours; k is numerically of the order of 0·32. After 450 hours, the observed values of C_λ were less than those given by (2*a*), and it is probable that the linear term $c_2't$ should be replaced then by another exponential term. For short-period loading it is clear that (2*a*) reduces to

$$C_\lambda = c_0' + c_1'[1 - \exp(-kt^{1/3})], \qquad (2b)$$

since c_0', c_1' and c_2' are of the order of 30 and 9 Brewsters, and 0·015 Brewsters per hour respectively. It is interesting to note that a relationship of the form of (2*b*) was originally suggested by Pierce[3] in connexion with the variation of the torsion of a cotton thread with time.

In the past, investigators have found a similarity between optical and mechanical 'creep' behaviours in various materials. A brief check of the mechanical 'creep' properties of 'Catalin' or *CR* 39, by measuring the deflexions of beams of the two materials when subjected to a constant bending moment, was made. Relations approximately analogous to those of (1) and (2*b*) were obtained.

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[1] *Proc. Camb. Phil. Soc.*, **12**, 55 (1902); *Proc. Roy. Soc.*, A, **130**, 410 (1931).
[2] *Proc. Inst. Mech. Eng.*, **158**, 244 (1948).
[3] *Mem. Shirley Inst.*, **2**, 278 (1923).

Amino-Acid Composition of Salmine

A detailed chemical analysis of the amino-acid composition of salmine (from a commercial source) was presented by Block and Bolling[1], who used chemical and microbiological techniques. The amino-acids found were arginine, alanine, *iso*leucine, proline, serine and valine. Tristram[2] confirmed the presence of these, and in addition demonstrated that glycine was also a constituent.

In the course of other work, analyses have been made in this Laboratory of hydrolysed salmine (commercial) by partition chromatography on paper. The 'ascending' modification of the original method was used[3]. We thought it of interest to report that our results confirmed those of Tristram. No other amino-acids were detected using one- or two-dimensional chromatograms when phenol with ammonia, collidine–lutidine mixture 1 : 1 (v/v), or *n*-butanol–acetic acid mixture 4 : 1 (v/v), were used as solvents.

An estimate of the proportions of amino-acids present has been made by the spot-dilution technique[4]. The results are presented in the accompanying table.

	Amino-acid per 100 gm. salmine		
Amino-acid	Authors	Tristram	Block
Arginine	87·5	85·2	88·4
Alanine	0·6	1·10	3·6
Glycine	3·6	2·94	—
*iso*Leucine	1·8	1·61	1·5
Proline	5·0	5·8	7·9
Serine	5·6	9·1	7·0
Valine	3·8	3·1	4·1