

of the free radicals formed on photolysis of the polyamide. Even in the presence of oxygen recombination would seem to be favoured at low temperatures. The reactions involved are undoubtedly complex as is shown by results which have been obtained with transparent films of nylon and other polymers<sup>3</sup>, and may involve cross-linking of the polymer molecules<sup>3</sup>.

The effect of temperature on the degradation of yarns of undyed silk, nylon and cellulose acetate rayon on irradiation in air at 0 and 100 per cent relative humidity is illustrated in Fig. 2. Except with acetate rayon the strength loss of the yarn is inhibited by water vapour. This effect is particularly evident with nylon, but as with acetate rayon, the strength loss increases substantially and at a much greater rate than in dry air, as the temperature is increased. The effect of water vapour on the degradation of cotton yarn by 2537 Å radiation has been shown<sup>1</sup> to depend on the parameter of degradation; the loss in strength being greater in the absence of water vapour, and the reverse being the case when the chain length of the cellulose (as measured by fluidity in cuprammonium) is considered. This evidence seems to suggest that in the presence of air and water vapour the polymeric free radicals formed on photolysis undergo secondary reactions involving not only gaseous oxygen but also water itself. It is possible that in certain circumstances hydrogen can be abstracted from a water molecule by the polymeric free radical. The resultant hydroxyl radicals would be expected to have a greater oxidative effect on cellulose than on polyamide fibres.

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<sup>1</sup> Egerton, G. S., *Nature*, **194**, 968 (1962).

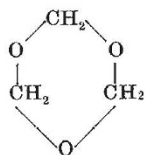
<sup>2</sup> Ford, R. A., *Nature*, **176**, 1023 (1955); Egerton, G. S., and Fitton, S. L., *Nature*, **178**, 41 (1956); Egerton, G. S., and Roach, A. G., *Nature*, **180**, 189 (1957).

<sup>3</sup> Moore, R. F., *Polymer*, **4**, 493 (1963).

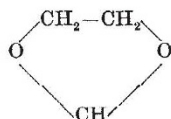
### Formation of Cyclic Molecules by Macro-radical Reactions

MACRO-RADICALS formed by thermal degradation of polymers are known to participate in depolymerization<sup>1</sup> with subsequent detachment of a volatile compound. We have found another type of macro-radical reaction, namely, the formation of cyclic molecules.

A radical  $\sim\text{OCH}_2\text{—OCH}_2\text{—OCH}_2$  is formed by thermal degradation of polyformaldehyde. As a result of chain conformation by addition of a free-valency carbon atom to oxygen or to another carbon atom this radical may form cyclic atoms of trioxane:



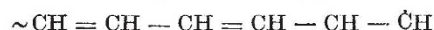
or of dioxalane:



These were identified by means of chromatography and mass-spectrometry. Sometimes cycles with many links are also formed; this was demonstrated by mass-spectrometry.

Similar macro-radical reactions were observed during an investigation of the thermal degradation of polyvinyl-

chloride. Here hydrochloric acid is the primary reaction product. Its detachment results in the formation of a macro-radical with a system of conjugated bonds:



In closing the cycle this radical is capable of detaching a benzene molecule. Benzene formed as a secondary product was identified by chromatography or mass-spectrometry.

So far as we know, no such cyclization of radicals in the degradation of polymers has previously been reported, though similar reactions of light radicals are known<sup>2</sup>.

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<sup>1</sup> Grassie, N., *Chemistry of High Polymer Degradation Processes* (London, 1956).

<sup>2</sup> Drew, C. M., and Gordon, A. S., *J. Chem. Phys.*, **31**, 1417 (1959).

## BIOCHEMISTRY

### Effect of Temperature on s-Ribonucleic Acid Aggregation induced by Magnesium Ions

RECENTLY, the aggregation of sRNA from *Escherichia coli* has been reported<sup>1</sup>. At neutral pH and at 25° C the aggregation process is dependent on nucleic acid and magnesium ion concentration. In 0.02 M magnesium, the aggregates dissociate into monomer units at low nucleic acid concentrations. This report shows that a modest increase in temperature (from 25° C to 45° C) partially dissociates the aggregates and that the decrease in molecular weight is reflected in the viscosity thermal profile.

*E. coli* sRNA was obtained from General Biochemicals, Chagrin Falls, Ohio, and freed of protein by repeated mechanical shaking with phenol. The aqueous supernatant was then chilled and the sRNA precipitated with two volumes of an ethanol-potassium chloride (0.3 M) solution. This was repeated twice. The final precipitate was dissolved in 0.01 M ethylenediamine tetraacetic acid (EDTA) and dialysed overnight against 0.01 M EDTA at 4° C. The solution was then treated twice with bentonite—50 mg/25 ml. of solution<sup>2</sup>. EDTA was then removed by dialysis against frequent changes of doubly distilled water at 4° over a period of 72 h. The aqueous sRNA was finally lyophilized.

The calibration, thermal control, use and calculation procedures with the Price-Phoenix light scattering photometer have already been described<sup>1</sup>. The instrument was modified in one respect; a narrow slit nosepiece was mounted in front of the photometer and the instrument refocused by a reflectance method. Viscosity measurements were made with a Ubbelohde viscometer with a solvent flow time of about 90 sec (25° C) or with a conventional viscometer with a 0.8 mm bore having a flow time of about 300 sec (25° C). Temperature regulation in viscometry was achieved as previously described<sup>1</sup>. For either viscometry or light scattering measurements, dust was removed by 'Millipore' filtration. sRNA concentration was estimated spectrophotometrically<sup>3</sup>.

A low ionic strength medium used in these and previous investigations<sup>1</sup> was chosen on the basis of the observations of Lipsett *et al.*<sup>4</sup>. These investigations clearly show a competition between moderate concentrations of neutral salt and magnesium ions for binding sites on polyribonucleotides and suggest that an investigation of the effects of magnesium ions on nucleic acids should be made in a low ionic strength medium.

Fig. 1 shows the effect of increasing temperature on the molecular weight of sRNA. In neutral salt, the apparent