Polymer Science U.S.S.R. Vol. 24, No. 6, pp. 1335–1344, 1982
Printed in Poland

0032-3950/82/061335–10$07.50/0
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NUCLEAR MAGNETIC RELAXATION AND SEGMENTAL MOTION OF NITROCELLULOSE IN SOLUTION*

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(*Received* 12 *December* 1980)

The transverse and longitudinal magnetic relaxation of solutions of cellulose nitrate (CN) with nitrogen contents of 13·5 and 11·9% have been studied in deuterated acetone in the temperature range from −100 to +70°C al two concentrations (34 and 50 wt. %). The two-component nature of the decay of the transverse magnetization points to the structural non-uniformity of CN in solution. The observed minima on the temperature dependence of the spin-lattice relaxation time in the laboratory system of coordinates, T_1, and in a rotating system of coordintes are caused by segmental movement in open-packed regions of the solution. The contribution of slow movements to the spectrum of correlation times at the temperatures of the minimum T_1 has been assessed. The values obtained for the activation energy for segmental motion in the unordered regions show that a vibrational-rotational mechanism predominates in the segmental motion of CN.

Previous investigations [1] of solutions of cellulose nitrates (CN) in acetone by the NMR impulse method have disclosed that the rate of transverse magnetic relaxation of the low-molecular weight component depends strongly on the molecular mobility of the polymeric chains and have enabled it to be suggested that they are non-uniform. It was therefore of interest to study the molecular motion of CN macro-chains in similar solutions. For this purpose, the proton NMR relaxation of CN dissolved in deuterated acetone has been studied in the present work.

Acetone-D_6 containing 99·8% of the basic substance, obtained from the Leningrad branch of the All-Union "Izotop" Unit, was used to prepare the solutions. The method used in preparing the solutions and the properties of the cellulose nitrates with nitrogen contents of 13·5 (CN-1) and 11·9% (CN-2) have been given in [1].

The NMR relaxation times were measured with a coherent impulse spectrometer having a working frequency of 22 MHz. The times for transverse magnetic relaxation, T_2, were determined from the decay in the free induction in a sufficiently uniform magnetic field and the time T_1 was determined from the restoration of the longitudinal magnetic intensity by the two-impulse method $180°-\tau-90°$ or $90°-\tau-90°$ the effective time $T_{2\,eff}$ was measured by means of a Mansfield–Wo impulse sequence ($MW-4$) $90^\circ_x-\tau-(90^\circ_y-2\tau)^n$ with $\tau=10$ μsec. The spin-lattice relaxation times in a rotating system of coordinates, $T_{1\rho}$, that

* Vysokomol. soyed. **A24**: No. 6, 1186–1193, 1982.