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Radiation damage in high polymers studied by NMR

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Résumé.

Des expériences ont été entreprises avec des rayons gamma de très faible intensité. Les effets observés avec deux sortes de polyamides peuvent s'expliquer en admettant que les molécules en grandes chaînes sont détruites avec exaltation de la mobilité des groupes moléculaires obtenus. D'autres expériences effectuées avec une plus grande intensité montrent la prédominance de liaisons croisées. On explique ce désaccord à l'aide d'un modèle simple.

EPR and NMR-studies give different informations on the effects of radiation on materials. EPR is observed only as long as the radicals exist, and it is possible to say something about the environment of these radicals; whereas line shapes of NMR depend on the mobilities of the molecules, thus giving informations on long existing changes of the substances in high polymers.

Hitherto experiments [1] were made with radiation of large intensity, mostly enlarging the rigidity of the lattice. Contrary to these experiments, we used relatively weak radium sources (about 20 to 30 mC). The probes sealed in glass tubes, were placed around this source in a distance of about 2 cm. Only the γ-radiation was effective.

At first, we used a great number of high polymers (PVC, Polytetrafluorethylene and others), but after two months we observed only with two kinds of Polyamides (Ultramid A and Ultramid B) effects of radiation. Consequently, we examined but these two high polymers (therefore we cannot say if the other polymers would show an effect after more than two months). The second moments of the proton lines were the following:

Duration of radiation	Ultramid A ΔH^2	Ultramid B ΔH^2
0 months . . .	14,3 G^2	16,0 G^2
2 ,, . . .	13,7 ,,	11,9 ,,
4 ,, ...	13,4 ,,	8,7 ,,
6 ,, . . .	0,07 ,,	0,07 ,,

The crystallinity of the Ultramides before radiation was at a temperature of 20° C about 95%, at a temperature of 70° C about 92%. After six months, about 10^{16} γ-quanta being absorbed by the polymers, no crystalline phase could be observed. The line shapes did not change after the heating to about 80° C and after a storing of several days. Therefore we may state that no radicals were responsible for the change of the second moment. The reduction of the line width can only be explained by the destruction of the molecular chains and by the enhancement of the mobility.

Comparing the results with those of others, we see that the effect of radiation on high polymers does not only depend on the number of the absorbed γ-quanta but is also determined by the intensity of radiation.

Experiments with other kinds of radiation and in other energy ranges are made in these days.

1. e.g. Fuschillo, N., J. A. Sauer, *J. appl. Phys*, *28*, 1073-1081, 1957; Kusumoto, H., *J. phys. Soc. Japan*, *12*, 826, 1957.