

THE INFLUENCE OF GAMMA RADIATION CONDITIONS ON THE PROPERTIES OF A POLYCARBONATE-DUROLON.

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INTRODUCTION

Due to special properties of polycarbonates they are utilized in many industrial applications. In nuclear installations, in particular, they are exposed to ionizing radiation which can cause alterations in their molecular structure which can have effects in its macroscopic behavior such as mechanical and optical properties.

Furthermore the irradiation conditions of temperature, dose rate, environment, etc. can also lead to different effects on materials properties changes.

In this work we make a contribution to improve the understanding of the radiolytic degradation mechanism in polycarbonates.

EXPERIMENTAL

In the present work, samples of the commercial polycarbonate-Durolon of the type bisphenol A manufactured by Policarbonatos do Brasil S/A were irradiated with gamma rays from of a ^{60}Co -source at room temperature in air and in vacuum with samples sealed in glass tubes. In all cases the dose range was between 0 - 500 kGy and dose rate was between 0.21 - 4.20 kGy/h. The irradiated samples were characterized by means of intrinsic viscosity and DSC measurements.

An Ubbelohde viscometer was utilized for intrinsic viscosity measurements. The solvent used was methylene chloride and the test temperature was about 20°C. The DSC analysis were carried out using a Shimadzu-DSC-50 instrument and the glass transition temperature was determined by heating the samples at a rate of 10 °C/min.

RESULTS AND DISCUSSION

When this polycarbonate is irradiated, main chain scissions (polymeric degradation) generally occur at random with formation of free radicals of the type phenoxy and phenyl and take place recombinations of these radicals. The free radicals that do not recombine become trapped in the polymeric matrix [1].

The relationship between the intrinsic viscosity ($[\eta]$) and the viscosity average molecular weight (\bar{M}_v), is given by the H. Schnell equation [2]:

$$[\eta] = a\bar{M}_v^b \quad (1)$$

where a and b are constants which for polycarbonate in methylene chloride solution have the value 1.23×10^{-5} and 0.83 respectively.

The number of main chain scissions per 100 eV absorbed, G -value, is proportional to the radiation dose (R). In the radiolysis of polycarbonate, in particular, the scissions occur preferentially in the carbonyl groups [1]. These scissions reduce the initial molecular weight \bar{M}_v' to \bar{M}_v by absorption of the dose R (kGy). The relationship between \bar{M}_v' , \bar{M}_v , G and R is given by [1]:

$$10^6/\bar{M}_v = 10^6/\bar{M}_v' + 0.054 G R \quad (2)$$

So the molecular weight of polycarbonate for each irradiation dose was obtained from intrinsic viscosity and G was determined from the slope of the plot $10^6/\bar{M}_v$ vs R (Fig 1).

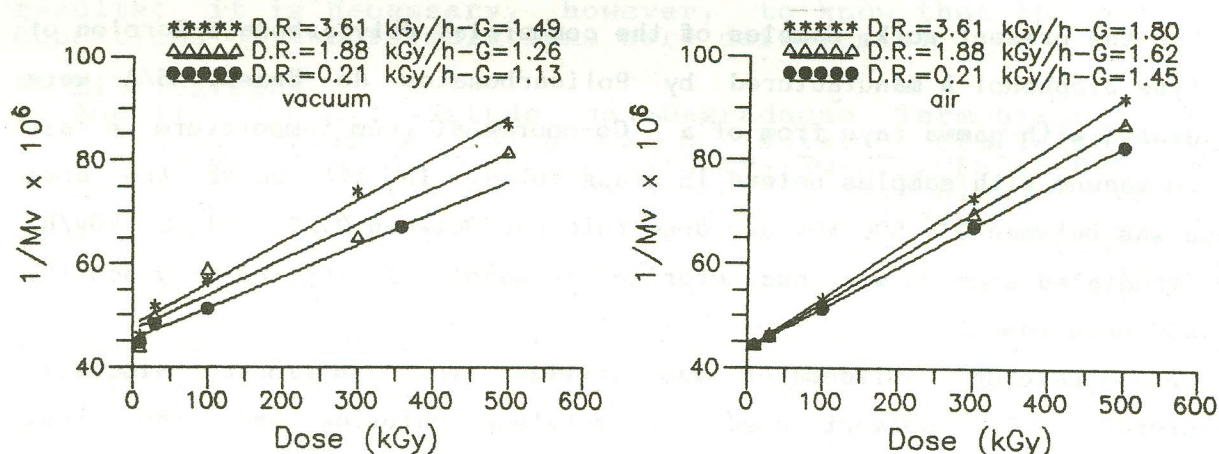


Figure 1. Viscosimetric average molecular weight vs absorbed dose at different dose rates in vacuum and air.

The above data indicate that in the irradiated samples in air a more pronounced degradation occurs than in those irradiated in vacuum. This behavior is in agreement with the hypothesis that the main chain scissions increase with the water content in the polycarbonate [3,4]. It can be seen that the dose rate effect is more significant for high dose values, above 100 kGy.

The glass transition temperature (T_g) was determined through DSC measurements curves using samples irradiated at different dose and dose rates. The straight line obtained in the plot T_g vs $1/\bar{M}_v$ (Fig.2) can be considered a good quantitative comparison between the viscosimetric and the DSC analysis results as already observed earlier [4].

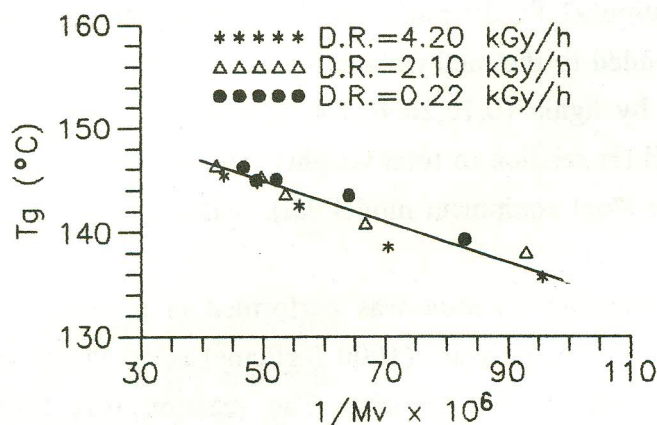


Figure 2. Glass transition temperature vs inverse of viscosimetric average molecular weight.

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