Differential Scanning Calorimetry Studies of Irradiated Polyethylene: II. The Effect of Oxygen

F. J. ZOEPFL,* V. MARKOVIC,† and JOSEPH SILVERMAN, *Laboratory for Radiation and Polymer Science, Institute for Physical Science and Technology, University of Maryland, College Park, Maryland 20742*

Synopsis

The effect of absorbed doses of ionizing radiation up to 2 MGy in the presence of air on the melting behavior of high- and low-density polyethylene was analyzed from data obtained by differential scanning calorimetry. Thermal measurements were made during the first melting after irradiation. The first melting temperature of polyethylene irradiated in air decreased with increasing absorbed dose. Above approximately 0.6 MGy bimodal endotherms were observed for high-density polyethylene. The heat of fusion remained unchanged after irradiation in air for absorbed doses of less than 2 MGy. Bimodal endotherms were not obtained for low-density polyethylene samples irradiated in air. The changes in melting temperature and the appearance of bimodal endotherms are related to the radiation chemistry of polyethylene in the presence of oxygen.

INTRODUCTION

The effect of absorbed doses of ionizing radiation less than 2 MGy on polyethylene (PE) in the presence of air has been investigated by many techniques, among which are infrared (IR) spectrophotometry,[1-6] ultraviolet (UV) spectrophotometry,[3,7] gel fraction determinations,[2,8] Fourier transform IR analyses,[9-11] mechanical measurements,[1,11] electron spin resonance spectrometry,[1,5,10,12-16] carbon-13 nuclear magnetic resonance (NMR) spectrometry,[17] gel permeation chromatography (GPC),[17] dielectric loss angle measurements,[3,13] and other methods, such as oxygen uptake measurements.[1,2] Few investigators, however, have examined the effect of ionizing radiation in the presence of air on the melting and crystallization behavior of PE.[19-22]

Differential scanning calorimetry (DSC) is an excellent means of examining the effect of oxygen on the radiation chemistry of the interface between the crystalline and amorphous regions of PE. In one DSC study Ahmad and Charlesby[22] found that the presence of air during irradiation had no effect on the melting temperature and heat of fusion of PE single crystals and high-density PE pellets. The data presented in this article for high-density PE irradiated in air provide evidence of a contrary nature.

* Permanent address: Pickard, Lowe and Garrick, Inc., Washington, D. C. 20036.

† Permanent address: Laboratory of Solid State Physics and Radiation Chemistry, Boris Kidrič Institute for Nuclear Science—Vinča, Post Office Box 522, 11001 Belgrade, YUGOSLAVIA

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