Differential Scanning Calorimetry Studies of Irradiated Polyethylene: I. Melting Temperatures and Fusion Endotherms

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Synopsis

The effect of ionizing radiation on the melting behavior of high-density and low-density polyethylene was examined with data obtained by differential scanning calorimetry. Melting temperatures and fusion endotherms were obtained after absorbed doses of gamma radiation up to 3 MGy. The changes in melting temperatures and heat of fusion for the first and second meltings are related to the radiation chemistry of polyethylene. The changes in the first melting temperature are caused by radiation-induced links that decrease the melt entropy and increase the fold surface free-energy-per-unit area of chain-folded polyethylene crystals. These effects are dependent on the lamellar thickness distribution and on the types of links formed (intramolecular or intermolecular). The changes in melting temperature and heat of fusion obtained in the second melting are related to the inhibition of crystallization caused by the presence of radiation-induced links.

INTRODUCTION

The effect of absorbed doses of ionizing radiation of less than 3 MGy on the melting and crystallization behavior of polyethylene has been the subject of many investigations.[1-25] In most of these studies the melting temperature of bulk, high-density polyethylene remains unchanged or increases slightly after irradiation.[13,14,19,20,23] A slight increase in the melting temperature of oriented, low-density polyethylene after irradiation has also been reported.[21] Irradiation of polyethylene single crystals has been found to lower the melting temperature,[8-10,14,15,19,20,23-25] although the results of one study[11] showed no change in the melting temperature of single crystals irradiated with absorbed doses up to 1 MGy. The melting temperature of low-density polyethylene has been reported decreased after irradiation.[1,2,7,18]

Ionizing radiation has no effect on the heat of fusion of bulk, high-density polyethylene.[14,20] The heat of fusion of polyethylene single crystals also

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