# CRYSTALLIZATION BEHAVIOR OF IRRADIATED POLY-L-LACTIDE AND ITS COMPOSITES WITH BIOCIDE

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One of the recent trends in the food packaging industry is the use of active packaging based on biodegradable polymers such as polylactide. This packaging contains a biocide incorporated into a polymer matrix and prevents pathogenic microorganisms growing on a food surface. The combined use of active packaging and radiation treatment is an effective method of food safety ensuring. Crystallization ability of the composite materials prepared for these purposes is among decisive factors influencing their properties.

The aim of this study is an effect elucidation of gamma irradiation on crystallization of poly-L-lactide (PLLA) and its composites with biocide.

Films based on PLLA preparing by reactive extrusion of PLLA 4043D (Nature Works LLC, USA) powder and containing 2 wt. % of oligo hexa-methylene guanidine hydrochloride (OHMG) as a biocide additive have been investigated. Films were gamma irradiated by 50 kGy dose in an air at a room temperature. Differential scanning calorimetry (DSC) permits us to obtain thermal characteristics of relaxation and phase transitions in the samples studied. Complex profiles of the overlapping peaks in DSC curves we analyzed by curve fitting procedure.

For both films with and without biocide $T_g$ was about 60 °C. After irradiation, this value decreased by 1 °C, most likely due to the PLLA destruction during irradiation and reduction of its molecular weight. The degree of crystallinity ($\chi$) of the initial polymer powder was about 20 %, with one melting peak detected, while the films were completely amorphous. After being exposed to irradiation the film $\chi$ value increased to 2–4 % apparently due to short chains formation with a mobility sufficient to form crystallites even at a room temperature.

Using curve fitting (fig. 1) we could accurately reveal two crystallite types with rather close melting temperatures ($T_m$) in DSC curves. Before irradiation, regardless of the OHMG presence, the melting peak was resolved into two components with maxima at 149 and 154 °C, the ratio of their areas being 1.0:0.6. The observation of two melting peaks indicates the presence of two forms of crystallites (more and less ordered one) with higher and lower $T_m$, respectively. Upon the film irradiation, the $T_m$ of the less ordered fraction decreased to 146 °C indicating an accumulation of defects, presumably due to oxidative destruction and isomerization of the PLLA. At the same time, the ratio of fractions alters. In the case of PLLA film without additives it changes to the value of 1.0:1.9, while in the case of the film containing OHMG to that of 1.0:2.6. Possible reasons are discussed concerning the increase in the share of the more ordered crystallite form.

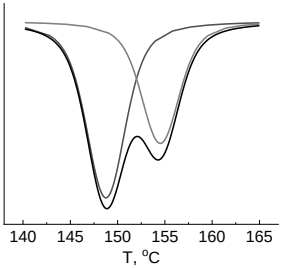


Fig. 1. Fitted melting peak of PLLA + 2 wt. % OHMG film
(temperature rise rate is 5 °C per minute)