Synthesis of New Polymeric Hindered Amine Light Stabilizers: Performance Evaluation in Styrenic Polymers

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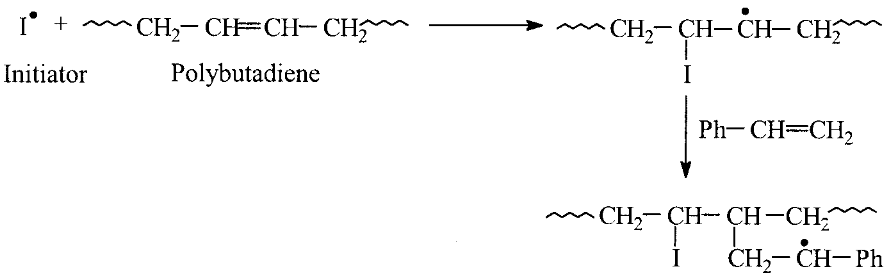
ABSTRACT: Polymeric hindered amine light stabilizers (HALSs), in which the HALS functionality was attached to the terminal isocyanate chain end of poly(styryl-*co*-styryl isocyanate), were synthesized by a two-step process. First, cinnamoyl azide was prepared and copolymerized with styrene by a free-radical copolymerization method. Polymeric low-molecular-weight and high-molecular-weight 2,2,6,6-tetramethyl-4-pipridinol-*graft*-poly(styryl-*co*-styryl isocyanate) and 4-amino-2,2,6,6-tetramethyl piperidine-*graft*-poly(styryl-*co*-styryl isocyanate) were synthesized by a grafting method. The photodegradation and stabilization of different grades of high-impact polystyrene (HIPS) were studied at 55°C in air at different time intervals, and the photostabilizing efficiency of polymeric HALSs was compared with conventional light stabilizers, such as 2,2,6,6-tetramethyl-4-pipridinol and bis(2,2,6,6-tetramethyl-4-piperidinyl)sebacate. Polymeric HALSs showed significant improvements in the photostabilization of HIPS. The solubility and diffusion coefficient of polymeric HALSs were studied. The morphological changes in HIPS caused by photooxidation were also studied. © 2003 Wiley Periodicals, Inc. J Appl Polym Sci 90: 1126–1138, 2003

Key words: additives; degradation; polystyrene; radiation

INTRODUCTION

High-impact polystyrene (HIPS) consists of a continuous glassy polystyrene (PS) matrix and an elastomeric dispersed polybutadiene (PB) phase. The dispersed PB phase is compatibilized with the glassy PS phase by the presence of PS grafts during the synthesis. The active groups for grafting in PB are the double bonds and the methylene hydrogen at the α position. These sites are attacked by the initiator radical or by the growing PS radical:[1,2]



The PB portion[3] in HIPS is generally 3–12 wt %. Although there is a significant increase in the elongation at break and fracture resistance in PS with the addition of PB, a simultaneous reduction in the transparency and modulus is also observed.

Polymers are susceptible to degradation by oxygen when subject to a combination of UV light and heat.[4] Scott et al.[5] showed that rubber-modified plastics undergo a loss of physical properties when exposed to outdoor weathering because of photooxidation. Photooxidation is also accompanied by a loss in the molecular weight and yellowing.[6] The oxidative degradation can partially be prevented by the introduction of suitable stabilizers into the polymer matrix. During the past decade, the chemistry and synthesis of stabilizers and their mechanism of action have been studied extensively.[7] Hindered amine light stabilizers (HALSs) have gained prominence as effective light stabilizers for a variety of polymers. The conventional stabilizers are low-molecular-weight compounds; therefore, they migrate and leach out from the polymer matrix by evaporation or extraction during processing and end use. For a polymer to have longer stability, the stabilizer must remain in its matrix in the active form; therefore, the chemical nature of the ad-

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