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Chemical Papers 68 (2) 233–238 (2014)
DOI: 10.2478/s11696-013-0439-0

ORIGINAL PAPER

Polycarbonate-based polyurethane elastomers: temperature-dependence of tensile properties

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Received 27 February 2013; Revised 6 May 2013; Accepted 9 May 2013

Novel polyurethane thermoplastic elastomers were prepared from polycarbonate diols, butane-1,4-diol (chain extender) and hexamethylene diisocyanate. They differ in the kind of macrodiol used and the ratio of macrodiol to chain extender OH groups (hence, in hard segment contents). The tensile properties of the elastomers at low and elevated temperatures were determined and discussed with regard to polyurethane composition and polycarbonate diol structure.

Keywords: polyurethane, elastomer, polycarbonate diol, tensile properties

Introduction

Polyurethanes (PUR) prepared from macrodiol (MD), diisocyanate and chain extender are among the typical thermoplastic elastomers. Thermoplastic polyurethanes (TPU) are mostly linear multi-block copolymers containing soft segments formed from MD and hard segments (HS) formed by the reaction of the chain extender with diisocyanate. The incompatibility of the hard and soft segments leads to the microphase-segregated structure of TPUs, which is very important for their properties (Hepburn, 1992; Prisacariu, 2011). The soft segments in conventional PUR elastomers are built from either polyether or polyester MDs (Hepburn, 1992; Kojio et al., 2008; Rogulska et al., 2008; Bagdi et al., 2011a; Oprea, 2011; Prisacariu, 2011; Zhu et al., 2011; Vojtová et al., 2012). The polyester type of MDs based on poly(alkylene carbonate) (PC) are increasingly used in current TPU formulations (Tanaka & Kunimura, 2002; Kojio et al., 2004, 2009a; Eceiza et al., 2008a; Hernandez et al., 2008; Kultys & Rogulska, 2011; Špírková et al., 2011). While the soft segments provide the elastomeric features of the TPUs, the HS serve as the material reinforcement because they provide the physical cross-linking of macromolecules by hydrogen bonds, the impact of which is similar to that based on chemical bonds in vulcanised rubber materials. Hence, TPU elastomers exhibit rubber-like behaviour; however (unlike conventional rubbers), they can be processed and recycled like thermoplastics. (Fernández-d'Arlas et al., 2010; Aurilia et al., 2011; Bagdi et al., 2011a, 2011b; Kultys & Rogulska, 2011; Mourier et al., 2011; Oprea, 2011; Sonnenschein et al., 2011; Zhu et al., 2011; Vojtová et al., 2012).

Polycarbonate-based thermoplastic polyurethanes (PC-TPU) belong to a relatively new and promising group of TPUs (Eceiza et al., 2008b; Kojio et al., 2009b; Kultys et al., 2009, 2011; Kuta et al., 2009; Špírková et al., 2009; Ma et al., 2011). Aromatic diisocyanates are those most frequently used in TPU formulations, mainly 4,4′-diphenylmethane diisocyanate (Tanaka & Kunimura, 2002; Kojio et al., 2004, 2008, 2009a, 2009b; Eceiza et al., 2008a, 2008b; Hernandez et al., 2008; Aurilia et al., 2011; Bagdi et al., 2011a, 2011b; Kultys et al., 2011; Kultys & Rogulska, 2011; Mourier et al., 2011; Sonnenschein et al., 2011) but aliphatic, mainly hexamethylene diisocyanate (HDI), has increased in use (Rogulska et al., 2008; Kultys

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