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Modification of cellulosic fiber with polyurethane acrylate copolymers. Part I: Physicochemical properties

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ABSTRACT

Polyurethane (PU) prepolymers were prepared by using two different diisocyanates i.e., toluene-2,4-diisocyanate (TDI) and or isophorone diisocyanate (IPDI), and poly (2-methyl-1,3-propylene glutarate), hydroxyl terminated group. PU prepolymer was reacted with 2-hydroxyethylacrylate (HEA) to form vinyl terminated PU prepolymer. Vinyl terminated PU prepolymers were further copolymerized with butyl acrylates (BuA) by emulsion process. The structure of proposed PUACs samples was confirmed by FT-IR, and their physicochemical properties were studied determining solid contents (%), emulsion stability and its appearance, tackiness and film appearance. Their acids and base chemical resistance was also studied and discussed. The synthesized PUACs samples were applied using dip-padding techniques on mill un-desized poly-cotton plain weave fabrics. The results emphasis that PUACs based on toluene-2,4-diisocyanate (TDI) have shown excellent performance against physical and chemical resistance as compared to isophorone diisocyanate (IPDI) based PUACs, however vice versa results were found in some studies.

1. Introduction

Polyurethanes (PUs) are a distinctive class of polymers, because they have a wide range of applications due to their properties which can be voluntarily adapted by the variation of their components (Oprea, Vlad, & Stanciu, 2000). Ever since the discovery of polyurethanes by Otto Bayer and co-workers in 1937, these have been developed as a unique class of synthetic polymers with wide variety of applications (Woods, 1990; Zia, Bhatti, & Bhatti, 2007). The urethane linkage is formed by the reaction of an isocyanate group of one reactant with the alcohol group of another component. The microstructure of a polyurethane block itself is generally known to be composed of different phases, i.e., it is based on domains which have been built of hard urethane-type segments derived from diisocyanates, and on soft domains which have been built from flexible segments derived from polyol components (Barikani, Zia, Bhatti, Zuber, & Bhatti, 2008). By controlling variables such as the functionality, chemical composition and the molecular weight of the different reactants, a wide class of materials with significantly varying properties can be obtained. This flexibility has led polyurethanes to find use as synthetic polymers in foams, elastomers, coatings, sealants, and adhesive based products. Some of the applications of polyurethanes lie in the textile finishing, automotive, furniture, construction, and thermal insulation and footwear industries (Zia et al., 2007).

Extensive work on detailed molecular characterization (Zia, Barikani, Zuber, Bhatti, & Bhatti, 2008), XRD studies (Zia, Barikani, Bhatti, Zuber, & Bhatti, 2008a), and thermal properties (Zia, Barikani, Zuber, Bhatti, & Sheikh, 2008) of chitin-based polyurethane elastomers (PUEs) have also been previously discussed and reported. In vitro biocompatibility and non-toxicity of chitin/1,4-butanediol blends based polyurethane elastomers has also been reported elsewhere (Zia, Zuber, Bhatti, Barikani, & Sheikh, 2009a, 2009b). Some reports are also available on molecular characterization and shape memory properties of chitin-based shape memory polyurethane elastomers (Barikani et al., 2008; Zia, Zuber, Barikani, Bhatti, & Khan, 2009). For the application of PU, their stability against terrestrial weathering is important (Kaczmarek & Chaberska, 2006; Kaczmarek & Podgorski, 2007; Zia et al., 2007). Photooxidative behavior and effect of chain extender length in polyurethane on photooxidative stability have also been reported (Zia, Barikani, Bhatti, Zuber, & Bhatti, 2008b; Zia, Barikani, Zuber, Bhatti, & Islam-ud-Din, 2008). Surface morphology of starch (Matsushita et al., 2008), cellulose (Yokota, Kitaoka, & Wariishi,

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Table 1
Fabric specification with quality and processed applications.

S. No.	Quality	Construction/count	Blend ratio cotton/polyester	Application
01	Plain weave poly-cotton	(100 × 80/40 × 40)	50/50	Unprocessed un-desized fabrics

2008), and chitin–humic acid (Santosa, Siswanta, Sudiono, & Utarianingrum, 2008) have also been investigated and well documented. XRD studies and surface characteristics of UV-irradiated and non-irradiated chitin-based polyurethane elastomers have also been presented elsewhere (Zia, Bhatti, Barikani, Zuber, & Bhatti, 2009; Zia, Barikani, Khalid, Honarkar, & Ehsan-ulHaq, 2009; Zia, Barikani, Zuber, Bhatti, & Barmar, 2009c, 2009d).

The scientific writings and other professional literature have for some time been reporting possible applications of water-borne polyurethane binders/vehicles not only for the production of environmentally friendly lacquers and/or adhesives, and for impregnation of materials with considerably high surface areas like fibrous mineral fillers, and adhesive for powdered ceramic materials as well (Kŕol, Kŕol, Pikus, & Skrzypiec, 2005). Water-borne polymer emulsions are an important class of materials, especially in the paint and coating industry. Increasing concern for health, safety, and the environment has driven many researchers to prepare water-borne polymers with sophisticated composition and

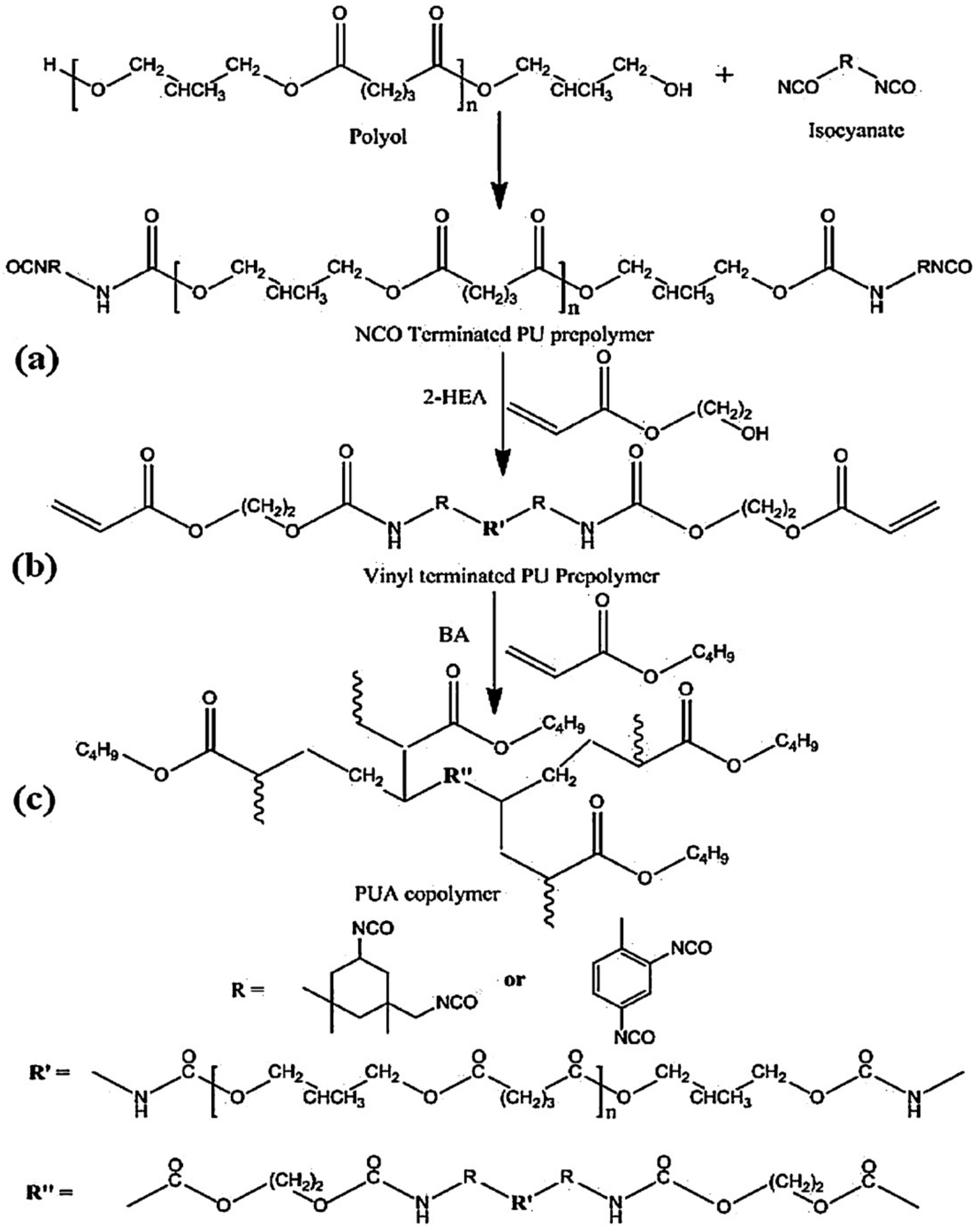

Fig. 1. General scheme for the synthesis of polyurethane acrylate co-polymers: (a) isocyanates (–NCO) terminated polyurethane (PU) prepolymer; (b) vinyl terminated PU prepolymer; (c) proposed polyurethane acrylate co-polymers.