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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	$(100 \times 80/40 \times 40)$	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

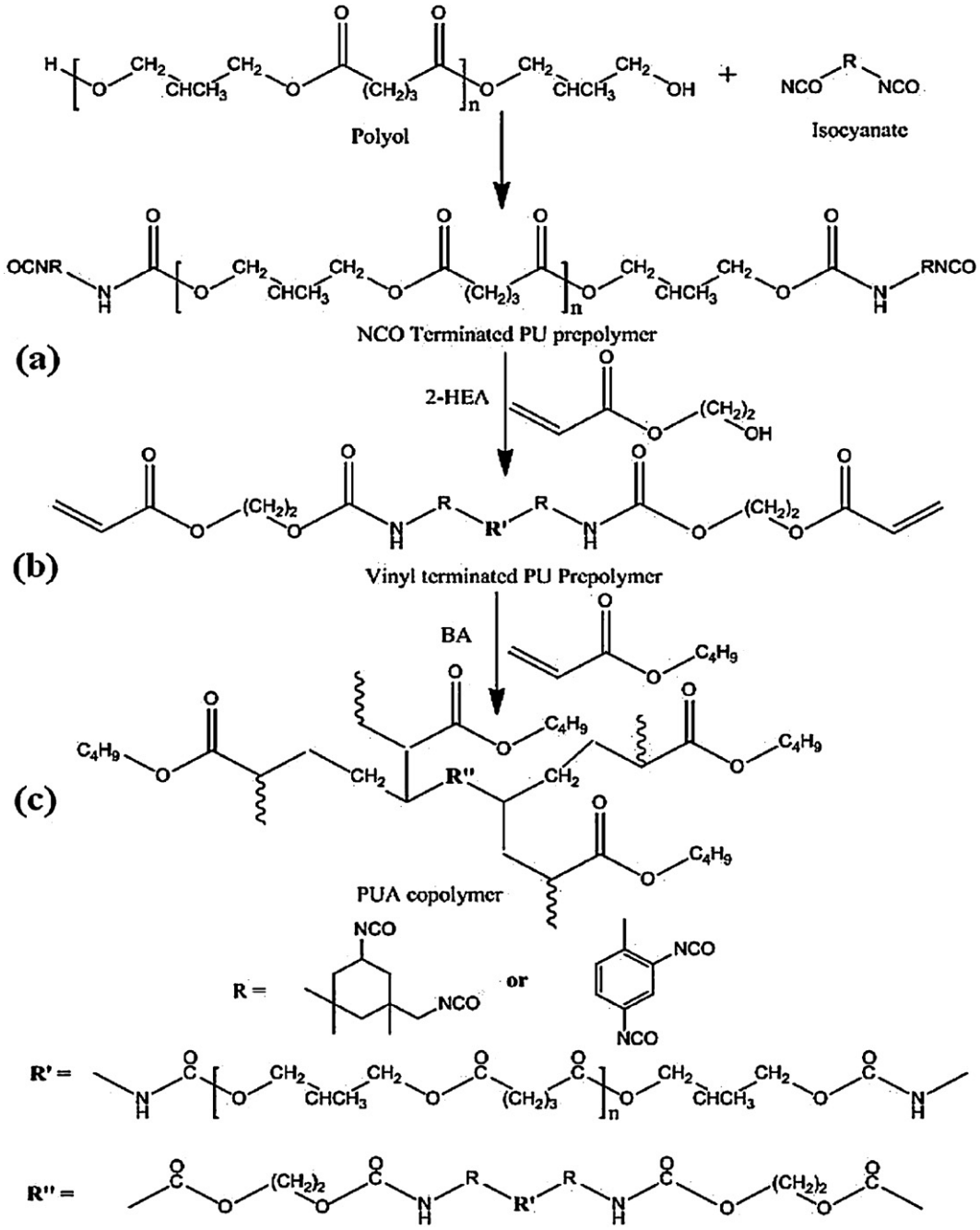

Fig. 1. General scheme for the synthesis of polyurethane acrylate co-polymers: (a) isocyanates (–NCO) terminated polyurethane (PU) prepolymer; (b) vinyl terminated PU prepolymer; (c) proposed polyurethane acrylate co-polymers.

architecture, which are expected to exhibit almost the same performances as conventional solvent-borne systems. Acrylic (AC) emulsions and polyurethane (PU) aqueous dispersions have been used extensively in coating applications. Both systems have some disadvantages such as reduced film formation, lower chemical resistance, and rough mechanical properties of acrylic, a high cost, low pH stability, and limited outdoor durability of PU (Hegedus & Kloiber, 1996). To improve the properties of an individual polymer system it is common to blend them. Better mechanical stability, solvent and chemical resistance, and toughness are obtained from the PU portion. Outdoor resistance, pigment ability, and lower cost are due to the acrylic (AC) component (Kukanja, Golob, Ic-Valant, & Krajnc, 2000). Polyurethane acrylates are also applied as ultraviolet-curable, pressure-sensitive adhesive (PSA) due to decrease in emission of volatile organic compounds (Czech, 2004; Horigome, Ebe, & Kuroda, 2004; Yaobin, Huiming, Longsi, Jianming, & Yongqiang, 2006). Regarding textile applications of the material few reports on amino silicone based softener are also available (Zia et al., 2011; Zuber et al., 2011). There are only a limited number of reports about the preparation and application of eco-friendly binder for textile finishing purposes. Great efforts have been dedicated to the combination of polyurethanes with acrylic polymers to increase the performance-to-cost of the coatings (Wang, Hu, & Tu, 2008). In this way, extensive possibilities are offered to obtain the polymer structure which will be compatible for particular intention (Kŕol et al., 2005). Polyurethane acrylate oligomers have gained more and more attention and speedy development. Considering excellent outdoor resistance of acrylic and versatile properties of polyurethane the present project is designed to compare the properties of synthesized polyurethane acrylate copolymer varying diisocyanate structure with excellent thermal properties, chemical resistance and physical characteristics.

2. Experimental

2.1. Materials

2.1.1. Chemicals

The chemicals used in this study for synthesis purposes are: toluene-2,4-diisocyanate (TDI) (Fluka Chemicals), isophorone diisocyanate (IPDI) (Aldrich Chemicals), poly (2-methyl-1,3-propylene glutarate) diol terminated (molecular weight 1020, Aldrich Chemicals), 2-hydroxyethylacrylate (HEA) (Aldrich Chemicals), butyl acrylate (BuA), ammonium persulphate (APS), sodium thiosulphate ($Na_2S_2O_3$), Tween 60 (polyoxyethylene sorbitan monolaurate – an emulsifier), polyvinyl alcohol (PVA), Na_2CO_3 and polyoxyethylene glycol octylphenol ethers. The polyol and acrylates used in this study were dried at 80 °C *in vacuo* for 24 h before use to ensure the removal of all air bubbles and water vapors that may otherwise have interfered with the isocyanate reactions. The molecular weight of used polyol was confirmed by following the procedure reported in ASTM D-4274C (ASTM, 2004). The TDI, IPDI and all of the other materials were used as received. All of the reagents used in this study were of analytical grade.

2.1.2. Plain weave poly-cotton fabric – a substrate

Mill un-desized, unscoured, non bleached, unprocessed, polyester/cotton (50:50) fabrics; plain weave was supplied by Arzoo Textiles Mills Ltd., Khurrianwala, Faisalabad, Pakistan. The characteristics i.e., quality of the fabric, construction, count, blend ratio etc., are presented in Table 1. Before application of the polyurethane acrylate copolymers, the fabric was further cleaned in the laboratory by washing at 100 °C for 60 min using a solution containing 2 g/L, Na_2CO_3 and 1 g/L, polyoxyethylene glycol octylphenol ethers: C_8H_{17}–(C_6H_4)–$(O\text{-}C_2H_4)_{1-25}$–OH: (Triton X-100) a non-ionic surfactant (BASF). The fabric was then washed several times with hot water then with cold water and finally dried at ambient conditions.

Table 2
Preparation of polyurethane acrylate copolymers (PUACs) emulsions.

S. No.	Ingredients	Quantity
1	PVA[a]	6 g (3% of emulsion)
2	Tween 60[b]	24 mL (12% of emulsion)
3	$Na_2S_2O_3$	One crystal
4	Distilled water	150 mL
5	PU prepolymer[c]	Varied from 5% to 30% of BuA
6	BuA[d]	Varied from 95% to 70%

[a] Polyvinyl alcohol.
[b] An emulsifier.
[c] Polyurethane prepolymer.
[d] Butyl acrylates.

2.2. Synthesis of polyurethane acrylate copolymers

Polyurethane acrylate copolymers have been synthesized by following three step synthesis processes.

2.2.1. Synthesis of isocyanate (NCO) terminated polyurethane (PU) prepolymer

The synthesis of PU prepolymers was carried out according to a recommended procedure (Barikani & Hepburn, 1986). First of all (18.54 g, 2 moles) of poly (2-methyl-1,3-propylene glutarate) diol terminated (polyol) was charged into a four-necked round bottom flask equipped with a mechanical stirrer, a thermometer, a reflux condenser, heating oil bath and a nitrogen gas inlet system. The temperature of the oil bath was increased to 60 °C. Poly (2-methyl-1,3-propylene glutarate) diol terminated was stirred continuously under the blanket of nitrogen gas for 30 min. Then 3 moles of toluene-2,4-diisocyanate (TDI) and/or 3.0 moles of isophorone diisocyanate (IPDI) were added to the reaction vessel and temperature was increased till 80 °C. It took almost 1.0 h to obtain NCO terminated polyurethane (PU) prepolymer (Fig. 1a). The NCO contents of the prepolymer were determined and found close to the theoretical value (experimental value 9.31%; theoretical value 9.29%). A Fourier Transform Infrared (FTIR) spectrum of the PU prepolymer was obtained to monitor the PU prepolymer reaction (Fig. 1).

2.2.2. Synthesis of vinyl terminated polyurethane prepolymer

After the confirmation of the isocyanate (NCO) terminated PU prepolymer synthesis, the temperature of the reaction vessel was decreased to 60 °C and 4.22 mL of 2-hydroxyethylacrylate (HEA) was introduced into the reaction mixture. It took almost 30 min to form a thick, viscous and transparent material in the reaction vessel (Wang et al., 2008) which was the indication of the formation of vinyl terminated PU prepolymer (Fig. 1b). A Fourier Transform Infrared (FTIR) spectrum of the vinyl terminated prepolymer confirmed the completion of the reaction regarding present step (Fig. 1).

2.2.3. Copolymerization of vinyl terminated PU prepolymer with butyl acrylate (BuA)

Copolymerization of vinyl terminated PU prepolymer with butyl acrylate (BuA) was carried out through emulsion polymerization processes, in the presence of polyvinyl alcohol (PVA), Tween 60 (polyoxyethylene sorbitan monolaurate-an emulsifier) and ammo-

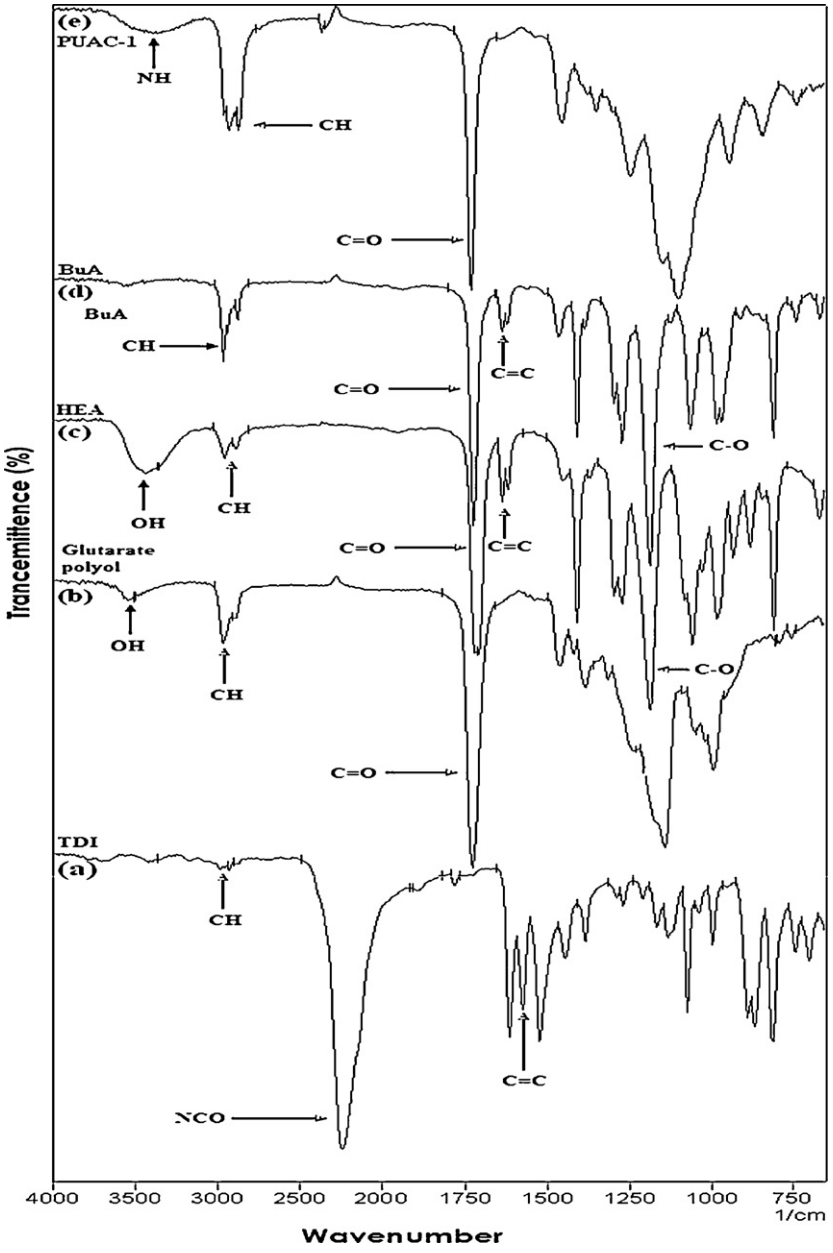

Fig. 2. FT-IR spectra: (a) toluene-2,4-diisocyanate (TDI); (b) 2-methyl-1,3-propylene glutarate-diol terminated polyol; (c) 2-hydroxyethylacrylate (HEA); (d) butyl acrylate (BuA); (e) TDI based polyurethane acrylate copolymers (PUACs-1).

nium persulphate (APS) with $Na_2S_2O_3$ (as redox initiator). The formulation about the preparation of polyurethane acrylate (PUA) emulsion is presented in Table 2. Water solutions of PVA 3% (w/v) and Tween 60 (an emulsifier) 6% (v/v) were prepared separately following the formulation given in Table 2, and then they were introduced into the reaction flask with 10 mL of 0.2% (w/v) initiator solution slowly. This whole process was completed in almost 3.5 h with continuous stirring at 55 °C (Fig. 1c). Total of the 30 samples (5 sets, 6 samples in each set) of the emulsion of BuA and vinyl terminated PU prepolymer, ratio of both were assorted progressively. White milky emulsions were obtained at the end of the process which was saved for further investigations. A schematic illustration of the chemical route for synthesis of PU acrylate copolymer is given in Fig. 1(a)–(c). All the copolymer emulsions were cured in the dry heating oven at 60 °C, for 48 h. Dried smooth films were obtained in aluminum cups. These films were used for further measurements.

2.3. Treatment of fabrics with polyurethane acrylate copolymers

Various dilutions of polyurethane acrylate copolymer samples i.e., 25 g/L, 30 g/L and 35 g/L were applied onto the plain weave poly-cotton fabric. Treatment of the fabric with synthesized polyurethane acrylate copolymer samples was carried out using pad-dry-cure technique. The fabric samples were treated with an aqueous solution of polyurethane acrylate copolymer samples with various dilutions (i.e., 25 g/L, 30 g/L and 35 g/L) dried at 100 °C for 4 min. The curing of the treated fabrics was done at 140 °C for 5 min.

2.4. Measurements

Structural characteristics of the synthesized PU acrylate copolymer were confirmed using Fourier Transform Infrared (FT-IR) Spectroscopy. FT-IR spectra of the PU acrylate copolymer samples were obtained in the transmission mode using a Shimadzu IR

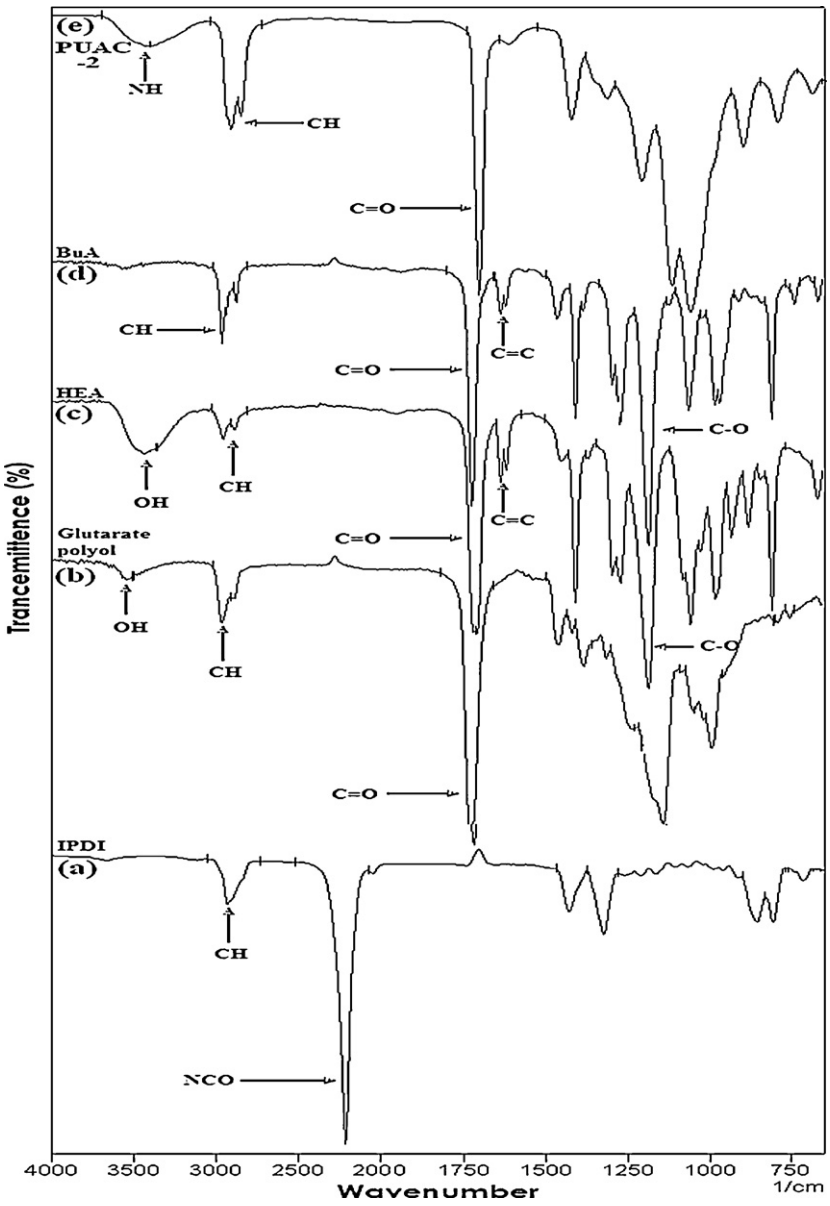

Fig. 3. FT-IR spectra (a) isophorone diisocyanate (IPDI); (b) 2-methyl-1,3-propylene glutarate-diol terminated polyol; (c) 2-hydroxyethylacrylate (HEA); (d) butyl acrylate (BuA); (e) IPDI based polyurethane acrylate copolymers (PUACs-2).

Prestige-21 Fourier Transform Infra-red (FT-IR) spectrometer. FTIR scans were collected on completely dried thin films cast on KBr discs from N, N′-dimethylformamide (DMF) solution. The spectra covered the infrared region 4000–500 cm^{-1}, the number of scans per experiment was 16 and resolution was 4 cm^{-1}. The abrasion test was performed following the method ASTMD 4966 (ASTM, 2004). Raw un-desized poly/cotton (with dimension 12 in. × 12 in.) was used for this purpose.

2.4.1. Physical characterization

Dry weight contents (solid contents) of PUA copolymers were determined by drying a weighed volume of emulsion in aluminum cups using dry heating oven at 60 °C for 3 h. The calculation was done as following:

Weight of empty aluminum cup $= A$
Weight of aluminum cup and PUA $= B$
Weight of the aluminum cup and PUA after heating $= C$
Solid contents (%) $= \frac{C - A}{B} \times 100$

The tackiness of films, emulsion stability, and appearance were also observed continuously and reported.

2.4.2. Chemical resistance

Chemical resistance of cured films was determined following the method reported in ASTMD 1647-89 (ASTM, 1998). Cured films were placed in glass plates and dipped for three days in 3% (v/v) sulphuric acid solution and then in 3% (w/v) sodium hydroxide solution. Qualitative changes in appearance were monitored day by day.

2.4.3. Textile testing

Abrasion test was performed according ASTMD 4966. Raw PC stuff (12 in. × 12 in.) was used for this purpose. After coating the fabrics were cured in dry heating oven as well as in vacuum oven for almost 48 h. Coated fabrics were compared with untreated fabric.

Table 3
Physical characteristics of polyurethane acrylate copolymers (PUACs) coatings.

Sample code	Solid content (%)	Emulsion stability	Emulsion appearance	Tackiness	Film appearance
PUAC-1[a]	35.32	<1 year	White milky	Slight tacky	Yellowish smooth
PUAC-2 [b]	38.28	>1 year	White milky	Tack free	Whitish smooth

[a] Toluene-2,4-diisocyanate (TDI) based polyurethane acrylate copolymers.
[b] Isophorone diisocyanate (IPDI) based polyurethane acrylate copolymers.

Table 4
Chemical resistance of cured films of polyurethane acrylate copolymers (PUACs) coatings.

Sample code	Chemical resistance					
	1st day		2nd day		3rd day	
	Acid	Base	Acid	Base	Acid	Base
PUAC-1[a]	Excellent	Very good	Excellent	Very good	Excellent	Very good
PUAC-2[b]	Excellent	Very good	Excellent	Very good	Excellent	Very good

[a] Toluene-2,4-diisocyanate (TDI) based polyurethane acrylate copolymers.
[b] Isophorone diisocyanate (IPDI) based polyurethane acrylate copolymers.

3. Results and discussion

3.1. FT-IR spectral studies

All the emulsion samples were cured in the dry oven at 45 °C, for 48 h. These films were used for further analysis. FTIR spectra of monomers (toluene-2,4-diisocyanate (TDI), 2-methyl-1,3-propylene glutarate diol terminated polyol), isocyanate (–NCO) terminated PU prepolymer obtained by the reaction of TDI and poly (2-methyl-1,3-propylene glutarate) diol terminated polyol, 2-hydroxyethylacrylate (HEA), vinyl terminated PU prepolymer, butyl acrylate (BuA) and polyurethane acrylate copolymers have already been presented and comprehensively discussed in our previous study (Sultan, Bhatti, Zuber, Bhatti, & Sheikh, 2011). For comparative studies of synthesized PU acrylates copolymers varying diisocyanate structure, the FTIR spectra of polyurethane (PU) acrylates copolymer with toluene-2,4-diisocyanate (TDI) (PUAC-1) and PU acrylates copolymer with isophorone diisocyanate (IPDI) (PUAC-2) are presented in Figs. 2 and 3 respectively.

FTIR spectra of isophorone diisocyanate (IPDI) (Fig. 3a) show an intense peak at 2233.66 cm^{-1} due to characteristic isocyanate (–NCO) groups attached to the isophorone diisocyanate (IPDI). The FT-IR spectrum shows sharp peaks at 2940 cm^{-1}, which is due to the C–H stretching of IPDI. The observed peaks in the functional group region of FT-IR spectrum of poly (2-methyl-1,3-propylene glutarate) diol terminated polyol (Fig. 3b) were assigned as: 3502 cm^{-1} (OH stretching vibration); 2959 cm^{-1} (CH asymmetric stretching of CH_2); 2867 cm^{-1} (CH symmetric stretching of CH_2 groups); 1724 cm^{-1} (C=O stretching of soft segment of poly (2-methyl-1,3-propylene glutarate) diol terminated polyol). The IPDI and poly (2-methyl-1,3-propylene glutarate) diol were reacted to prepare isocyanate (–NCO) terminated PU prepolymer which was further reacted with hydroxyl ethyl acrylates (HEA) (Sultan et al., 2011). The hydroxyl ethyl acrylate (HEA) showed a very broad peak at 3486 cm^{-1} corresponds to OH stretching vibration. The other peaks observed in the FT-IR spectrum of HEA (Fig. 3c) were assigned as: 2946 cm^{-1} (asymmetric CH_2 stretching); 2833 cm^{-1} (symmetric CH_2 stretching); 1723 cm^{-1} (C=O stretching); 1533 cm^{-1} (C=C stretching); 1135 cm^{-1} (C–O, C–C stretching). After the reaction of –NCO terminated PU prepolymer with that HEA; the vinyl terminated PU prepolymer was formed. The detailed FTIR spectrum of vinyl terminated PU polymer has been discussed elsewhere (Sultan et al., 2011). The resulted vinyl terminated PU prepolymer was further extended with the addition of butyl acrylate. The FT-IR spectrum of butyl acrylate (BuA) is given Fig. 3(d). The observed peaks in the FT-IR spectrum of BuA (Fig. 3d) were assigned as: 2950 cm^{-1} (asymmetric CH_2 stretching); 2836 cm^{-1} (symmetric CH_2 stretching); 1729 cm^{-1} (C=O stretching); 1533 cm^{-1} (C=C stretching); 1134 cm^{-1} (C–O, C–C stretching). The Fig. 3(e) represents the complete synthesis of PU acrylate copolymers (PUAC-2). It shows presence of N–H groups at about 3452 cm^{-1}, carbonyl group at 1733 cm^{-1} and peaks at 2932 cm^{-1}, 2872 cm^{-1} for CH antisymmetric and symmetric stretching, respectively (Yaobin et al., 2006). The FT-IR spectra obtained for the final PU acrylate sample (PUAC-1 and PUAC-2) confirmed the completion of polymerization reaction due to the disappearance of the NCO peak at 2269 cm^{-1} and the appearance of N–H peak at 3387 cm^{-1}. FT-IR spectrum of the final polyurethane acrylate copolymers obtained support the proposed structure of the final polymer. The observed peaks in the spectrum imply that the reaction was completed and the predesigned PU acrylate copolymer was formed. The FT-IR comparisons of both the synthesized materials (PUAC-1 and PUAC-2) have been presented diagrammatically in Figs. 2 and 3, respectively; and interpretation of FT-IR spectra of PUAC-1 has already been discussed elsewhere (Sultan et al., 2011).

3.2. Physical characterization

Physical parameters such as solid contents (%), emulsion stability, emulsion appearance, tackiness and film appearance of

Table 5
Abrasion test results of polyurethane acrylate copolymers (PUACs) coatings (vacuum and dry heating oven cured).

Sample code	Vacuum cured			Dry heating oven cured		
	Shade change	Texture condition	Rating	Shade change	Texture condition	Rating
PUAC-1[a]	Slight	No thread was broken	4	Poor	No thread was broken	2–3
PUAC-2[b]	Noticeable	No thread was broken	3	Noticeable	No thread was broken	3
Uncoated fabrics	Very poor	Few thread was broken	1–2	Very poor	Few thread was broken	1–2

[a] Toluene-2,4-diisocyanate (TDI) based polyurethane acrylate copolymers.
[b] Isophorone diisocyanate (IPDI) based polyurethane acrylate copolymers.

polyurethane acrylates' copolymers (PUA's) are reported in Table 3. These characteristics are important and helpful for further use of emulsions in various applications. Solid content of the synthesized material is in the range of 35–40% (Huybrechts, Bruylants, Vaes, & De Marre, 2000). The reported results in Table 3 emphasis that dry weight content of aromatic based PU acrylate copolymers (PUAC-1) is lesser as compared to the cyclo-aliphatic based (PUAC-2), moreover the emulsion stability of PUAC-1 (aliphatic based PU acrylate copolymer) is more pronounced which represents the better shelf life of these products. It is worthwhile mentioning that high solid contents reduces the shipping and storage costs due to the lower water content, allow increased productivity of plant equipment, have a short drying time and an adjustable film thickness in fewer passes. Emulsion appearance is almost same in all the studied samples, but when films were formed by dry heating, PU acrylates emulsions containing TDI (PUAC-1) in backbone give yellowish tint but the samples containing IPDI based emulsion films appear transparent white. The yellowing of the aromatic diisocyanates (e.g., TDI) based polyurethane on exposure to light or heating has already been reported by other researcher (David & Steve, 2002). Regarding tackiness of the samples IPDI based films are tack free whereas TDI based films have shown slight tackiness. The tack coat is a light coat that is applied to the surface to promote adhesion of successive coats. This coat covers the surface but does not fully wet out the substrate as the coating will have a light, uneven and transparent appearance.

3.3. Chemical resistance

To evaluate the overall performance of coatings, cured films were subjected to acid and base solutions (Vilas et al., 2009). From the data displayed in Table 4, it is obvious that chemical resistance shown by both types of PU acrylates copolymers (PUAC-1 and PUAC-2) is same, excellent to acid environment and very good to basic solutions. Acid solutions were transparent till the third day of examination whereas basic solution became slightly hazy from the very first day, it may be due to the action of alkali on urea bonds. However, this remarkable chemical resistance of PU acrylate copolymers is in agreement with the observation of Vilas et al. (2009).

3.4. Textile testing

PU coatings are used in textile industry as finishing agents to improve the durability and fleeting look of the fabric (Zia et al., 2007). The results presented in Table 5, illustrate that fabric samples coated with PU acrylates copolymers have shown more pronounced effects than untreated fabrics samples. The treated samples (with PUAC-1 and PUAC-2) were cured in two different ways i.e., vacuum cured and dry heating oven cured. The results presented in Table 5 showed that vacuum cured samples have shown some better results as compared to the dry heating oven samples. For curing purpose the vacuum cured is preferred and recommended. In comparison of both the samples i.e., PUAC-1 and PUAC-2, the PUAC-1 has more prominent effect as finishing agent. Furthermore aromatic diisocyanate (TDI) is much cheaper so its use in textiles is advantageous economically also.

4. Conclusion

Polyurethane acrylate copolymers (PUACs) samples were prepared varying diisocyanate structure i.e., toluene-2,4-diisocyanate (TDI) and or isophorone diisocyanate (IPDI), and poly (2-methyl-1,3-propylene glutarate), diol terminated. The chain extension was carried out using 2-hydroxyethylacrylate (HEA) to form vinyl terminated PU prepolymer which was further copolymerized with butyl acrylates (BuA) by emulsion process. The FTIR spectra confirmed the proposed PUACs structure. The physicochemical properties were studied and discussed. The mill un-desized poly-cotton plain weave fabrics were treated with synthesized PUACs samples using dip-padding techniques. The outcome of the results fully correlates the structure property relationship of the synthesized materials.

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