J Mater Sci (2009) 44:1813–1820
DOI 10.1007/s10853-008-3238-1

Acetylation of β-cyclodextrin in ionic liquid green solvent

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Received: 12 September 2008 / Accepted: 30 December 2008 / Published online: 27 January 2009

Abstract The ionic liquid (IL), 1-butyl-3-methylimidzolium bromide ([C_4mim]Br), synthesized under supercritical CO_2, was developed as a green solvent for the dissolution, regeneration and acetylation of β-cyclodextrin (β-CD). The dissolution of β-CD in [C_4mim]Br of 25 wt% could be reached at 25 °C. The acetylation of β-CD was carried out under acetic anhydride in [C_4mim]Br in the absence of catalyst. β-CD acetates with different degrees of substitution of 0.07–1.14 were obtained directly under the homogeneous reaction conditions. The reaction medium of IL applied can be easily recycled and reused after the synthesis of β-CD acetate. The effects of reaction time, temperature, and acetic anhydride/AGU on the acetylation of β-CD were investigated. The acetylated β-CD samples were characterized by NMR, FT-IR, and X-ray diffraction (XRD) spectroscopy. It is the first time that we have demonstrated that ILs can be used as an environmentally friendly solvent for the acetylation of β-CD, which will open a new route to acetylation of β-CD under green solvent without catalyst.

Introduction

Cyclodextrins (CDs) are cyclic oligosaccharides and natural byproducts of enzymatic starch degradation [1]. The most common and industrially produced CDs are α-, β-, and γ-CD, containing 6, 7, and 8 D-(+)-glucopyranose units, respectively. The increasing interest in these compounds is primarily associated with the fact that they, having a chiral internal cavity, possess a unique ability to form various host–guest inclusion compounds with hydrophobic guests [2]. Such inclusion complexes have been used to mask the bitter taste or unpleasant odor of a guest compound, to solubilize a hardly soluble guest compound, to enlarge the stability of a guest compound against heat, light, or air, and to stabilize emulsions. They are commercially available, nontoxic, and water soluble, which make them suitable for numerous applications in the pharmaceutical industry, pesticides, foodstuffs, toilet articles, and textile processing [3–5]. Unfortunately, their applications are limited by their low solubilities, especially in the case of β-CD, whose solubility in water at 25 °C is 18.5 g L^{-1} [6]. A common method to increase the solubility of the CD is to carry out chemical derivatization on the free hydroxyl groups. The hydroxyl groups have the potential for esterification, methylation, hydroxypropylation, and other reactions. Acetylated CDs are of particular interest, since they can be prepared by a well-known method in the carbohydrate chemistry, i.e., by reacting with acetic anhydride in pyridine. Since free β-CD is poorly soluble in most inert organic solvents, homogeneous acetylation can be performed in DMF or pyridine only. The standard *O*-acetylation reaction uses acetic anhydride as the primary reagent and a wide range of solvents and catalysts. Pyridine is the most widely used solvent/catalyst for the acetylation of saccharides [7]. However, these catalysts have demerits such as toxicity, cost, difficulty of solvent recovery, or instability in processing, which limit their industrial application.

In the chemical industry, in addition to traditional objectives such as productivity and cost, environmental

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considerations are now becoming important. According to the principles of green chemistry, a key approach for reducing pollutant emissions from chemical processes is pollutant prevention rather than treatment or clean up after they have formed [8]. Most of the organic and polymerization reactions are carried out in organic solvents of which some eventually end up polluting environment by evaporation or leakage. Recently, there have been intense research efforts to replace conventional organic solvents with novel solvent systems which are recyclable and environmentally compatible and therefore reduce waste and hazard. Ionic liquids (ILs), which consist of organic cations and appropriate anions, have received much attention due to their potential as a green and recyclable alternative to traditional organic solvents [9, 10]. As reaction media, ILs have several advantages such as enhancement of reaction rates, improvement of selectivity and yields, or ease of recycling catalysts owing to their special properties such as extremely low vapor pressure, low toxicity, non-flammability, strong solvent power for organic and inorganic compounds, a wide liquid range, high thermal stability, high ionic conductivity, and ability to dissolve complex macromolecules and polymeric materials with high efficiency, etc. [11–15]. Recently, biopolymers such as starch, zein protein, and cellulose were found to be soluble in ILs such as 1-butyl-3-methylimidazolium chloride (BMIMCl) in concentration up to 10% (w/w) [16]. Acetylation reactions of the biopolymers can successfully be carried out in ILs [17, 18]. Furthermore, the dissolution of high concentrations of α-CD (350 g L^{-1}) in 1-methoxymethyl-3-methylimidazolium bromide has been reported [19].

Up to now, there have been no reports of acetylation of β-CD in ILs. Our interest is focused on ILs as reaction media for the acetylation of β-CD. The combination of the renewable raw material β-CD with the recyclable IL was investigated to yield a contribution to environment protection. Homogeneous acetylation of β-CD dissolved in IL in the absence of any catalyst was investigated. The conditions of the acetylation, for example, reaction temperature, time, and the dosage of acetic anhydride were studied. The modified β-CD samples were characterized by degree of substitution (DS), Fourier transform infrared (FT-IR), and ^{1}H NMR spectroscopy. As a result, we found a green approach to one-stage synthesis of water-soluble β-CD acetylated by primary or secondary hydroxyl groups.

Experimental

Chemicals

1-Methylimidazole was purchased from the Linhai Kaile Chemical Factory, China (industrial grade), and *n*-butyl bromide (CP grade) was provided by the Sinopharm Group Chemical Reagent Co., Ltd. *N*-Methylimidazole and *n*-butyl bromide were freshly distilled over potassium hydroxide under reduced pressure before use. β-CD (BR grade) was obtained from the Tianjin Kermel Chemical Reagent Co., Ltd. and used as received. The acetic anhydride, diethyl ether, and ethanol were supplied by the Xi'an Chemical Co. Ltd., and all are of analytical pure grades, which were used directly without further purification.

Instrumentation

The ^{1}H NMR and ^{13}C NMR spectra were recorded on a superconducting Fourier digital NMR spectrometer (Bruker, AVANCF 300 MHz). FT-IR was performed on a Nicolet 870 spectrometer, taking 32 scans for each sample recorded from 4000 to 400 cm^{-1} at a resolution of 2 cm^{-1} in the transmission mode, using the KBr-disk method. The samples were pressed into KBr pellets with a sample/KBr ratio of 2/200 mg. Powder wide-angle X-ray spectra of 2θ were recorded from 5° to 60° with a D/Max-2000PC Rigaku wide angle X-ray diffractometer equipped with a graphite monochromator in the diffracted beam and using Cu Kα radiation at λ of 0.154 nm (40 kV, 40 mA). The custom-manufactured high-pressure vessel (SF-400) with a maximum pressure of 40 MPa, a maximum temperature of 473 K, and an internal volume of 60 cm^3, which rests on a magnetic stirrer was used to carried out the acetylation of β-CD in IL under supercritical CO_2 conditions. The ISCO model 260D high-pressure syringe pump was used to charge CO_2 fluids into the high-pressure vessel.

Preparation of 1-butyl-3-methylimidazolium bromide ([C_4mim]Br)

[C_4mim]Br was prepared according to the published procedures [20]. The synthesis of [C_4mim]Br was carried out in a high-pressure vessel of $scCO_2$. The [C_4mim]Br synthesized was characterized by ^{1}H NMR.

[C_4mim]Br, ^{1}H NMR ($CDCl_3$, δ/ppm relative to TMS): 10.04 (s, 1H), 8.24 (s, 1H), 8.15 (s, 1H), 4.50 (t, 2H), 4.23 (s, 3H), 1.94 (m, 2H), 1.35 (m, 2H), 0.91 (t, 3H).

Dissolution of the β-cyclodextrin

β-Cyclodextrin was recrystallized twice from deionized water and then dried at a temperature of 110 °C for 12 h before use. For dissolution of the β-CD, β-CD was added to the [C_4mim]Br in a 10-mL reacti-vial glass vial under a dry N_2 atmosphere. The temperature was increased to 10 °C above the melting point of the IL applied [21]. The mixture of β-CD/IL was stirred at this temperature up to 12 h to guarantee the complete dissolution of the β-CD.

Regeneration of β-CD

The β-CD dissolved in IL was precipitated in a fivefold amount of ethanol. The resulting mixture was separated by filtration. The solid was washed three times with ethanol and dried at 60 °C under vacuum [22]. To recycle the IL, the combined filtrates were concentrated under vacuum and finally freeze-dried.

Acetylation of β-CD in [C_4mim]Br

In glass vials, the required amount of acetic anhydride was carefully added to a solution of 0.5675 g (0.5 mmol) β-CD in 3.00 g [C_4mim]Br at 25, 35, 45, 55, 65, and 75 °C. The vial was then sealed. The mixture was heated in oil bath for a certain time under N_2 atmosphere with stirring [23]. The reaction was conducted for 2, 4, 6, 8, and 10 h. After the completion of the reaction, the mixture was cooled to a room temperature. The product was obtained by precipitating the mixture into 30 mL diethyl ether and ethanol with stirring for 60 min, then filtered and washed several times with ethanol, and finally dried in a vacuum oven at 60 °C overnight. The product was subsequently stored in a desiccator at a room temperature.

Determination of degree of substitution (DS)

The substituted CDs are characterized by the average degree of substitution (DS). The DS indicates the number of substituents which are bonded on average per anhydroglucose. The DS of the unmodified β-CD is 0, which means no hydroxyl was substituted by –$COCH_3$. The theoretical maximum of DS for β-CD is 3. The DS of acetylated β-CD was determined by ^{1}H NMR spectroscopy using the ratio of the 1/3 three methyl protons absorbance at 1.9 ppm divided by 1/7 of the total CD carcass CH areas at 3.3–3.9 (6H) and 5.2 (1H) ppm [2].

Results and discussion

Dissolution of β-CD in IL

A solution of β-CD in [C_4mim]Br up to 25 wt% was obtained and kept clear and transparent after cooling to a room temperature (25 °C). The regenerated β-CD was washed three times with ethanol and dried at 60 °C under vacuum. Figure 1 shows the FT-IR spectra of β-CD before and after regeneration. FT-IR spectra of β-CD before and after regeneration showed that the two spectra are quite similar. No new peaks appear in the regenerated β-CD, which indicates that no chemical reactions occurred between IL [C_4mim]Br, and β-CD during the dissolution and regenerative process of the β-CD. Therefore, this IL is expected to be a promising direct solvent for β-CD.

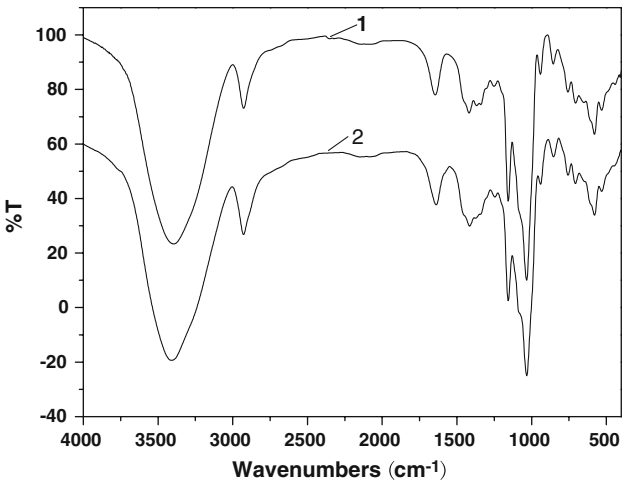

Fig. 1 FT-IR spectra of native β-CD (spectrum 1) and β-CD regenerated from [C_4mim]Br (spectrum 2)

Further studies on the state of dissolution of the β-CD in IL were carried out by ^{13}C NMR spectroscopy. The ^{13}C NMR spectrum of [C_4mim]Br, β-CD, regenerated β-CD and a solution of β-CD in [C_4mim]Br are shown in Fig. 2. Results are listed in Table 1. The chemical shifts for neat β-CD are well consistent with that obtained in [C_4mim]Br solution. Besides the characteristic peaks of β-CD and [C_4mim]Br, no new peaks appear in spectrum 1. It is obvious that the IL has no effect on the β-CD. The β-CD is steady in [C_4mim]Br. Spectrum 3 shows the ^{13}C NMR spectra of regenerated β-CD obtained after dissolution in [C_4mim]Br and regeneration from ethanol. As can be seen in the spectra 3 and 4, the chemical shifts of all protons in AGU did not change in these two products. We could not

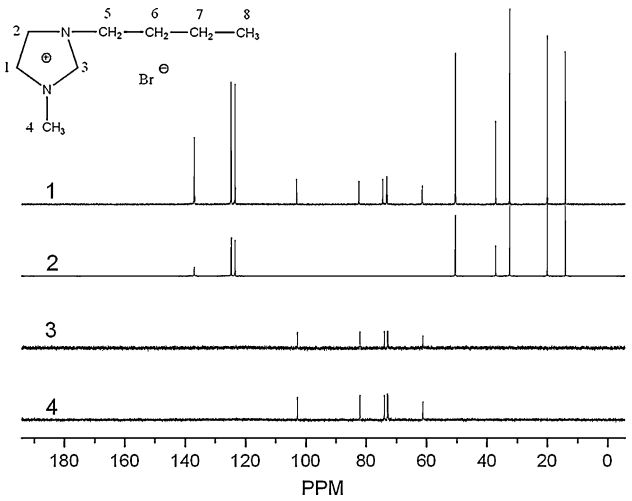

Fig. 2 ^{13}C NMR spectra of 20 wt% β-CD solution in [C_4mim]Br (spectrum 1), [C_4mim]Br (spectrum 2), regenerated β-CD (spectrum 3), and native β-CD (spectrum 4)

Table 1 Results of ^{13}C NMR

Spectrum 1	δ (ppm)	102.58	81.94	73.89	72.89	72.67	61.17		
	Assigned	C-1	C-4	C-3	C-5	C-2	C-6		
Spectrum 2	δ (ppm)	137.00	124.80	123.48	50.50	37.19	32.53	20.02	14.05
	Assigned	C-3	C-1	C-2	C-5	C-4	C-6	C-7	C-8

observe the peaks of [C_4mim]Br in spectrum 3, which indicates that after regeneration the IL can be washed completely. We can obtain pure β-CD after the dissolution of β-CD through a simple precipitation method. In summary, our results showed that after a typical dissolving process in IL, [C_4mim]Br, the chemical shifts of β-CD were not altered. This indicates that this IL can be classified as the so-called non-derivatizing β-CD solvent.

Acetylation of β-CD

We found that β-CD was soluble in IL, [C_4mim]Br, at 80 °C, up to 25% by weight. However, the viscosity increased with the concentration of the β-CD that it was difficult to stir. Thus, 10% solutions were reacted with anhydrides to demonstrate the utility of IL as a solvent medium for the chemical modification of β-CD. The structures of products were characterized by FT-IR and NMR spectroscopy. Under the conditions for the acetylation, the system remained completely homogeneous as the reaction proceeded. The aim of our study was to obtain water-soluble β-CD derivatives with DS no more than 1, since the acetyl group increases with the increase degree of acetylation, thus decreasing the solubility of the products in water and improving their solubility in organic solvents.

The acetylation of β-CD was monitored by examining the infrared spectra of native and acetylated β-CD. Figure 3 shows the FT-IR spectra of β-CD and acetylated

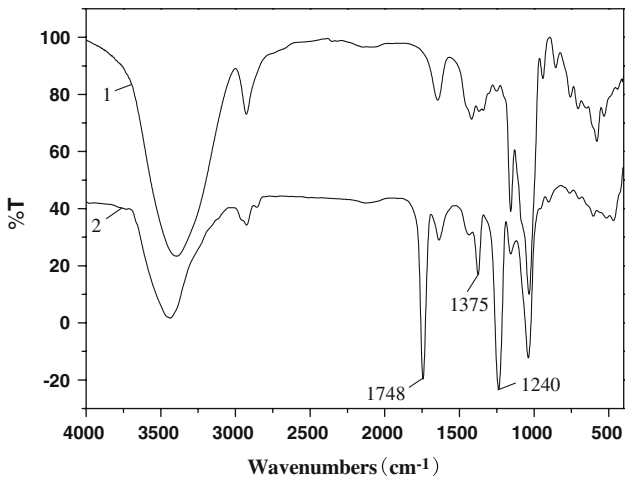

Fig. 3 FT-IR spectra of β-CD (spectrum 1) and acetylated β-CD (DS = 0.8) (spectrum 2)

β-CD (DS = 0.8). In the spectra of native β-CD (spectrum 1), there are several characteristic absorption bands at 945, 703, and 576 cm^{-1}, which were attributed to the entire anhydroglucose ring stretching vibrations [24]. The strong absorption at 3415 cm^{-1} is due to the stretching of O–H groups and the one at 2926 cm^{-1} to the C–H stretching of $–CH_2$ and $–CH_3$ groups. The absorption band at 1156 cm^{-1} relates to C–O–C anti-symmetric bridge stretching in pyranose ring. The intense band at 1645 cm^{-1} is assigned to H–O–H bending of adsorbed water. The peaks observed are associated with the untreated β-CD. Compared with that of unmodified β-CD, the spectra of acetylated β-CD have several differences to certain extents. After the acetylation, a new acetyl group is added to β-CD as indicated in spectrum 2. The spectra of the acetylated sample shows the expected acetyl group vibration at 1748 cm^{-1} assigned to carbonyl C=O stretching of ester. The spectra of unmodified β-CD show absorptions at 1375 cm^{-1}, attributed to the –C–H bending vibration. After esterification, the added contribution of acetyl ($–C–CH_3$) stretching vibration intensifies this absorption peak greatly. The presence of band at 1240 cm^{-1} is assigned to C–O stretching of acetyl group. The evidence of acetylation is clearly provided by the presence of and/or enhancement of three important ester bonds at 1748, 1375, and 1240 cm^{-1}. The peak intensities at this –OH stretching band in the acetylated samples were observed to be lower than in the untreated sample spectra further indicating some partial acetylation. Compared with that in the unmodified β-CD, characteristic peak of –OH in the modified sample shifts to higher wave number. This observation indicates that the intermolecular hydrogen-bonding association decreases with the active hydroxyl partial substitution by acetyl. As was to be expected, the absence of absorption region of 1840–1760 cm^{-1} in spectrum 2 revealed that the product is free of the unreacted acetic anhydride and the lack of absorption bands at 1700 cm^{-1} for carboxylic groups demonstrates that the product is also free of the byproduct of acetic acid.

^1H NMR of acetylation of β-CD

With esterification process, acetyl groups were introduced into β-CD, proton resonances of anhydroglucose unit showed some changes compared with that of native β-CD. The ^1H NMR spectra of both untreated β-CD (spectrum 1)

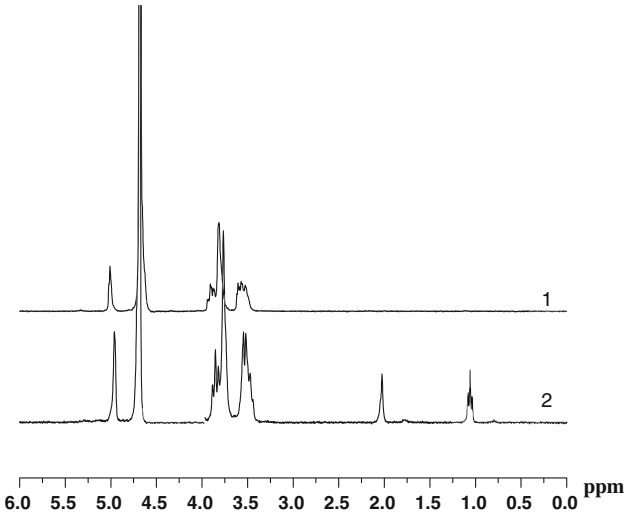

Fig. 4 ^{1}H NMR spectra of β-CD (spectrum 1) and acetylated β-CD (DS = 0.8) (spectrum 2)

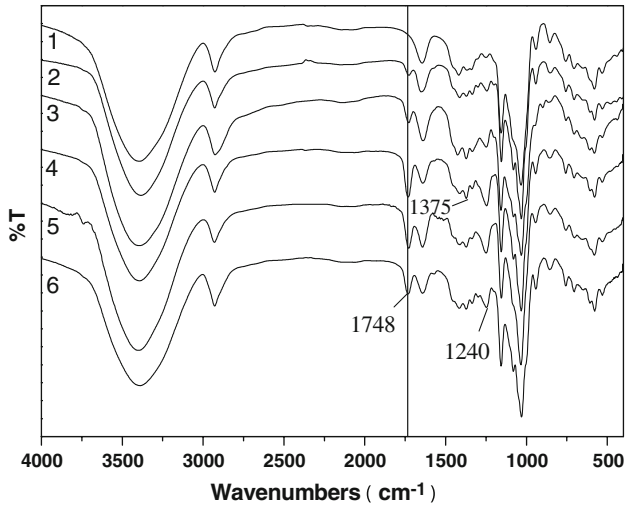

Fig. 5 FT-IR spectra of unmodified β-CD (spectrum 1), and β-CD prepared for 2 h (spectrum 2), 4 h (spectrum 3), 6 h (spectrum 4), 8 h (spectrum 5), and 10 h (spectrum 6)

and the acetylated sample (spectrum 2) are presented in Fig. 4. Spectrum 2 provided some evidence of acetylation since it revealed the presence of methyl band of the acetyl group in the range from 0.80 to 2.20 ppm. ^{1}H NMR spectrum (D_2O), δ/ppm: 1.06 (m, $CH_3C(O)OC^6$), 2.02 (m, $CH_3C(O)OC^2$, $CH_3C(O)OC^3$), 3.40–3.90 (m, H^2–H^5 and H_2^6), 4.96 (m, H^1). Evidently, the FT-IR and NMR spectra indicate that the acetylated β-CD was formed in [C_4mim]Br under the conditions given. The results gave the detailed information of low and high DS-acetylated β-CD, which can help us to analyze the structure of samples.

Effect of reaction time

The effect of reaction time on DS is illustrated in Figs. 5 and 6. Figure 5 shows the FT-IR spectra of unmodified β-CD and β-CD prepared at different reaction times. The DS of acetylated β-CD prepared at different reaction times is also shown in Fig. 6. For these experiments, the molar ratio of acetic anhydride/AGU in β-CD was 1:1.4, the reaction temperature was 65 °C. As shown in Fig. 5, the peak intensity at this –OH stretching band is gradually becoming weak from 2 to 6 h. The peaks at 1748, 1375, and 1240 cm^{-1} increase substantially with an increment in reaction times from 2 to 6 h. However, it was observed at 6–10 h reaction times that there was a slight gradual increase in the intensity of the –OH stretching band and decrease in the intensity of three ester peaks at 1748 (C=O stretching of ester), 1375 (C–H bond in –O(C=O)–CH_3), and 1240 cm^{-1} (C–O stretching of acetyl group). As illustrated, an increase in reaction times from 2 (spectrum 2) to 4 h (spectrum 3) and to 6 h (spectrum 4) led to an increment in the extent of acetylation. A gradual lowering

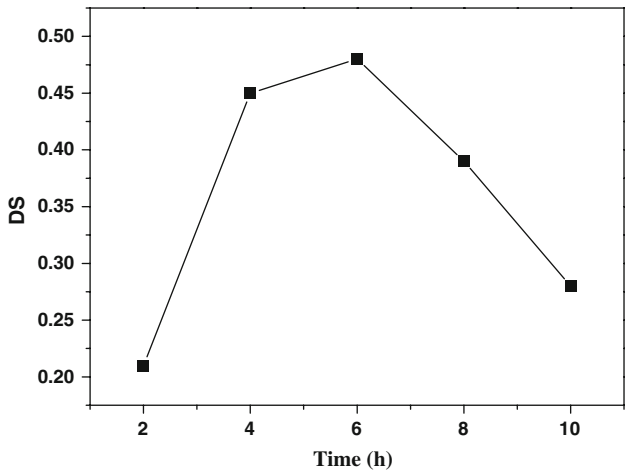

Fig. 6 Effect of reaction time on the DS

of the extent of acetylation at relatively high reaction times is again provided by the slight gradual decrease in the intensity of the three ester peaks at 1742, 1368, and 1234 cm^{-1} as the reaction time was increased beyond 6 h. Obviously, from the data shown in Fig. 6, increasing the reaction time from 2 to 6 h resulted in a significant DS increase from 0.21 to 0.48. In contrast, as the reaction was further increased from 6 to 10 h, the DS showed a decrease from 0.48 to 0.28. Under the same condition, the DS increases with the prolonging of reaction time. Because the activation of β-CD needs a period of time, esterification reaction was insufficient when reaction time was short, and so the DS was low. The reaction duration with the increased time enhances the collisions of acetic anhydride with β-CD. The DS increases as reaction time extends.

Acetylation of β-CD is an equilibrium reaction just like any other esterification reaction such that de-acetylation can take place under appropriate reaction conditions [25]. It is, therefore, possible for de-acetylation to occur for the longer time reactions thereby leading to re-formation of the free hydroxyl groups of the β-CD. The DS decreases as the reaction time was increased beyond over 6 h. The DS results obtained from ^{1}H NMR are consistent with the results obtained from FT-IR. From the above assumptions, the optimal reaction time was 6 h.

Effect of temperature

The effect of reaction temperature on the DS of modified β-CD was also examined, and their spectra are shown in Fig. 7. The molar ratio of acetic anhydride/AGU in β-CD was 1:1.4, and the reaction time was 6 h. As shown, the DS increased from 0.21 to 0.48 by an increment in temperature from the room temperature to 65 °C. The reason for this enhancement of the acetylation with increasing temperature was probably due to the favorable effect of temperature on compatibility of the reaction ingredients, swellability of β-CD, diffusion of the esterifying agent, and the mobility of the reaction molecules [26]. In contrast to the increasing trend, the DS decreased on raising the temperature from 65 to 75 °C by 0.24. This decrement could be ascribed to the partial degradation of the β-CD at high temperature. In addition, as the acetylated reaction releases much heat, the reaction process becomes unstable. The DS decreased sharply with the temperature beyond 85 °C. Colors of the β-CD acetates prepared by this method were from white to light tan. Reaction at higher temperature gave products which became much brownish in color. Considering the DS and color of the acetylated β-CD, we ascertained that the temperature levels of <75 °C was used to carry out acetylated reaction.

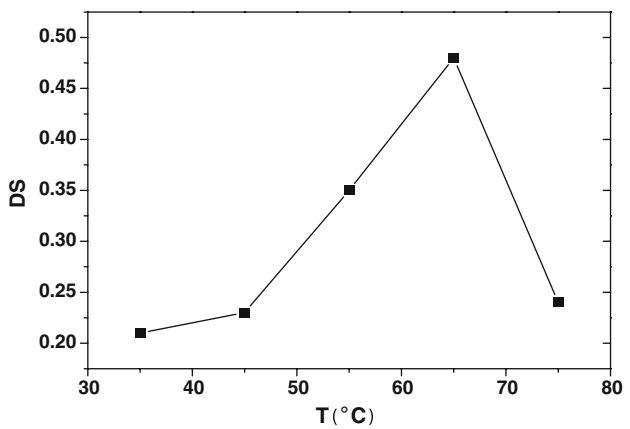

Fig. 7 Effect of reaction temperature on the DS

Effect of acetic anhydride/AGU ratio

The effect of the molar ratio of acetic anhydride/AGU in β-CD on the DS of product was investigated. Results are given in Table 2. Increasing the molar ratio of acetic anhydride/AGU generally increases the DS of product. These increases in DS by an increment of the reactant concentration could be interpreted in terms of greater availability of acetic anhydride molecules in the proximity of the β-CD molecules at higher concentration of the acetic anhydride. Increasing the molar ratio of acetic anhydride/AGU from 1:7 to 1:1 resulted in an increment in the DS of the products from 0.09 to 0.57. When the molar ratio was increased from 1:1 to 2:1, there was only a minimal increase in DS (0.07). It is very likely that excess acetic anhydride had no significant effect on the acetylation rates of β-CD in [C_4mim]Br. Depending on the amount of acetic anhydride used, we were able to control the DS. These results indicated that it is possible to control the DS value by stoichiometric method.

XRD characterization

X-ray diffraction (XRD) measurements were performed to check whether chemical modification altered the crystallinity of β-CD. The XRD spectra of native β-CD, regenerated β-CD and acetylated β-CD, are presented in

Table 2 Effect of the molar ratio of acetic anhydride/AGU in β-CD on the DS

Acetic anhydride/AGU	1:7	3:7	5:7	1:1	9:7	2:1	20:7	23:7	26:7
DS	0.09	0.28	0.48	0.57	0.58	0.64	0.79	1.00	1.14

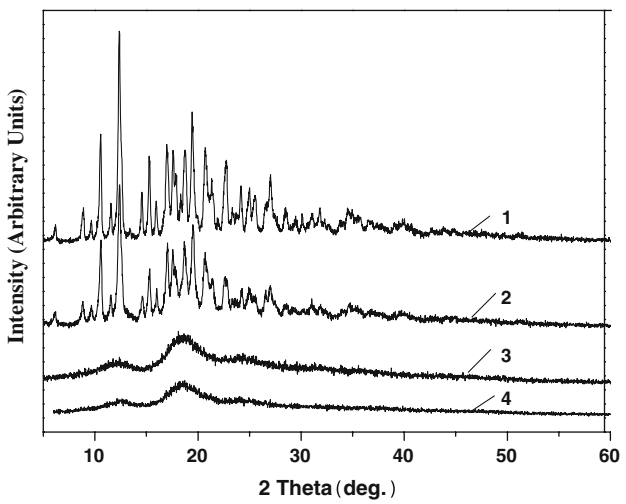

Fig. 8 X-ray spectra: unmodified β-CD (1); regenerated β-CD (2); acetylated β-CD (DS = 0.21) (3); acetylated β-CD (DS = 0.48) (4)

Fig. 8. The regenerated β-CD was obtained from the 20 wt% β-CD solution of [C_4mim]Br IL by addition of ethanol. The XRD spectrum of β-CD agrees quite well with that of regenerated β-CD, which indicates that [C_4mim]Br did not change the crystal structure of β-CD during the process of dissolution and regeneration. The X-ray spectra of β-CD with a DS of 0.21 and 0.48 differentiate from unmodified β-CD greatly. In contrast with the acuate diffraction peaks in spectra 1 and 2, the spectra 3 and 4 show no obvious peaks but nearly a straight line revealing a decrease of crystallinity and transition of structure of β-CD into amorphous region. The results of XRD are also consistent with the results of DS. As DS decreased, an increase in crystallinity was observed due to the decrease of acetyl content in low-DS sample. As DS increased, the crystallization peaks disappeared gradually. The XRD indicated that with esterification processing the reagent entered into the crystalline region of β-CD, which destroyed the crystalline structures of native β-CD and promoted formation of the amorphous structures.

Effect of IL recycling times

This IL could be recovered after the acetylated β-CD regeneration to almost 100% [27]. [C_4mim]Br forms a hygroscopic liquid with a low content of water by recycling. To guarantee the solution power of the IL for β-CD, it must be ensured that the IL does not contain any water. Freeze drying and recrystallization lead to water-free solids. The recycled IL had the same efficiency to dissolve β-CD compared to the starting IL.

The influence of freshness of [C_4mim]Br on the acetylation was also studied. The results are shown in Table 3. As a result, β-CD acetate with a similar DS was obtained under comparable reaction conditions. After only a simple distillation or freeze drying of recycled [C_4mim]Br, [C_4mim]Br with high purity was obtained. Furthermore, ^{1}H and ^{13}C NMR studies of the IL after recycling also showed no differences compared with that of the starting solvent, revealing again that no side reactions between IL and β-CD or the reaction agent occurred during the dissolution and modification of β-CD in IL. Because of negligible vapor pressure and good thermostability, the recycling and isolation of this IL are very easily done. This advantage makes this IL potentially attractive for industrial applications.

Table 3 Conditions and results of the acetylation of β-CD

Sample No.	[C_4mim]Br	T_R[a] (°C)	Time (h)	Molar ratio[b]	DS[c]
1	Fresh	65	6	5:7	0.48
2	Once recovered	65	6	5:7	0.46
3	Secondary recovered	65	6	5:7	0.47
4	Third recovered	65	6	5:7	0.47

[a] Reaction temperature

[b] The molar ratio of acetic anhydride/AGU in β-CD

[c] The DS of acetylated β-CD

Conclusions

The IL, [C_4mim]Br, is a non-derivatizing solvent for β-CD. Our results confirm that ILs are viable solvent systems for dissolving and regenerating β-CD. It makes it possible to prepare acetylated β-CD directly in one-step reaction by means of reacting native β-CD with acetylating agents in the absence of a catalyst. The process is a simple process without any elaborate purification steps. The optimum technique conditions required for preparation of acetylated β-CD by reacting β-CD with acetic anhydride in IL were determined. It was shown that β-CD acetates with different DS values can be obtained by varying the molar ratio in a completely homogeneous synthesis. It also makes it possible to prepare reaction products which are less colored. Product can be separated out in a simple manner by precipitation. Moreover, compared with the traditional β-CD acetylation reactions, more green reaction conditions are applied. Regarding the potential of ILs as promising green solvents, homogeneous functionalization of β-CD in ILs is expected to attract more attention in the future.

Acknowledgements The authors gratefully acknowledge the financial support from the Specialized Research Fund for the Doctoral Program of Higher Education (Grant No. 20070718003). We are also extremely grateful for the support provided by Natural Science Foundation of Shaanxi Province (2007B07).

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