THE SEPARATION & UTILIZATION OF POLYESTER/ COTTON BLENDS

AUTHORS Rasike De Silva[1] | Xungai Wang[1] | Nolene Byrne[1]
ORGANISATION [1]Institute for Frontier Materials, Deakin University, Pigdons Road, Waurn Ponds, Victoria, Australia, 3217

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Summary

Textiles are commonly made from intimate blends of polyester and cotton, which makes recycling of such textiles very difficult through mechanical means. We report the use of ionic liquid in the separation of polyester cotton blends. By selective dissolution of the cotton component, the polyester component can be separated and recovered in high yield. This finding presents as an environmentally benign approach to recycling textile blend waste.

Introduction

Improving the recycling of textiles has become an issue for the 21st century. Annually approximately 1 trillion tons of textile waste is discarded to Australian landfill (TTNA aims to recycle fibre waste from landfills 2010). The recycling of textiles is complicated by the issue that he majority of textile products are blended materials. For example the majority of clothing is manufactured from a polyester/ cotton yarn (Zou et al. 2011; Kalliala and Nousiainen 1999). Separation of polyester and cotton into its individual components is difficult; mechanical separation is not possible and chemical separation requires harsh processing parameters (Zou et al. 2011; Wakelyn et al. 2007). We report a new environmentally friendly and convenient approach to separate and subsequently utilize polyester/cotton blends using ionic liquids (ILs). We have selected cellulose dissolving 1-allyl-3-methylimidazolium chloride (AMIMCl) (De Silva et al. 2013; Zhang et al. 2005). The polyester/cotton blend can be separated by selectively dissolving the cotton component, with the benefit that the IL can be recycled and reused (De Silva et al. 2013; Cao et al. 2009). The polyester; a non-renewable petroleum resource was recovered in high yield of more than 98% .The benefit of using ILs in this process is the ease with which the polyester and cotton can be separated. This technology reported here shows a facile route to the recycling of clothing in the form of polyester/cotton blends. We measure the material properties of the recovered polyester and cotton and show that no significant differences can be seen between the recovered polymers and the as received 100% polymers.

Materials and methods

To determine the solubility of polyester, 100% polyester as received was submerged in the 1-Allyl-3-methylimidazolium chloride at 80 ˚ C and monitored using polarizing optical microscopy. Over a 48 hour period, no dissolution was observed. Then the 50:50 polyester/cotton blend yarns were added to the ionic liquid at 80 ˚ C. After 6 hours, the undissolved component was removed, rinsed with water and weighed. The IL was able to be recovered and recycled as previously reported as water was used as the coagulating solvent to regenerate cotton(Cao et al. 2009).

Results and discussion

FIGURE 1 shows the general scheme for the separation of the cotton/polyester blend using AMIMCl. The IL was able to be recovered and recycled as previously reported as water is the coagulating solution (Cao et al. 2009; De Silva et al. 2013).

FIGURE 2a shows scanning electron image of the polyester cotton blend; prior to separation both cotton and polyester fibres can be observed.

FIGURE 2 b shows the recovered polyester, only polyester fibres are observed. We also characterized the structure of the recovered polyester, using a combination of DSC, TGA, NMR and FTIR shown in FIGURE 3a-d. For comparison we include the as received 100% polyester. It can be seen that no change in the melt temperature of the polyester is measured (endothermic peak around 252˚C), which is important since polyester can be recycled by melting the polyester and reshaping the polyester into the desired form (fibres, bottles, etc). The 13C NMR spectrum and FTIR do indicate that some small amount (less than 2%) of cotton may remain with the recovered polyester as evidenced by the additional peaks observed at 60 and 110 ppm(Zhang et al. 2005), and the presence of the hydroxyl peak at 3300 cm-1 (Fan et al. 2012) in the FTIR spectrum.

We now turn our attention to the recovered cotton. It is shown that fibres and/or films can easily be prepared from the cotton/AMIMCl solution. FIGURE 4a-c shows a series of material characterization experiments performed on the recovered cotton from the blend compared with as received cotton dissolved and regenerated from the same IL, AMIMCl. As can be seen no difference in the tensile properties are observed between the two regenerated cotton samples. Similarly the thermal degradation temperature and FTIR show no appreciable differences.

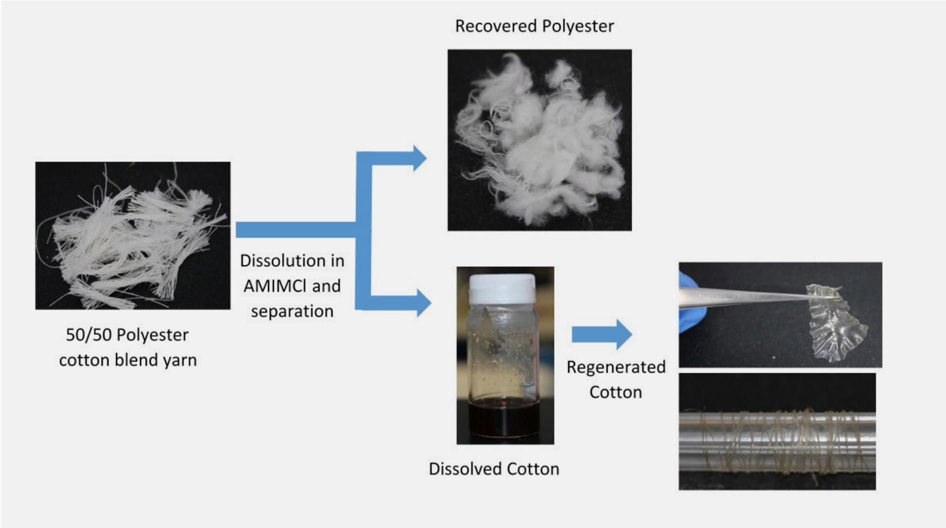

FIGURE 1. Separation and utilization of polyester/cotton blends using AMIMCl

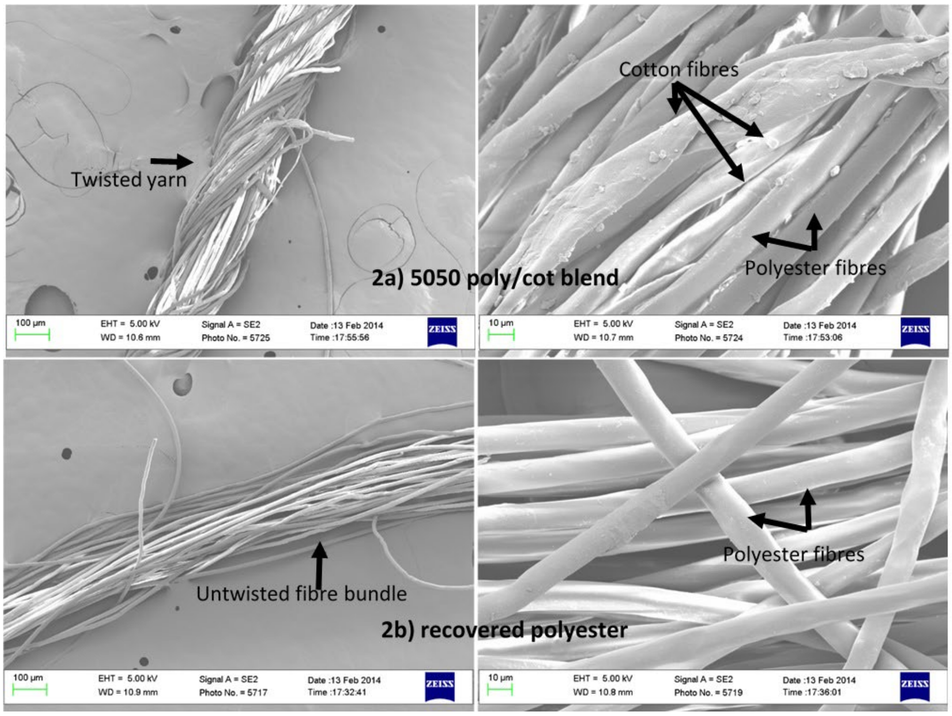

FIGURE 2. (2a)-SEM of polyester/cotton blend; (2b)-SEM of recovered polyester

Conclusion

Here we described the facile and efficient separation of polyester/cotton blends into their individual components. This was achieved by selective dissolution of the cotton component using the ionic liquid AMIMCl. We showed that the cotton could be regenerated using water as the coagulated solvent. Regenerated cotton is a material finding increased use in the textiles industry, in the carbon fibre industry as low cost precursor materials (Dumanli and Windle 2012) and as the starting material for bioethanol (Zhu et al. 2006).Current work is in progress to develop a new regenerated textile fibre using the cotton recovered from the textile blend waste.

Acknowledgement

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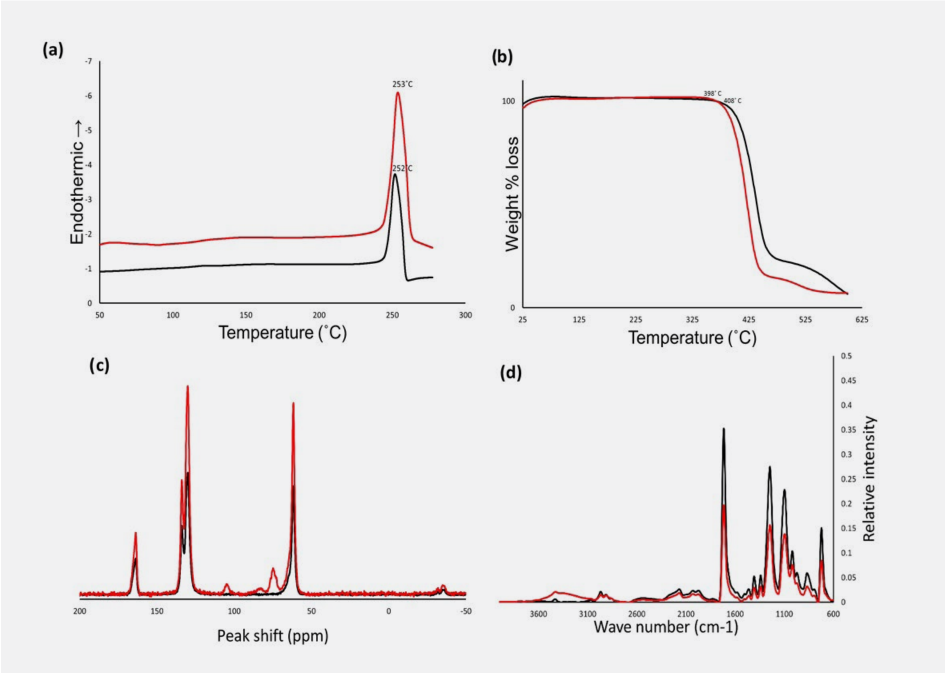

FIGURE 3A-D. Characterization of the recovered polyester (red curve) compared with the as received polyester (black curve) a) DSC curves b) TGA curves, c) 13C- CP-NMR and d) FTIR , all show little to no difference between the two polyester samples.

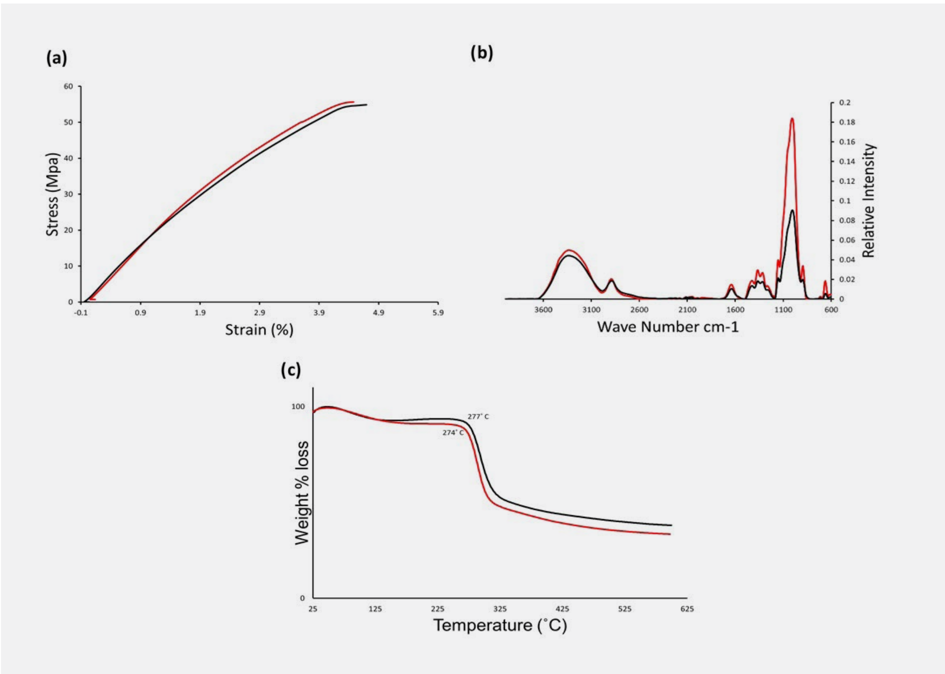

FIGURE 4a-c: Characterization of the recovered cotton (red curve) compared with as received cotton (black curve) a) DMA curves b) TGA curves, c) FTIR , all show little to no difference between the two cotton samples. Both samples are regenerated cotton.

Presenting & corresponding author

Rasike De Silva
rdesil@deakin.edu.au