

# The modified influence the composite PBT melt blowing nonwoven for the leucocytes filtration

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## Introduction

The leucocytes present in red cell and platelet components have been implicated in several important immunological and infective complications of blood transfusion [1]. Leukocyte depletion of blood components may prevent or ameliorate some of these harmful effects. A variety of techniques have been developed to prepare leukocyte-poor blood components [2]. Among the various methods to remove or reduce leukocytes in blood components, filters have been shown to be most efficient. Therefore, leucodepletion by filtration is a well accepted method used to minimize the risk of transfusion associated infections. Filters are used in the medical device industry to ensure that patients do not receive ‘undesirables’ in procedures such as blood transfusions may also be used to treat blood disease. The observation that leukocyte removal by filters was accomplished, a melt-blowing process, in which a melt polymer is cast into nonwovens by a high velocity stream of gas and collected as a nonwoven web, is used to prepare webs of nonwovens with an average fiber diameter of less than  $2\mu\text{m}$  [3,4]. Current leukocyte filters consist of different layers of nonwoven poly(butylene terephthalate) (PBT) filters have been shown to be very effective in the preparation of leukocyte-poor blood. Although most currently used leukocyte filters show a high efficiency, further optimization is still desirable. Several reports have tried to relate the extent of cell adhesion to the chemical composition of the substrate surface, but very few specific studied using leukocytes are available [5]. Overall results of this study demonstrated that the immobilization of heparin onto the surface composite of PBT nonwovens would be beneficial to improve the hydrophilicity and hemocompatibility.

## Experimental

### Materials

PBT, heparin, acrylic acid, glutaraldehyde, 1-Ethyl-3-(3-di-methylaminopropyl) carbodiimide, *N*-hydroxysuccinimide and 4-morpholineethanesulfonic acid monohydrate were purchased from Sigma, USA. Chitosan was obtained from China Textile Institute, Taipei, Taiwan. Anti-coagulant citrate dextrose human blood was provided from the Blood Center in Taiwan.

### Surface modification

The HEP immobilization on the PBT nonwoven was prepared in accordance with the chemical scheme shown in Fig.1 The PBT nonwovens were cut into pieces of  $20\text{cm}\times 20\text{cm}$  and treated with  $\text{O}_2$ -plasma. Afterwards, the nonwovens were treated with the previous study [6].

## Results and Discussion

Surface  $\text{O}_2$ -plasma oxidation has been widely employed for surface modification because it has the advantage of uniformly introducing peroxides on the polymer surface and offers an easy-to-handle, inexpensive technique. The surface density of peroxide groups was determined by the DPPH method. As shown in Fig 1, the maximum surface density ( $106.1\text{ nmol}/\text{cm}^2$ ) of the peroxide groups appeared after treating 3 min with  $\text{O}_2$ -plasma.

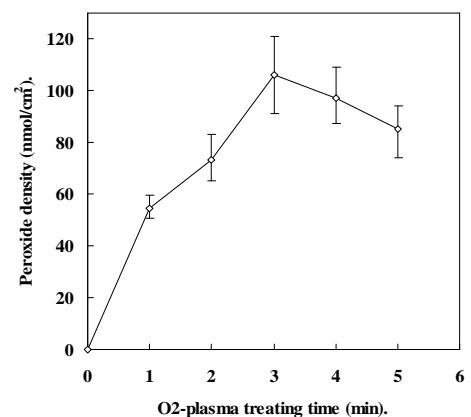


Fig. 1 The dependence of the peroxide surface density on the  $\text{O}_2$ -plasma treating time.

Fig. 2 shows the surface density of the carboxyl groups attained  $91.6\text{ nmol}/\text{cm}^2$ . The HEP was covalently bonded directly to the EDC/NHS-activated PBT-AA fiber or covalently bonded with amino groups of PBT-CS via GA. Fig. 3 shows the effect of the surface modification on the hydrophilicity evaluated by water contact angle measurements. The results indicate that pure PBT was the most hydrophobic, whereas those fibers immobilizing with HEP was hydrophilic. Fig. 4, the immobilization of HEP can reduce the adhesion of platelet on the surface. Comparing with native PBT, the highest adhesion level (32.4%) appeared on PBT

after 2 h incubation, whereas the lowest (14.1%) appeared on PBT-CS-HEP. Platelet adhesion increased slightly with incubation time between 30 min and 2 h. As reported in our previous study [6], the platelet adhesion is reduced by electrostatic repulsion between platelets and negatively charged functional groups such as carboxyl groups and sulfonic groups.

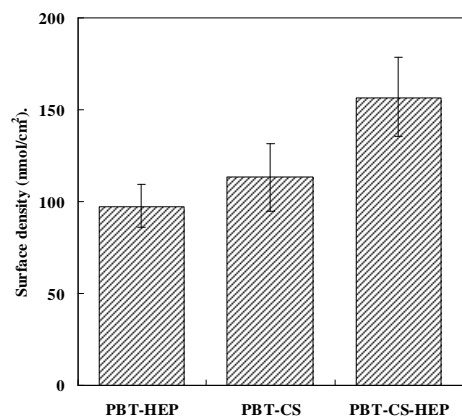


Fig.2 Surface density of the modified PBT fibers  
a. Sulfonic group, determined by staining with toluidine blue O. (PBT-HEP、PBT-CS-HEP)  
b. Amino group, determined by staining with C.I. Acid Orange 7. (PBT-CS)

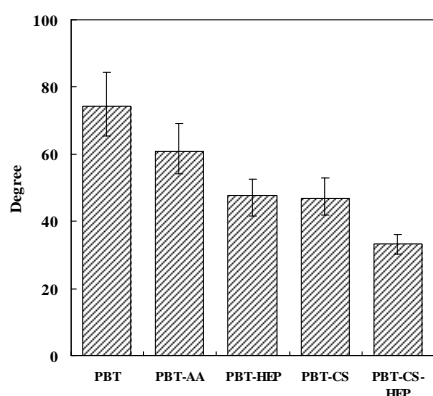


Fig. 3 The contact angle of the native and modified PBT fibers.

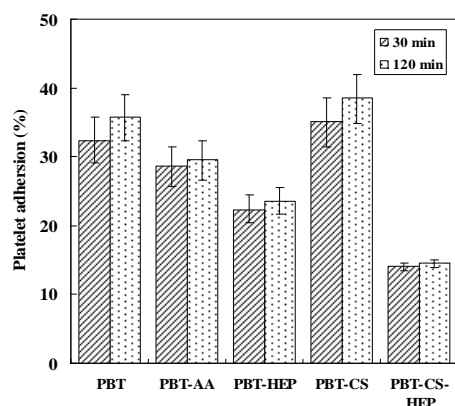


Fig. 4 Comparison of platelet adhesion to various fibers after 30 and 120 min incubation with PRP containing ( $n=5$ , mean $\pm$ S.D.).

Fig. 5 shows that the clotting times of native PBT and surface-modified PBT were essentially the same as those of human plasma (the negative control). The APTT of PBT-CS-HEP was 7.9 times of those of native PBT. This suggests that HEP should be an effective agent in prolonging the blood clotting time, thereby exerting an anti-coagulant effect, thus the hemocompatibility of PBT-CS-HEP fibers was improved over native PBT.

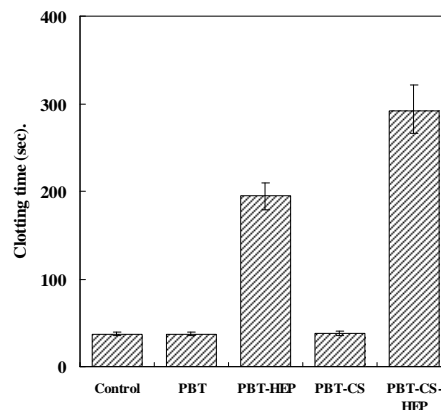


Fig. 5 Comparison of anti-coagulant properties of fibers: APTT ( $n=5$ , mean $\pm$ S.D.)

### Conclusion

The results show that by the coupling of chitosan, the heparin-immobilized amount can be significantly increased. Water contact angle decreased with the increased amount of immobilized heparin, suggesting the increasing hydrophilicity. Further does of the heparin-modified PBT composite nonwovens by 20 layers the filter efficiency to reach 96%.

### References

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