

## Protein adsorption on carbon nanotube-polyurethane composites

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In recent years, carbon nanotube (CNTs) - polymer composites have been received keen interest, due to their potential applications ranging from biochemical sensors, in-vivo nanostructured electronic devices, controlled drug release pharmacology and so on. Many researches have demonstrated that homogeneous dispersion of carbon nanotubes in polymer can provide the composites with enhanced mechanical and antithrombotic properties [1]. However, the interactions between CNTs composites and biological environment are still not well understood.

Xu<sup>[2]</sup> has investigated the fibrinogen adsorption and platelet adhesion on CNTs- polyurethane(PU) composite, which was prepared by dispersing carbon nanofiber into polyurethane. It was shown that the platelet adhesion was obviously suppressed although there was large amount of fibrinogen adsorbed on the composite's surface. We think that the reduced platelet adhesion may be due to absorbed albumin, which is considered as a passivating agent. In order to better understand the blood compatibility of PU/CNTs composite, the adsorption of both Human serum albumin and fibrinogen on the surface of self-crosslinkable PU/CNTs composite were investigated in this work.

**Methods:** CNTs ( purchased from Nanotech Port Co., Shengzhen, P. R. China, with diameter of 20-40 nm and length of 5-15 $\mu$ m) was purified and treated with a mixture of nitric and sulfuric acid to form hydroxyl group-rich carbon nanotubes. Different amounts of functionalized CNTs were introduced into the segmented PU prepolymer system and self-crosslink takes place at 80°C to obtained homogeneous PU/ CNTs composites with various CNTs contents.

The mechanic properties of the samples were tested using the crosshead speed of 50 mm/min at room temperature on Instron Series IX Automated Materials Testing System with Interface type of 4200.

Fibrinogen (Fg) and Human serum albumin (HSA) were labeled with <sup>125</sup>I using the ICI method [3]. For studies of protein adsorption from buffer, labeled protein was mixed with unlabeled protein (1:19, labeled:unlabeled) at a total concentration of 1.0 mg/ml with Tris buffered saline (TBS, pH 7.4). The surfaces were incubated with Fg-<sup>125</sup>I and HSA-<sup>125</sup>I solution for 2 h at room temperature. After rinsing, the surfaces were transferred to clean tubes for radioactivity measurement by gamma counter (PE 1840). The radioactivity was converted to adsorbed protein amounts. Adsorption results are shown in Fig 2.

**Results/Discussion:** As shown in Figure 1, a small amount of CNTs incorporated into the polyurethane increased the Young's modulus dramatically. The modulus of composite, which contains only 0.1% CNTs, was increased to more than 40Mpa.

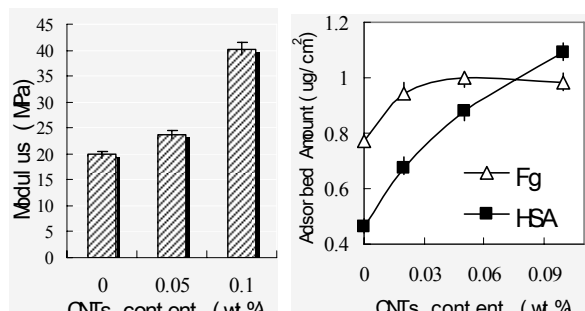


Fig 1. The effect of CNTs contents on the modulus of PU /CNTs Composites.

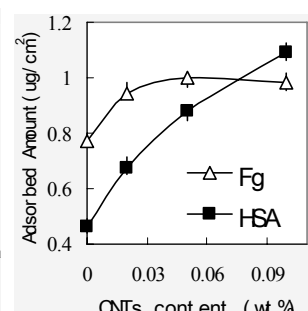


Fig 2. The effect of CNTs contents on Proteins adsorption to the various PU/CNTs Composites surface.

increased to more than 40Mpa.

Datas for protein adsorption on the PU/ CNTs composites surfaces with various CNTs contents are shown in Figure 2. The amounts of adsorbed Fg and HSA on all composites' surfaces were significantly higher, compared to PU control. It is noticeable that the adsorption of HSA on the composites increases continuously with the increasing content of CNTs, while the saturated amount of Fg adsorption was found at 0.05% CNTs. This observation indicates that the interactions between the composite and various proteins are quite different and the ratio of absorbed Albumin/Fibrinogen increased with the increase of CNTs content. Since increasing the ratio of Albumin/Fibrinogen can improve the biocompatibility of biomaterials<sup>[4]</sup>, incorporating more CNTs into polyurethane is expected to form better blood compatible biomaterials.

**Conclusions:** A very small amount of CNTs incorporated in polyurethane can increase the Young's modulus of the composite dramatically. The ratio of absorbed Albumin/Fibrinogen on composite surfaces increased with increasing CNTs content.

### Acknowledgements

This work was supported by the National Natural Science Foundation of China (No.20574055, 90606013, 20634030), and the Program for Excellent Talents in Hubei Province [2005ABB020, 2005ABB032 ].

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