

## Rapid Communication

# The Design and Fabrication of Water-Resistant Sticky Mosquito Polypropylene Net and Its Application in Capturing Mosquitoes

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## Introduction

Mosquitoes can spread many diseases through biting, such as malaria, lymphatic filariasis, yellow fever, dengue fever, epidemic encephalitis B and so on [1]. Therefore, in order to prevent the spread of this disease, it is extremely necessary to kill mosquitoes. Compared with chemical insecticides [2,3], physical killing is safer and environmentally friendly, and sticky mosquito glue is very popular in the market [4,5]. The traditional sticky fly mosquito glue is mainly divided into two categories [6]. One is made of different kinds of natural products, mainly including rosin, tung oil, castor oil, gum Arabic, honey, etc. Sometimes, it also contains peach glue, organic pesticides, honey, lactic acid, etc. Another is mainly synthetic polymer adhesives. For example, a type of glue is mainly composed of butyl rubber, hydrogenated tackifying resin, naphthenic rubber oil, polyisobutylene and polyethylene.

However, at present, the effect of these sticky glue is easily damaged by the moisture. Once the air become wet, it will lose its adhesion ability. On the other hand, the preparation process is also relatively cumbersome and laborious. Therefore, it is necessary to optimize the preparation procedure and improve simultaneously the water resistance of these sticky mosquito (fly) gums. The recently reported polydimethylsiloxane (PDMS)/polytetrafluoroethylene (PTFE) or polydimethylsiloxane (PDMS)/(polyvinylidene fluoride) (PVDF) formed by electrostatic interaction is a simple water-resistant adhesive, but the adhesive strength does not meet the requirements of use, and there is no report on application as glue in sticking mosquitoes and flies [7,8]. Inspired by the structure of spider web [9], the water-resistant sticky polypropylene net was fabricated here for capturing mosquitoes, which can be used in the humid air, at the same time, its adhesion strength was enhanced by adding tetraethyl silicate (TEOS) for the purpose of sticking mosquitoes [10].

## Abstract

In this work, inspired by the structure of spider web, the water-resistant sticky polypropylene (PP) net was fabricated for capturing mosquitoes here. The water-resistant pre-glue was first obtained through mixing liquid polydimethylsiloxane (PDMS), solid polytetrafluoroethylene (PTFE) microparticles and tetraethyl silicate (TEOS), where TEOS was used as cross linker to enhance adhesion strength. The sticky mosquitoes PP net was obtained through heating the PP net painted with the water-resistant pre-glue uniformly on the two sides of PP net at 60°C for 2 days. This sticky mosquitoes PP net works well in sticking mosquitoes even in the humid air.

**Keywords:** Sticky mosquitoes; Polypropylene net; Water resistance glue; Electrostatic interaction; Crosslinking

## Materials and Methods

### Materials

Hydroxyl terminated PDMS (Sigma-Aldrich 18,000-22,000 cSt), tetraethyl orthosilicate (TEOS), and polytetrafluoroethylene (PTFE) were purchased from Aladdin Industrial Inc (Shanghai, China). Plastic net, namely, polypropylene (PP) net, were purchased from the supermarket in Nanjing city.

### Fabrication of PP net coated with PDMS/PTFE

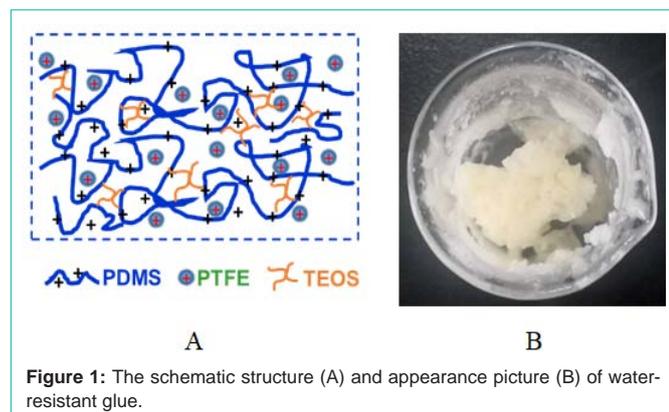
The fabrication of the coated PP net was carried out through the following three steps according to the reference [11]. First, liquid polydimethylsiloxane (PDMS) and micro particle polytetrafluoroethylene (PTFE) (weight ratio 1:2 of PDMS to PTFE) and tetraethyl silicate (TEOS) (10% of total weight of PDMS and PTFE) are mixed uniformly to obtain a white paste as sticky pre-glue. The schematic structure and appearance of the obtained glue was showed in Figure 1. Second, the above as-prepared white paste was painted uniformly on the two sides of PP net through using a teeth brush. Third, the coated PP net was heated at 60°C for 2 days to further enhance the adhesion strength (Figure 2).

### Capturing of mosquitoes

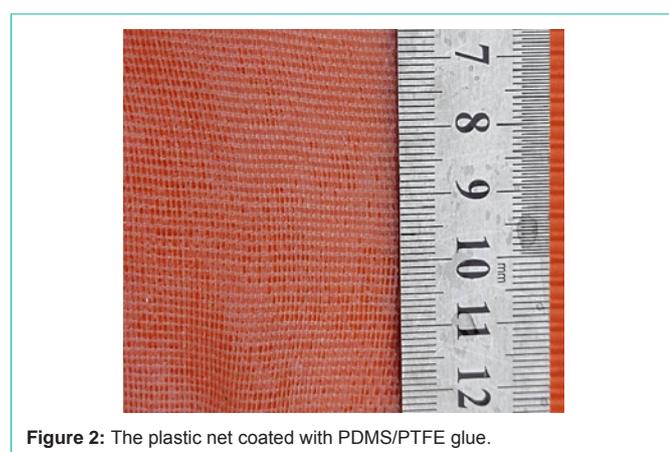
The PP net coated with PDMS/PTFE was waved slowly in order to contact those nasty mosquitoes flying in the humid air on the grass land (Figure 3).

## Results and Discussion

According to the reported results [8], the mixture of PDMS and PTFE is a kind of excellent underwater adhesive through the electrostatic interactions of hydrogen atom in liquid polydimethylsiloxane (PDMS) and fluorine atom in micro particle polytetrafluoroethylene (PTFE), where the optimized weight ratio of PDMS to PTFE is 1:2. This weight ratio was therefore chosen here.



**Figure 1:** The schematic structure (A) and appearance picture (B) of water-resistant glue.



**Figure 2:** The plastic net coated with PDMS/PTFE glue.

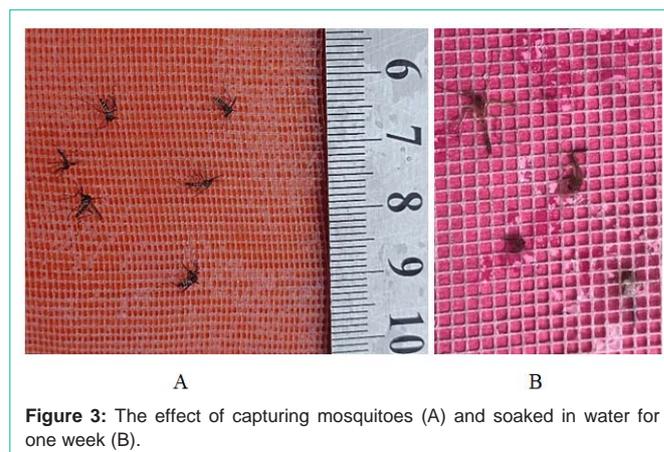
Additionally, tetraethyl silicate (TEOS) was used as crosslinking agent to further remarkably improve the adhesion strength of the mixture of PDMS and PTFE through heating crosslinking of TEOS and PDMS [10]. In the previous research, it was found that the addition of 10% of TEOS content can effectively work. Therefore, in the process of fabrication of coating of PDMS/PTFE on PP net, these optimized parameters, namely, the weight ratio 1:2 of PDMS to PTFE and the addition of 10% TEOS content were adopted. The adhesion strength can be 46 kPa after further heated for 2 days at 60°C [11]. The PP net coated with the white paste with the optimized formula was endowed with very excellent sticky ability for capturing mosquitoes. In the humid air, when this coated PP net was slowly waved, once mosquitoes were encountered, these nasty mosquitoes can be fast stuck on the coated PP net, which works like the spider web. Moreover, this PP web is water-resistant, after soaked in water, it still can work very well (SI).

## Conclusion

The plastic net (PP) can be coated effectively with PDMS/PTFE glue through heating at 60°C. This PDMS/PTFE-coated PP net can be used to capture those nasty mosquitoes as the spider web even exposed to the rain. This sticky PP net is very effective, long-lasting, environmentally friendly.

## Declaration

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**Figure 3:** The effect of capturing mosquitoes (A) and soaked in water for one week (B).

## Supplementary data

Movie S1: The appearance of the adhesive PDMS/PTFE and soaking of PDMS/PTFE coated PP net in water (MP4).

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