

Preparation of coated surfaces on synthetic mesh for application in PM 2.5 dust adsorption

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Abstract

This research investigated the properties of triboelectric static electricity generation and the preparation of coatings on synthetic mesh for PM 2.5 dust adsorption applications. Two types of triboelectric coatings were examined: negative triboelectric coatings, composed of polydimethylsiloxane (PDMS), polymethyl methacrylate (PMMA) and polyethylene (PE), and positive triboelectric coatings, composed of aluminum oxide (Al_2O_3), silicon dioxide (SiO_2) and barium titanate (BaTiO_3). The coating technique used was spray coating. Toluene and deionized water used as solvents for the coating solution. The solution was stirred for 1 h under atmospheric pressure and room temperature and then sprayed onto the synthetic mesh using a spray coating technique. The coated mesh was then air-dried for PM 2.5 dust adsorption testing. The morphology of the samples was analyzed using scanning electron microscopy (SEM). The wettability of coated mesh was measured by water contact angle (WCA). When the negative and positive triboelectric coatings were applied to synthetic meshes, variations in PM 2.5 dust adsorption efficiency were observed. These findings highlight the potential of tailored triboelectric coatings for enhancing dust capture in air filtration applications.

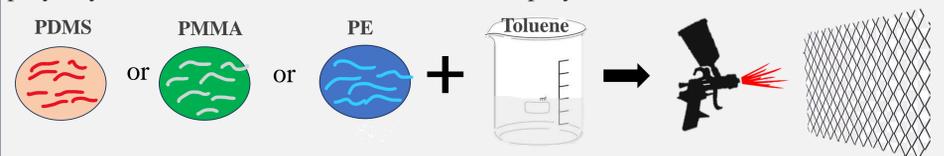
Introduction

Air pollution from PM_{2.5} is a problem that affects health and the environment. PM_{2.5} is a small particle that can enter the respiratory system and bloodstream, causing various diseases. Currently, there are many technologies that can reduce the impact of PM_{2.5}, such as air purifiers and dust masks. However, these technologies still have limitations, such as high cost and cannot directly solve the cause of pollution. To solve these problems, this research focuses on the development of a method to adsorb PM_{2.5} dust using triboelectric properties, which is an electrostatic phenomenon that occurs when two materials rub against each other, causing the exchange of electrons and creating an electric charge. The application of triboelectric technology to capture PM_{2.5} dust has a significant advantage in that it can capture small dust particles without using external power sources. This study aims to adhering PM_{2.5} particles to the surface of the workpiece using a spray coating technique, which is a cost-effective and effective solution to capture and reduce the amount of dust in the air.

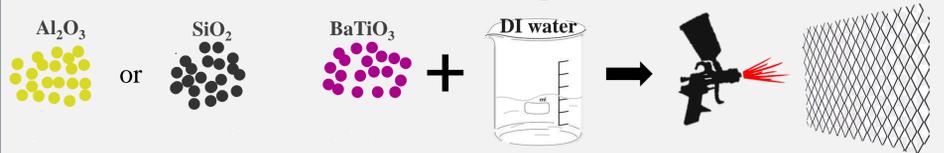


Experiment

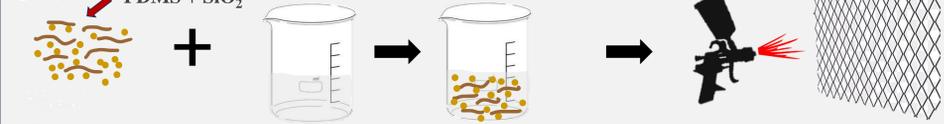
1. Set 1: Prepare polydimethylsiloxane (PDMS), polymethyl methacrylate (PMMA) and polyethylene (PE) mixed with toluene and then sprayed



2. Set 2: Aluminium oxide (Al_2O_3), silicon dioxide (SiO_2) and barium titanate (BaTiO_3) mixed with deionized water (DI water) and then sprayed



3. Polydimethylsiloxane (PDMS) and silicon dioxide (SiO_2) mixed with toluene and then sprayed



4. The samples were characterized by scanning electron microscopy, pendant drop tensiometry and PM_{2.5} measurements



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Results

Fig. 1 SEM images

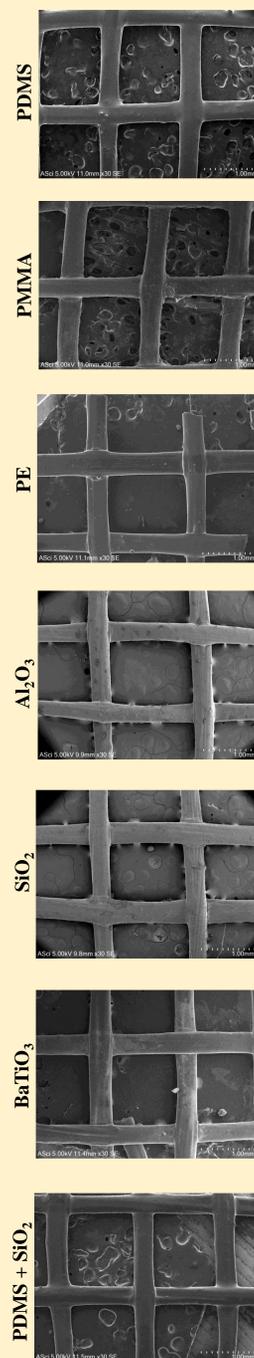


Fig. 2 Water contact angle images

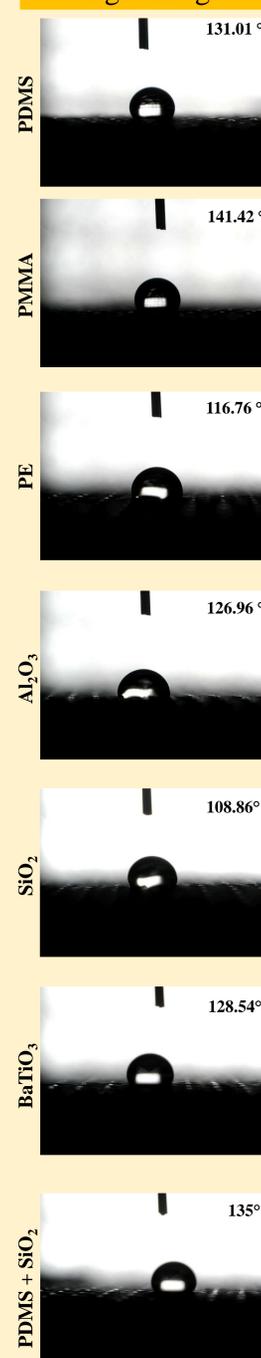


Fig. 3 PM 2.5 adsorption efficiency

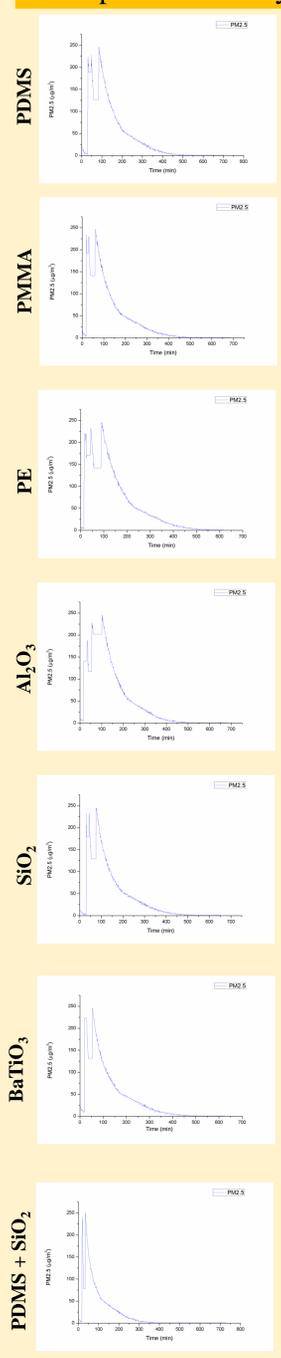


Fig. 1. shows the morphological characteristics of the coating on the synthetic meshes. Fig. 2. shows the water contact angle analysis. Fig. 3. shows the PM_{2.5} adsorption efficiency of coated meshes.

Discussion & Conclusions

From the experimental results, morphology analysis, water droplet contact angle analysis, and PM_{2.5} adsorption efficiency, it was found that the use of both negative and positive triboelectric coatings increased the thickness and PM_{2.5} adsorption capacity of the synthetic mesh. However, the PM_{2.5} adsorption efficiency varied depending on the types of coatings. In particular, the hybrid triboelectric coatings (Set 1) showed potentially lower PM_{2.5} adsorption efficiency compared with the hybrid triboelectric coatings (Set 2). These results indicate that the electrostatic properties of the coatings play an important role in improving dust entrapment, with the hybrid triboelectric coatings having a better tendency to improve PM_{2.5} adsorption in air filtration applications. The positive and negative hybrid coatings have good dust adsorption properties due to the use of both positive and negatively charged substances, which can attract dust with different charges or properties both chemically and electrically.