$P\hbar\psi s \cdot M\alpha\tau s$

PM 2.5 dust adsorption efficiency of coatings on different substrates prepared by spray coating technique.

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Abstract

This study investigates the efficiency of PM 2.5 dust adsorption by coatings applied to different substrates using a spray coating technique. Two types of triboelectric coatings were investigates: negative-charge coatings, comprising trichloro(1H,1H,2H,2H-perfluorooctyl)silane (PFOTCS) and polyvinylidene fluoride (PVDF); and positive-charge coatings, composed of polyvinyl alcohol (PVA), titanium dioxide (TiO_2), and aluminum oxide (Al_2O_3). All mixture solutions were prepared at a concentration of 3% w/v or v/v in deionized water or toluene, respectively. These solutions were stirred for 1 h at atmospheric pressure and room temperature before being applied to different substrate types, such as acrylic, wood, and mirror glass, using a spray coating technique. The physical and structural of the coatings were characterized using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS). The effects of different coating types on morphology and PM 2.5 adsorption efficiency were evaluated and compared. The findings of this study provide valuable insights into the potential application of these coatings on various substrates for future developments.

Introduction

Nowadays, PM 2.5 dust has a huge impact on the body's health directly. It has a negative effect on the body, such as lung cancer, which in the long run may be at risk of death. Therefore, the use of a coating with triboelectric properties was invented to adsorption PM 2.5 dust. The principle of triboelectricity is that materials do not allow themselves to easily lose positive or negative charges. When placed in an open area The material will induce a charge of dust in the air similar to the electrostatic phenomenon which eventually leads to the adsorption of PM 2.5 dust. In this study, we investigated coatings capable of generating triboelectric effects by evaluating dust adsorption efficiency. These coatings can be applied in various ways, such as on exterior walls, interior surfaces, or even on materials like steel and wood, transforming them into dust-absorbing materials through the principles of materials science. The insights gained from this research not only contribute to addressing current pollution challenges but also pave the way for further advancements in materials science, with potential applications across diverse fields in the future.

Experiments
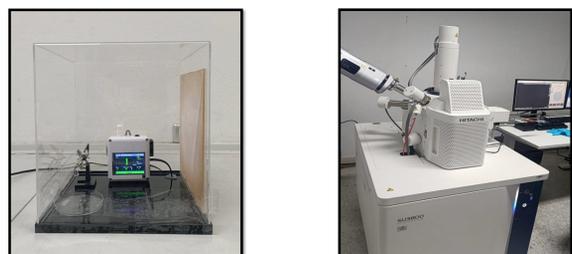
1. Prepare acrylic substrate

Size 25x25 cm — 25 cm × 25 cm
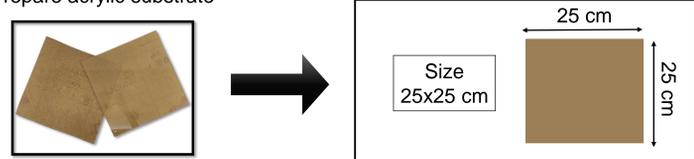
2. Prepare coatings solution by
 - PFOTCS/PVDF+ toluene (3% v/v)
 - TiO_2/Al_2O_3 + deionized water (3% w/v)
 - PFOTCS+TiO_2 + toluene (3% w/v)

3. Take coating solution in spray gun and spraying on acrylic substrate

4. Test PM 2.5 dust adsorption efficiency in chamber, and the sample characterized by scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS).

Result

Fig. 1 SEM images

TiO_2 3%

Al_2O_3 3%

PVDF 3%

PFOTCS 3%

PFOTCS+TiO_2 3%

Fig. 2 EDS images

TiO_2 3%

Element	Wt%
C	34.28
O	16.26
Si	0.24
Ti	23.59
Au	25.62
Total	100

Al_2O_3 3%

Element	Wt%
C	37.11
O	19.43
Al	15.18
Ti	3.18
Au	25.1
Total	100

PVDF 3%

Element	Wt%
C	50.47
O	8.81
F	8.98
Ti	4.03
Au	27.71
Total	100

PFOTCS 3%

Element	Wt%
C	17.89
O	2.67
F	38.38
Si	7.26
Ti	0.76
Au	33.03
Total	100

PFOTCS+TiO_2 3%

Element	Wt%
C	22.88
O	11.62
F	21.72
Si	2.8
Ti	15.89
Au	25.09
Total	100

Fig. 3 PM 2.5 adsorption efficiency

Fig.1 shows the morphology of TiO_2, Al_2O_3, PVDF, PFOTCS and PFOTCS+TiO_2 coated on acrylic substrate. Fig. 2 shows the chemical composition of samples. Fig.3 show The decreasing of PM 2.5 dust for measurement PM 2.5 dust adsorption efficiency of coatings.

Discussion & Conclusion

The PFOTCS+TiO_2 coating demonstrated optimal PM2.5 dust adsorption efficiency within a time range of 20 to 200 minutes compared to other coatings. This was followed by the positive-charge coating containing TiO_2 and Al_2O_3, and then the negative-charge coating comprising PFOTCS and PVDF, in successive order. This is due to the fact that PM 2.5 dust contains both positive and negative charges, the PFOTCS+TiO_2 coating, which combines elements of both charge types, exhibited superior dust adsorption efficiency compared to using either a positive-charge or negative-charge coating alone. This synergistic effect highlights the potential of hybrid coatings in enhancing PM2.5 adsorption capabilities.
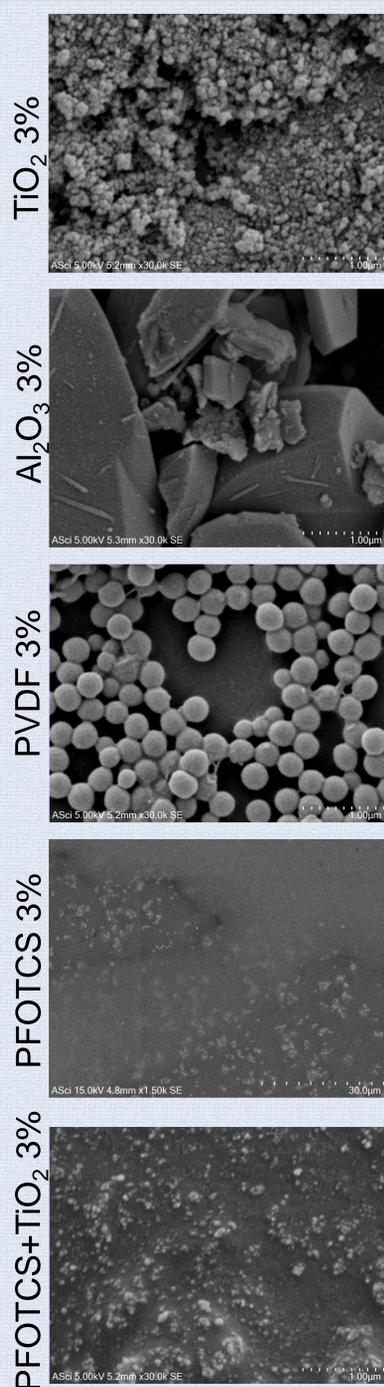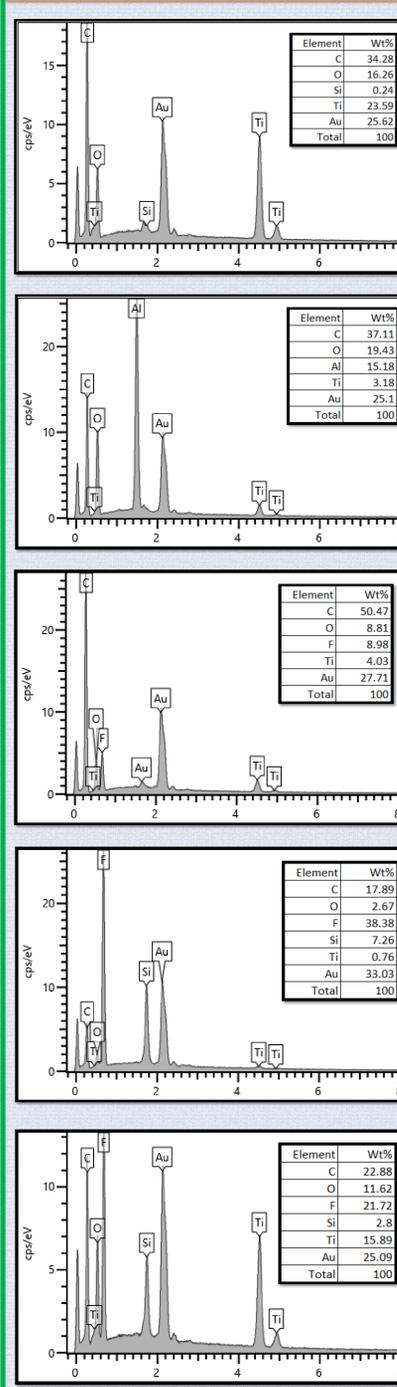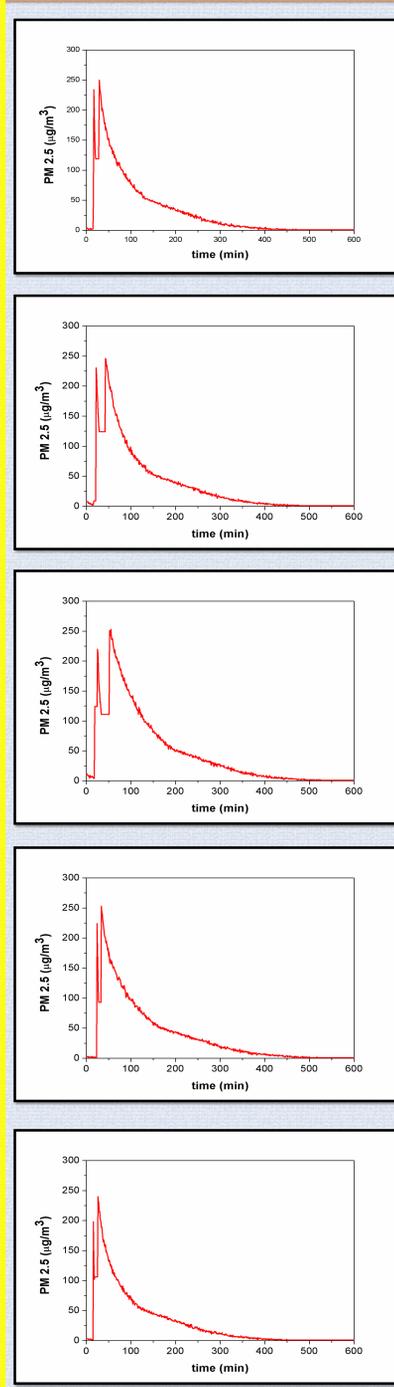
Acknowledgement

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