Journal Name

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Supporting Information

Metal-Organic Framework-Based Nanofiber Filters for Effective Indoor Air Quality Control

Ye Bian,[ab] Rutao Wang,[a] Shijie Wang,[a] Chenyu Yao,[a] Wei Ren,[a] Chun Chen,*[a] Li Zhang*[a]

[a]Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Shatin N.T. Hong Kong SAR 999077, China.
[b]Department of Biomedical Engineering, The Chinese University of Hong Kong, Shatin N.T. Hong Kong SAR 999077, China.

Corresponding authors:
* L. Zhang: lizhang@mae.cuhk.edu.hk;
C. Chen: chunchen@mae.cuhk.edu.hk

PM removal mechanisms of inertial impaction and Brownian diffusion

Inertial impaction occurs when a particle cannot adjust its origin trajectory to follow an abruptly changing streamline near a fiber. In such cases, the particle would go across those streamlines and hit the fiber. Brownian diffusion refers to the random Brownian motion of small particles. When these small particles are travelling with a streamline near a fiber, the random Brownian motion may push the particle towards the fiber.

Stokes number (Stk) is the parameter that governs the inertial impaction, which is defined as:

$$Stk = \frac{C_c \rho_p {d_f}^2 U}{18 \mu d_f}$$

where ρ_p (kg/m^3) is the particle density, d_f (m) is the fiber diameter, μ (kg/ms) is the dynamic viscosity of air, and C_c (unitless) is the Cunningham coefficient caused by slippage, U (m/s) is the face velocity. A larger Stk can result in enhanced inertial impaction for particles.

Peclet number (Pe) is the parameter that governs the Brownian diffusion, which is defined as:

$$Pe = \frac{d_f U}{D}$$

where d_f (m) is the fiber diameter, U (m/s) is the face velocity, and D (m^2/s) is the particle diffusion coefficient. A larger Pe can result in enhanced Brownian diffusion for particles to hit and stick on the fibers.

From the expressions, the Stokes number and Peclet number increase with the increase in fiber diameters. With the generation of ZIF-67 nanocrystals on the PAN fibers, the diameters of the nanofibers did increased. Consequently, the inertial impaction and Brownian diffusion increased as well so that the overall PM removal efficiency was improved.

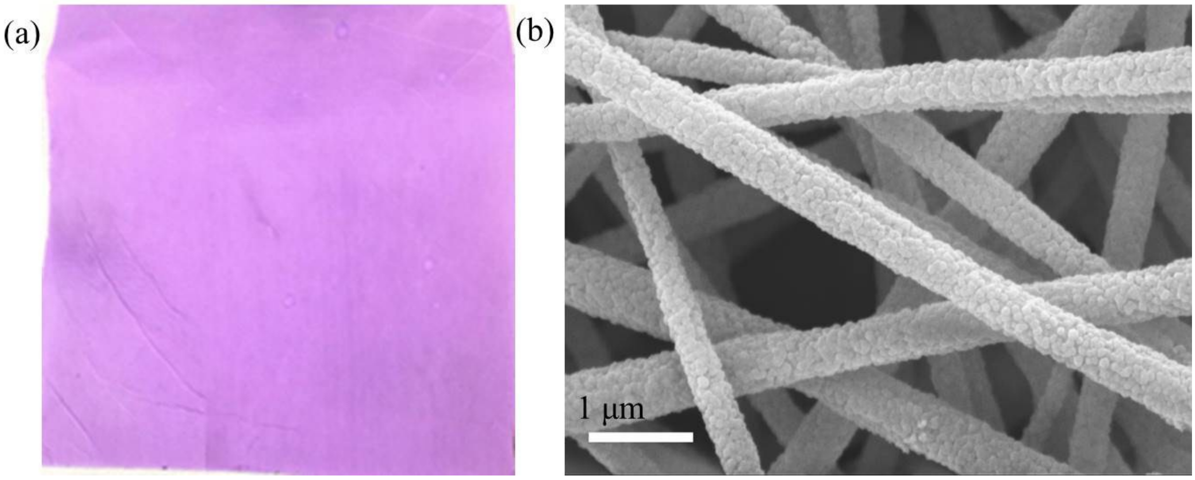

Fig. S1 (a) Photograph and (b) SEM image of the ZIF-67@PAN filter after blowing at a large wind velocity of 10 m/s. The two images show no changes in the filter and the structure under such a large fan velocity, which indicates the strong wind resistance of the prepared MOFs filter.

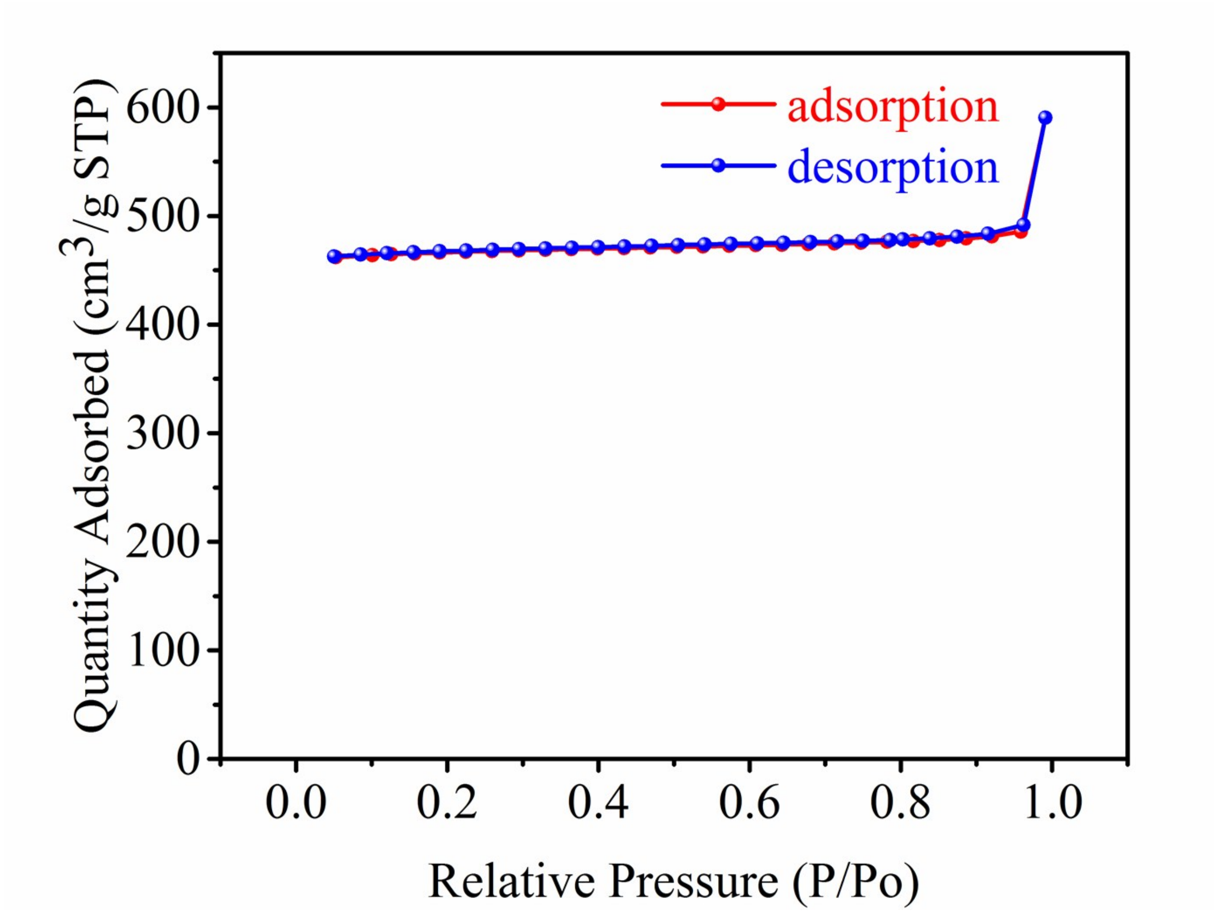

Fig. S2 N_2 adsorption–desorption isotherms of pure ZIF-67, the specific surface area of ZIF-67 calculated through Brunauer–Emmett–Teller (BET) method is 1401 m^2/g.

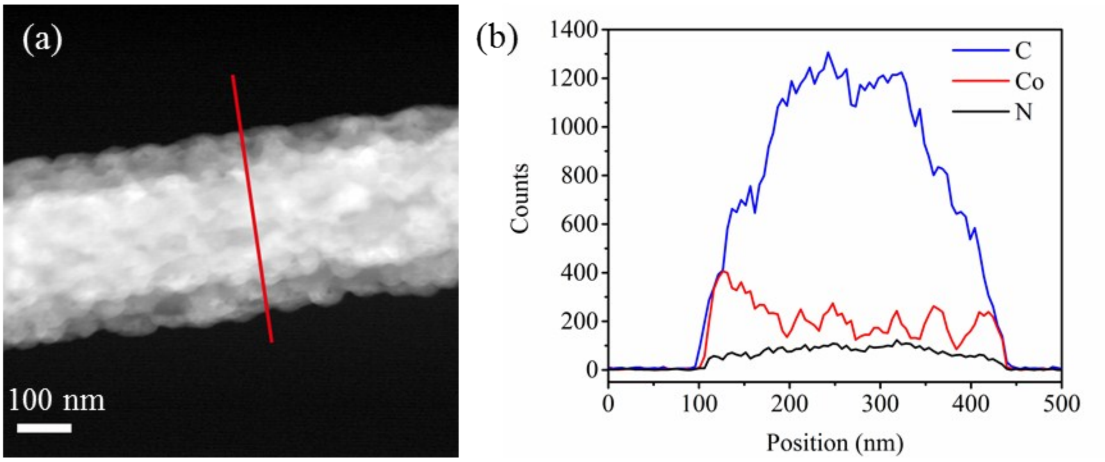

Fig. S3 (a) Dark-field TEM image of the ZIF-67@PAN filter; (b) TEM-EDS linear scan profile along the red line shown in (a).

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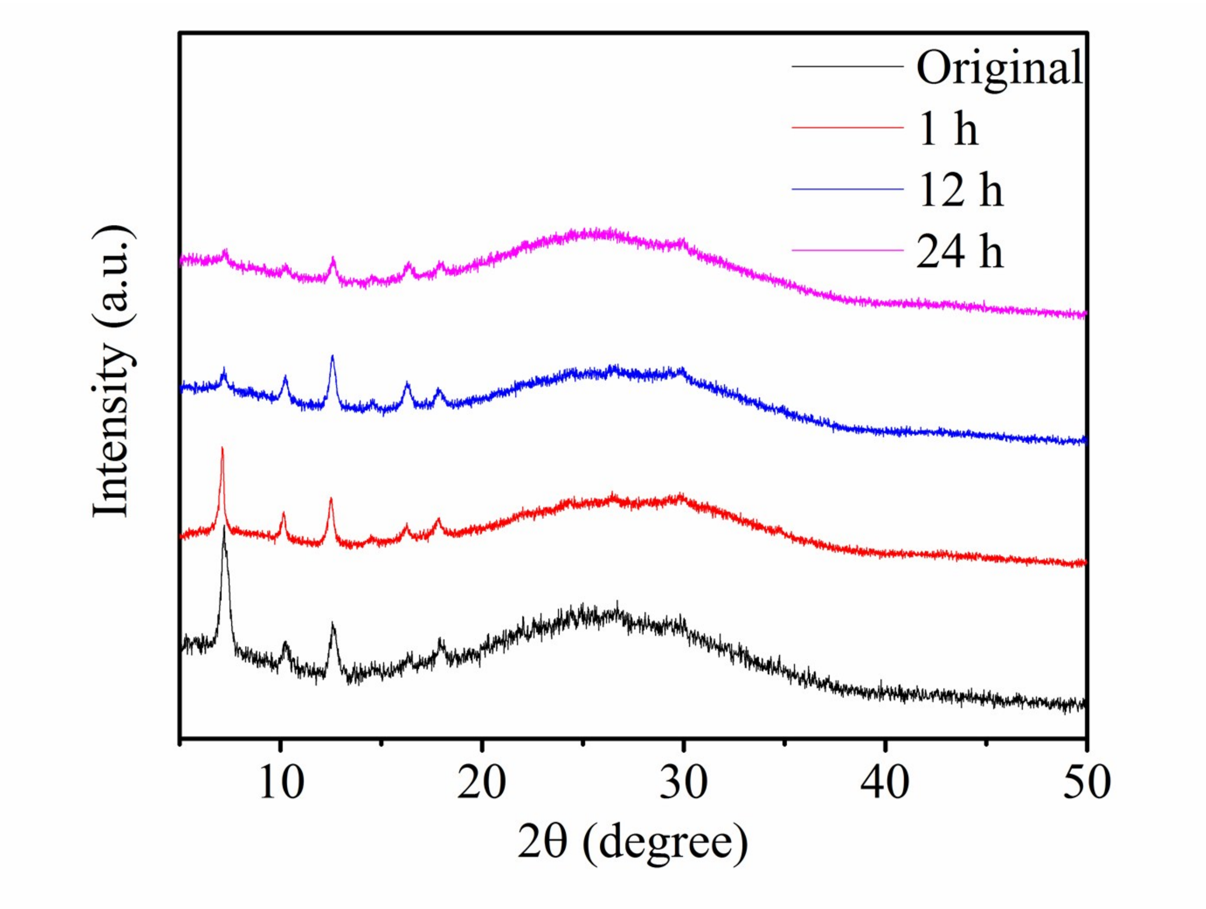

Fig. S4 XRD spectra of the original ZIF-67@PAN filter and the filters used for PM filtration for 1h, 12h, and 24h, respectively.

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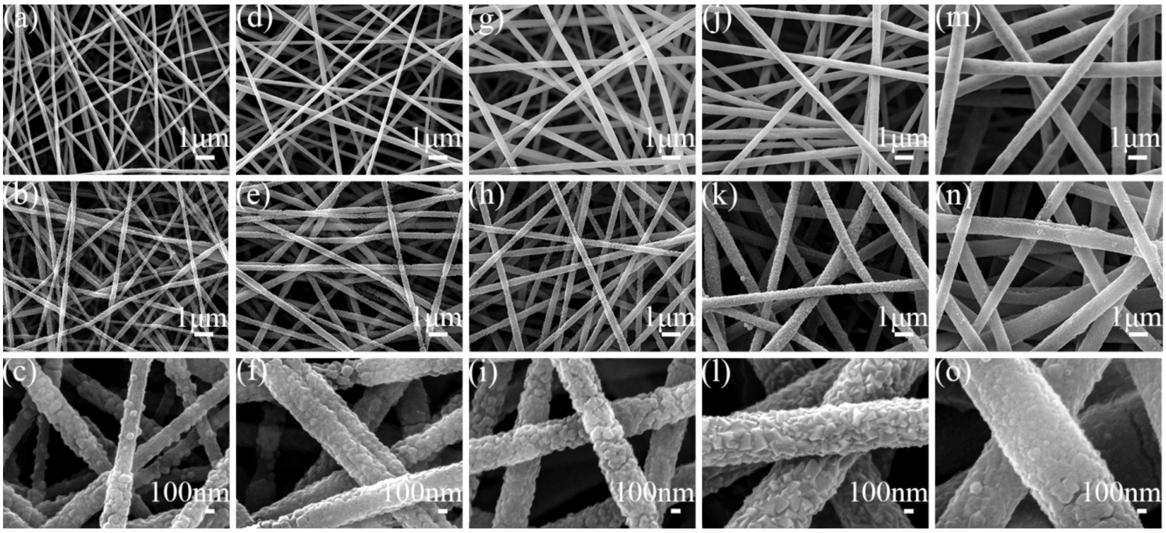

Fig. S5 SEM images of $Co(AC)_2$/PAN electrospun fiber with the mass ratio of $Co(AC)_2$ to PAN of (a) 40%, (b) 80%, (c) 120%, (d) 160%, and (e) 200%; ZIF-67@PAN composite electrospun fiber with the mass ratio of $Co(AC)_2$ to PAN of (f, k) 40%, (g, l) 80%, (h, m) 120%, (i, n) 160%, and (j, o) 200%.

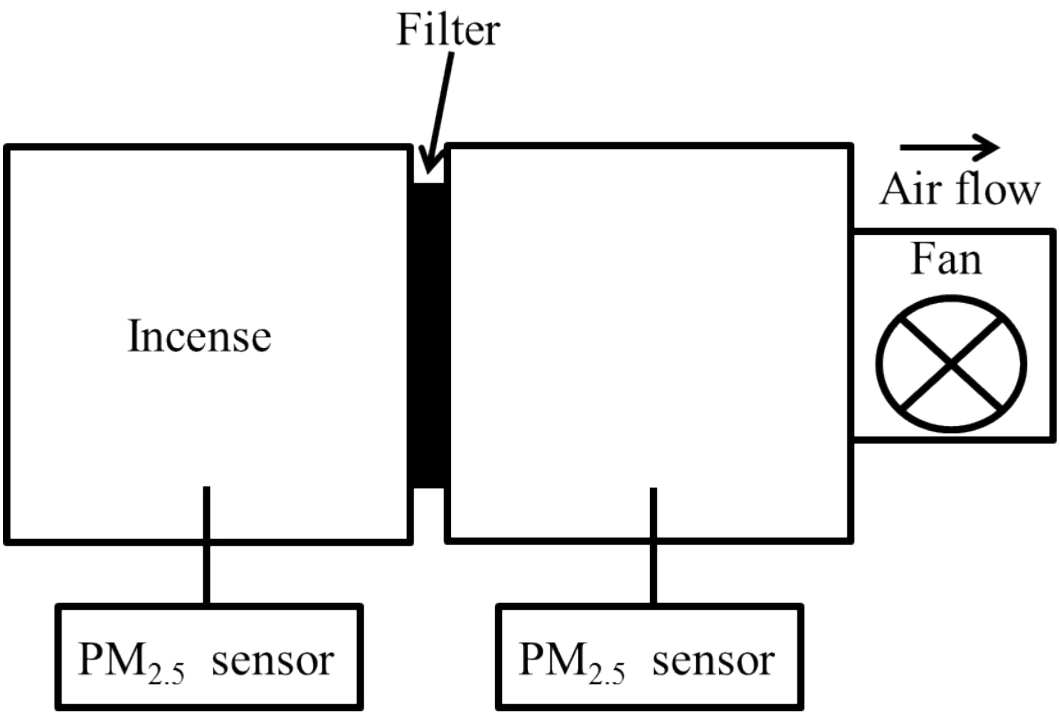

Fig. S6 Schematic representation of the testbed for measuring the long-term $PM_{2.5}$ removal efficiency over a month from November 22, 2017, to December 22, 2017, of the ZIF-67@PAN fiber filter.

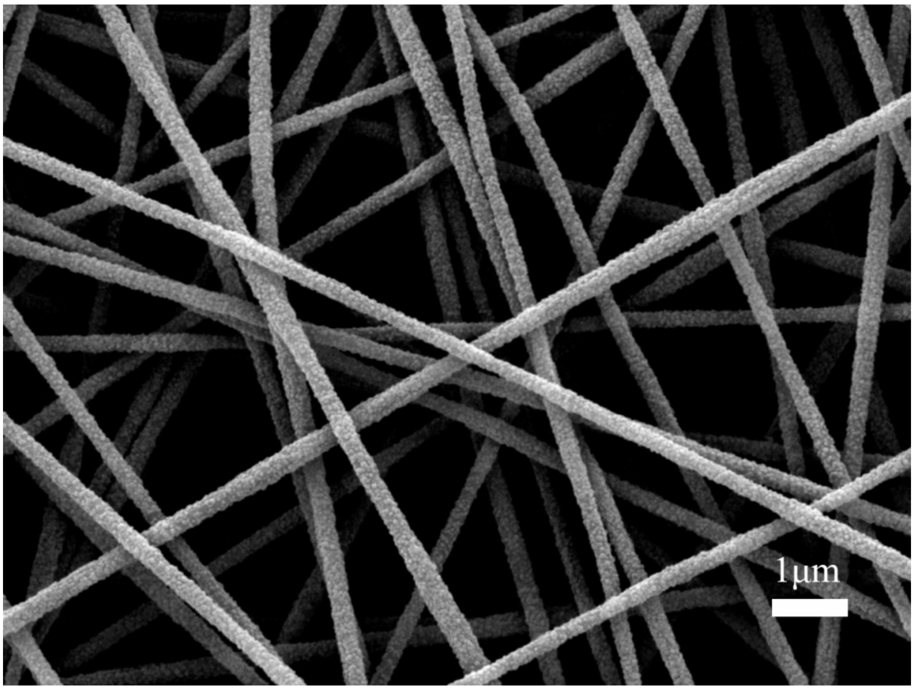

Fig. S7 SEM image of ZIF-67@PAN fiber filter after formaldehyde filtration over 2 h, which shows no change in the fiber as compared to that before filtration.

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