Supplementary Content

for the manuscript

Photo-crosslinked PVA/PEI electrospun nanofiber membranes: Preparation and preliminary evaluation in virus clearance tests

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Figure S1. Schematic illustration of the dead-end filtration system.
Figure S2. Permeate flux measured for a) PAN, b) PCTE, c) a-PVA/a-PEI ENM d) MFP membrane and e) PAN/PSf ENM at different values of the transmembrane pressure.
Adsorption kinetics

Figure S3. Kinetics of MS bacteriophage adsorption on electrospun a-PVA/a-PEI nanofibers.
Comparison of fits to Langmuir and Freundlich isotherms

Freundlich and Langmuir isotherms are given by eq. (S1) and (S2), respectively.

\[ q_e = k_F C_e^{1/n} \]  
\[ (S1) \]

\[ q_e = \frac{q_e^{\text{max}} k_L C_e}{1 + k C_e} \]  
\[ (S2) \]

The linearized versions of equations (S1) and (S2), are

\[ \log q_e = \log k_F + \frac{1}{n} \log C_e \]  
\[ (S1a) \]

\[ \frac{C_e}{q_e} = \frac{1}{q_e^{\text{max}} k_L} + \frac{1}{q_e^{\text{max}}} C_e \]  
\[ (S2a) \]

where \( q_e \) is the amount of viruses adsorbed at equilibrium per unit weight of ENMs (PFU/mg), \( q_e^{\text{max}} \) is the monolayer capacity of the adsorbent (PFU/mg), \( C_e \) is the equilibrium MS2 concentration present in the solution after adsorption, \( k_L \) (mL/PFU) and \( k_F \) (PFU\(^{1-1/n}\) mL\(^{1/n}\) mg\(^{-1}\)) are constants in the Langmuir and Freundlich isotherm models, and \( n \) is the Freundlich isotherm constant that measures the adsorption intensity.

From the comparison of experimental data fits to Langmuir (Figure S4) and Freundlich (Figure 5) isotherms, it is clear that Freundlich isotherm describes the data significantly better. (The linearity of these plots indicates the applicability of the two models.)
Figure S4. Langmuir isotherm of MS2 adsorption on electrospun nanofiber membranes.

\[ y = 0.0076x + 2.0601 \quad R^2 = 0.4969 \]

\[ y = 0.0003x + 1.101 \quad R^2 = 0.1745 \]
Scanning electron microscopy images of the PET support

Figure S5: SEM image of the non-woven PET support.
Calculation of the porosity of the non-woven support

The manufacturer reported the porosity of the non-woven support, $\varepsilon_{nw}$, in terms of its permeability to air and gave the value of 0.181 m$^3$/m$^2$/s measured at the transmembrane pressure, $\Delta P$, of 200 Pa. Applying Darcy’s law (eq. S1) and assuming the dynamic viscosity of air, $\mu_a = 1.82 \times 10^{-5}$ kg/m/s and thickness of the non-woven support, $L_{nw} = 110$ µm, gives the permeability, $k_{nw}$, of $1.81 \times 10^{-12}$ m$^2$.

\[
\frac{Q}{A} = \frac{k_{nw} \Delta P}{\mu_a L_{nw}}
\]  

We can now use the Drummond and Tahir’s expression for the permeability of a bed of randomly oriented rods (eq. S2) [46] to calculate the volume fraction of rods (fibers in our case), $\phi$, in the bed based on its permeability, $k$, and the radius of the rods (fibers), $a$:

\[
\frac{k_{nw}}{a^2} \approx \frac{3}{20\phi_{nw}}(-ln\phi - 0.931)
\]  

Porosity is related to the volume fraction via

\[
\varepsilon_{nw} = 1 - \phi_{nw}
\]  

Using $2a = 16.95$ µm, the eq. (S4) gives $\phi_{nw} = 0.37$ so that porosity, $\varepsilon_{nw}$, is equal to 0.63.

Calculation of the porosity of the electrospun nanofiber membrane

The overall porosity of the ENM layer on the non-woven support is given by eq. S3:

\[
\varepsilon = \frac{V_{pores}}{V_{total}} = \frac{\varepsilon_{nw}V_{nw} + \varepsilon_{enm}V_{enm}}{V_{nw} + V_{enm}}
\]
where sub-indices "nw" and "enm" denote the non-woven support and the ENM layers.

Normalizing by the surface area recasts eq. S3 in terms of layer thicknesses:

\[
\varepsilon = \frac{\varepsilon_{nw} d_{nw} + \varepsilon_{enm} d_{enm}}{d_{nw} + d_{enm}} \quad (S7)
\]

so that

\[
\varepsilon_{enm} = \varepsilon \left( 1 + \frac{d_{nw}}{d_{enm}} \right) - \varepsilon_{nw} \frac{d_{nw}}{d_{enm}} \quad (S8)
\]

Substituting values of \(\varepsilon\) (76.3%), \(\varepsilon_{nw}\) (63.0 %), \(d_{nw}\) (110 \(\mu\)m), and \(d_{enm}\) (98 \(\mu\)m) into eq. S5 gives \(\varepsilon_{enm}\) of 91.3%.