ADVANCED FUNCTIONAL MATERIALS

Supporting Information

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Ultra-thin Self-Assembled Protein-Polymer Membranes: A New Pore Forming strategy

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S1

Fluorescence microscopy analysis of the lifted interface-assembled cross-linked protein-polymer membrane

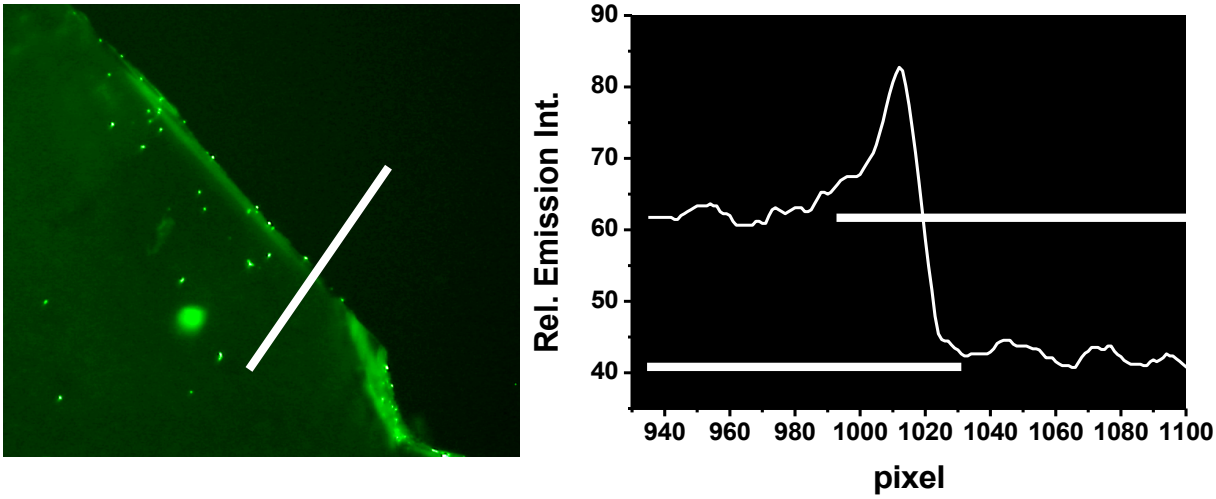


Figure S1. Fluorescence microscopy image of the lifted interface-assembled protein-polymer membrane of which the polymer was fluorescently labeled, on the right a fluorescence profile across the edge of the membrane with the glass substrate as the background. The membrane produced as shown in Figure 1 in the main article.

S2

Transmission electron micrograph of self-assembled ferritin-polymer membrane

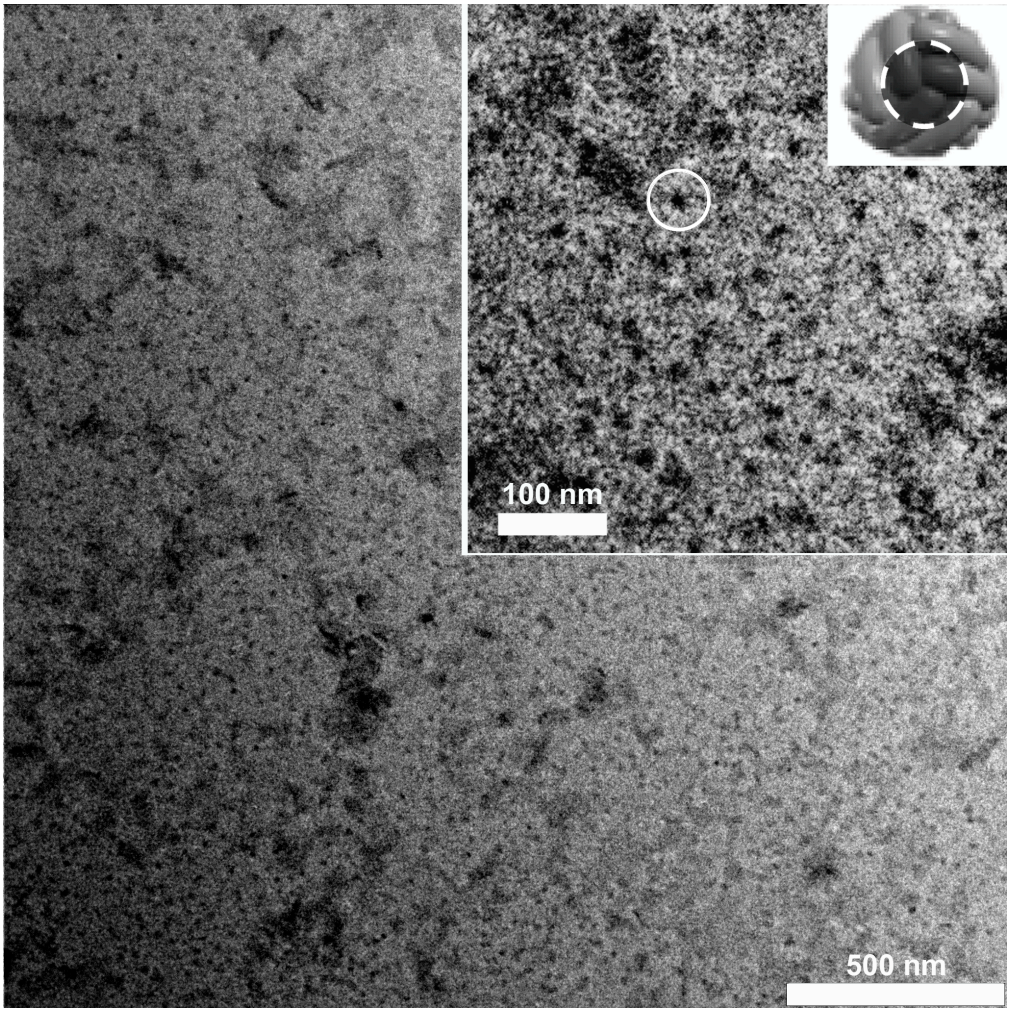
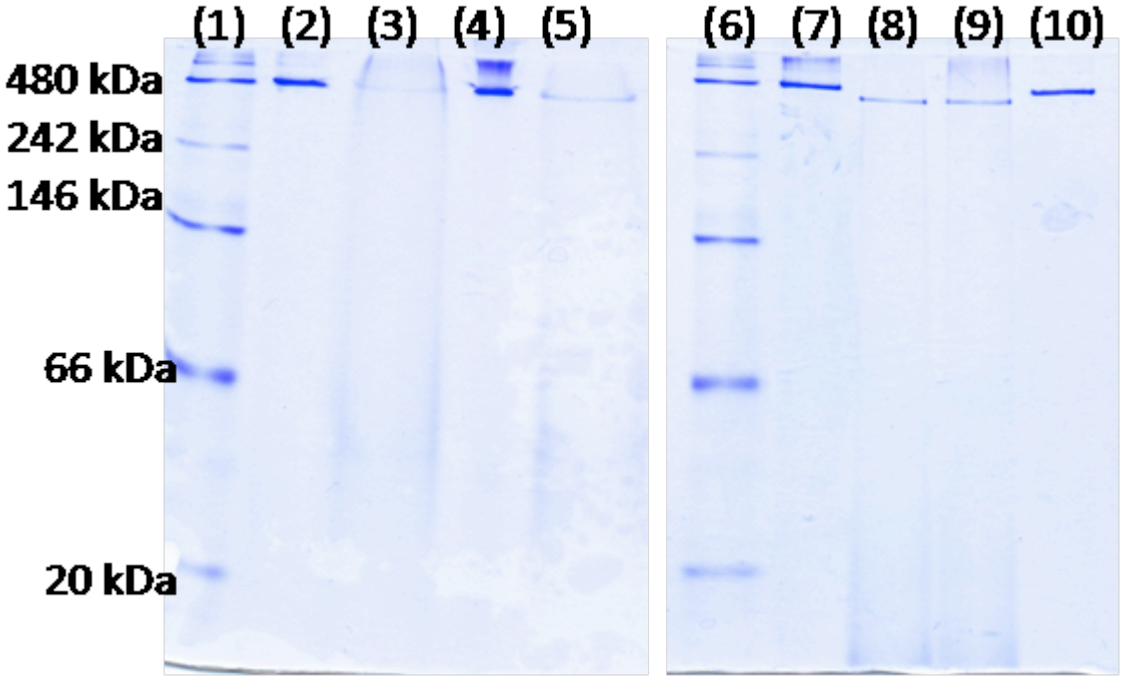


Figure S2. TEM image of the membrane as formed using the drying-mediated self-assembly process. Inside the polymer matrix one can easily distinguish the ferritins due to the presence of an iron core inside the ferritin cage.

S3

Polyacrylamide gel electrophoresis



Time of exposure to denaturing agents: 3 h

- 1) Marker
- 2) Ferritin high purity water at pH 4.4, 90 °C
- 3) Ferritin 7 M guanidinium chloride at pH 4.4, 90 °C
- 4) Ferritin in high purity water at pH 7.4, 90 °C
- 5) Ferritin in 7 M guanidinium chloride at pH 7.4, 90° C
- 6) Marker
- 7) Ferritin in high puritiy water at pH 9, 90 °C
- 8) Ferritin in 8 M Urea, 90 °C
- 9) Ferritin in 8 M Urea and 1 mM DTT, 90 °C
- 10) Ferritin in 10 mM DTT, 90 °C

Figure S3. Gel electrophoresis for different denaturing conditions to which ferritin was subjected.

Circular Dichroism

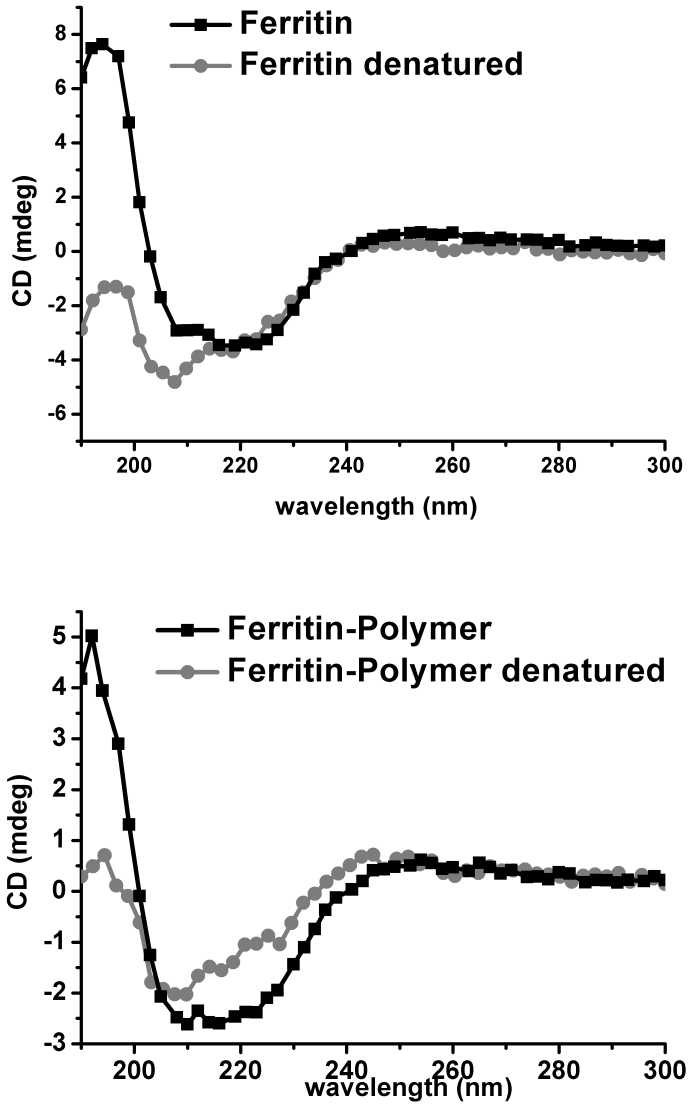


Figure S4. Change in secondary structure of the ferritin (top) and ferritin-polymer conjugate (bottom) analyzed by Circular Dichoism at 1 mg/ml concentration. Both initial spectra display a high amount of α-helix signal which transforms into a random coil signal upon denaturation. Both particles follow the same behavior indicating that the presence of the polymer does not inhibit the denaturation process with Urea treatment. Treatment time was 3 hrs.

SFM imaging of pore formation using conjugates with shorter polymer chains

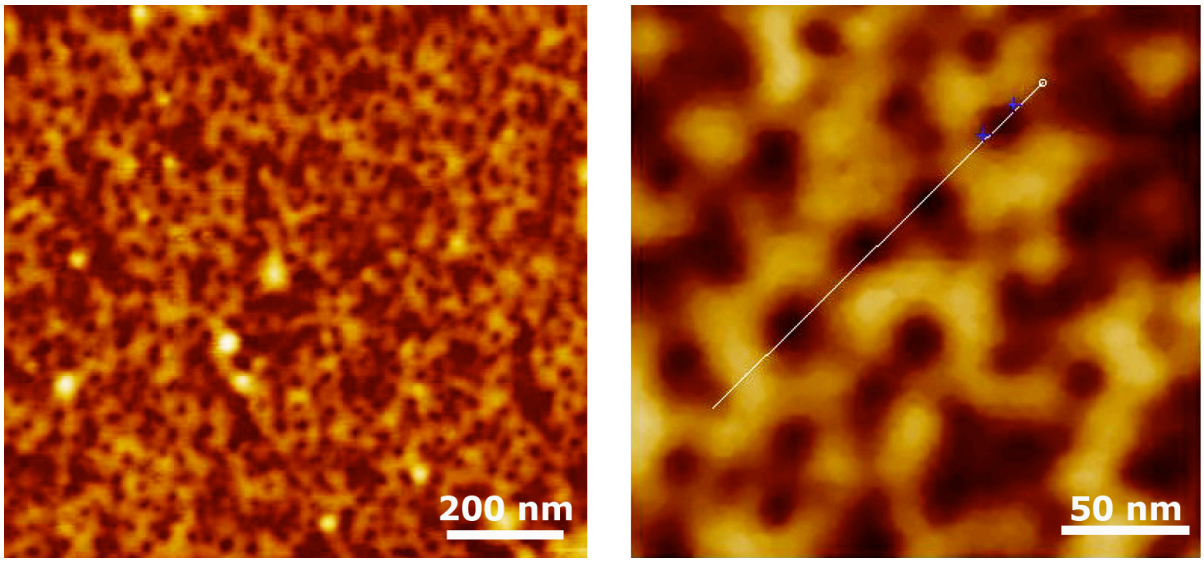


Figure S5. Membrane preparation of ferritin-polymer conjugates synthesized with 10 times lower monomer ratio. Pore density is much higher and hence coincide making this size not favorable for selectivity measurements. It does however, show a clear presence of the polymer matrix and the stability of the membrane structure during denaturation.

S6

Flow-station setup for membrane testing

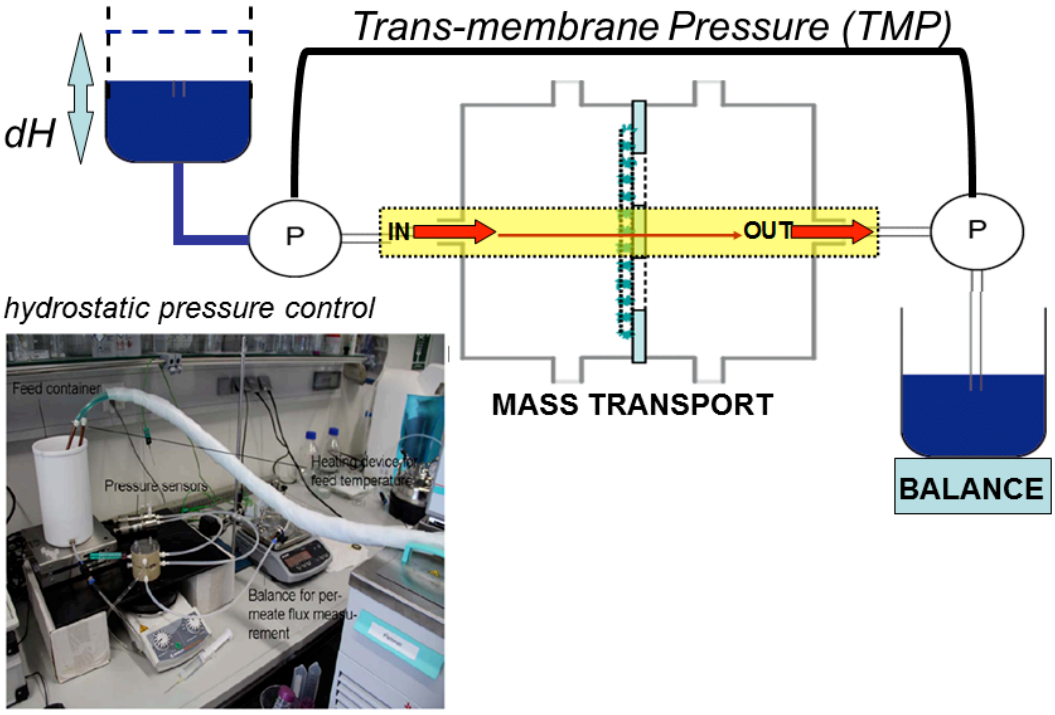


Figure S6. A schematic representation of the setup shown below which was specially designed for the testing of the self-assembled membranes. Flux and trans-membrane pressure can be measured real-time and the system is controlled by using hydrostatic pressure which can be easily adjusted by changing the height of the feed solution.

S7

Transmission electron micrographs used for size determination

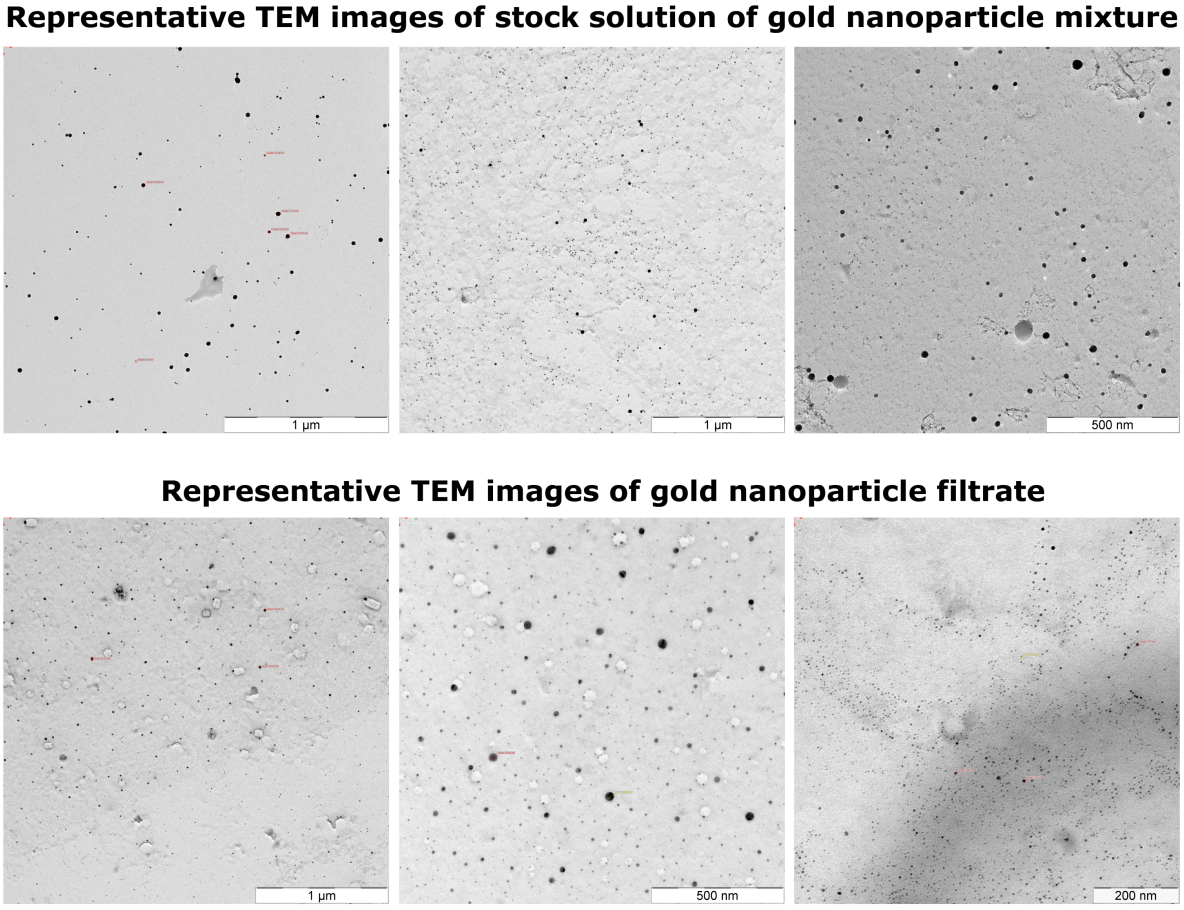


Figure S7. Representative TEM images of the nanoparticles used which are present in the feed/stock solution and the filtrate after filtration across the denatured protein-polymer membrane at 40°C. About ~750 and 600 particles were counted for the stock solution images and filtrate images, respectively. 10-15 TEM images for various spots on the grid were used for each sample.

S8

Scanning Electron Microscopy of membrane surface after filtration

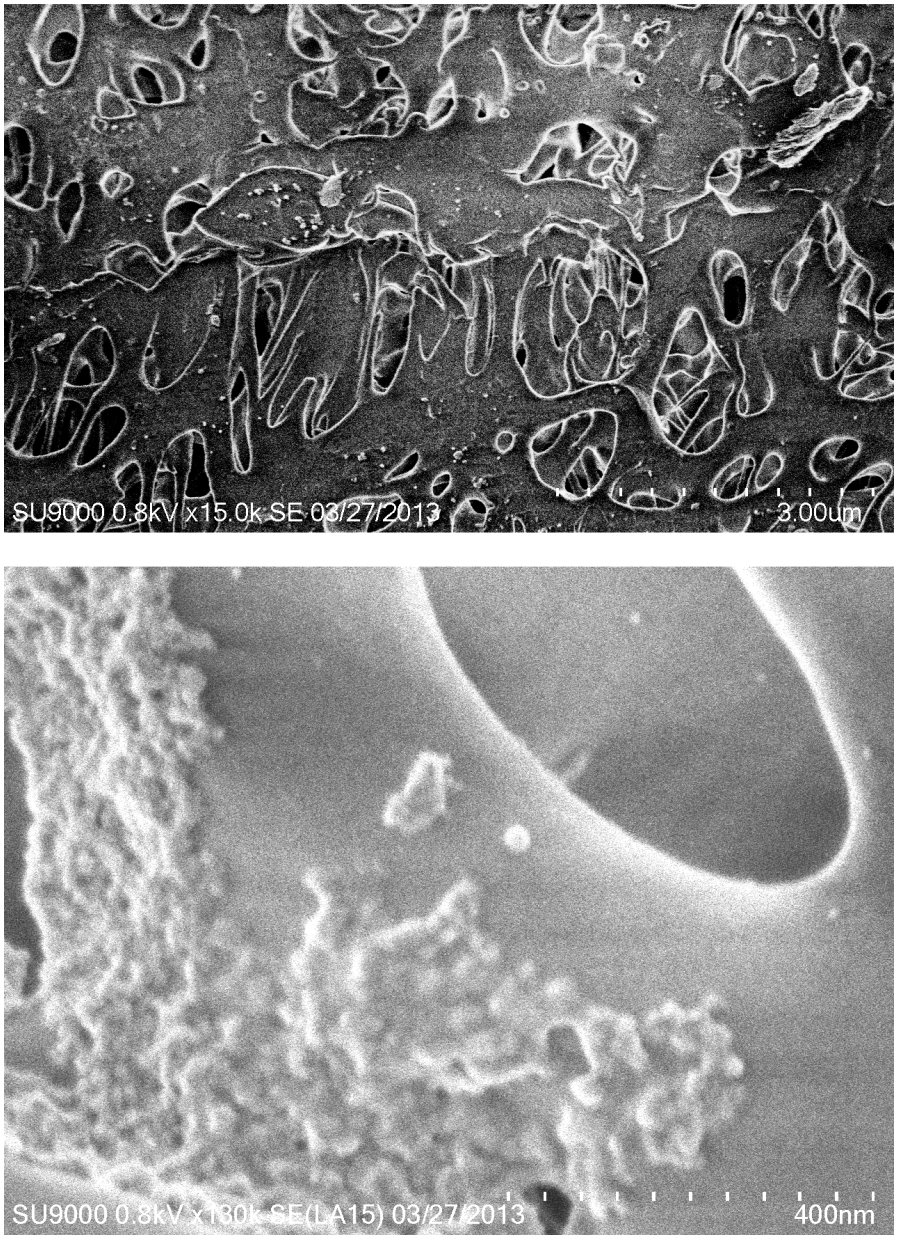


Figure S8. SEM imaging of the porous support with the denatured protein-polymer membrane after filtration, note that under these conditions the actual protein-polymer membrane cannot be visualized. Observed is that predominately the larger particles remain on the surface supporting the findings by UV-Vis and TEM analysis.