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Supporting information

Preparation of nano-porous MWCNT membrane

A modified chemical vapor deposition (CVD) method is used to grow the vertically aligned MWCNT arrays on Si wafer with 100nm SiOx buffer layer and a Fe/Al(1nm/10nm) catalyst bilayer. The as-prepared aligned CNT arrays have a height in the range of 0.1 - 1 mm and an inner diameter of 10 ± 2 nm. The as-prepared CNT arrays are then mixed with an epoxy precursor solution and cured in a vacuum oven. The composite film is peeled off from the Si substrate after HF etching and cut into 10µm-thick membranes using a microtome (RMC, Boeckeler Instruments, Inc.). After that, the membrane is treated in an O₂ plasma oven (PDC-32G, Harrick Plasma Inc. 18W for 10min, O₂, 500 mtorr) to remove the organics around the CNT tips.



Figure S1. SEM images of a) a typical CNT array film and b) the CNT array film after the epoxy embedment and microtome-cut; c) Our measurement setup including the diffusion cell, two silicone pads(indicated by the red arrows) and one piece of sliced CNT porous membrane.



Figure S2. UV-vis spectra of 20 nm Au colloid feed (black curve) and the permeate solution (red curve) after 48 hours diffusion in an aligned CNT membrane for void-free test



Figure S3. Standard absorbance curve of $Ru(bipy)_3^{2+}$.