Thinnest nanofiltration membrane to date

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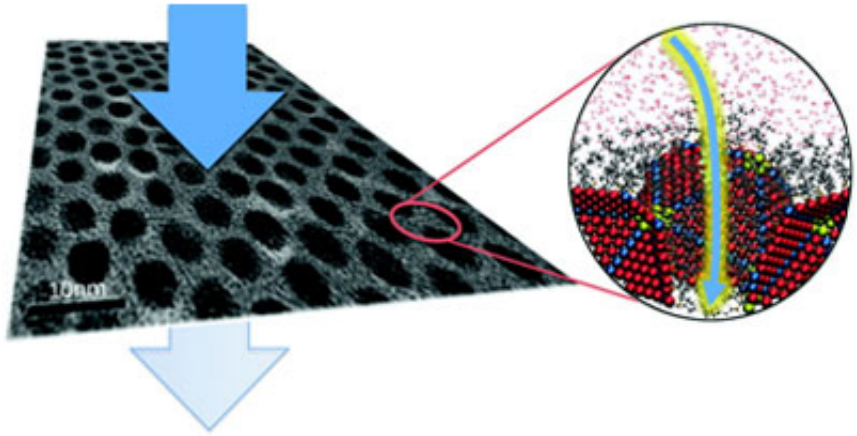

Close-packed nanoparticle monolayers self-assembled from dodecanethiol-ligated gold nanocrystals. TEM image (left) and atomistic simulation of tryptophan transport through a pore.

A recent collaboration between researchers at the University of Chicago and the University of Illinois at Chicago with the Center for Nanoscale Material's Electronic & Magnetic Materials & Devices Group at the Argonne National Laboratory has produced the thinnest nanofiltration membrane achieved thus far, at about 30 nm, made of just four layers of nanoparticles.

A separation membrane is a key component in both nanofiltration and reverse osmosis filtration systems. Typically they are microns-thick polymer films. Reducing the thickness of the membrane reduces the pressure that needs to be applied across the membrane in order to

achieve a certain amount of flux, which is a major operational cost in these devices. The filtration coefficient of this membrane for aqueous solutions is two orders of magnitude larger than for typical polymer-based nanofiltration systems. Near only 80 kPa pressure, the membrane exhibits pronounced charge sensitivity for a variety of dyes and other molecules, while rejecting molecules greater than 1.7 nm in size. Guided by atomistic molecular dynamics simulations, it was found that molecular transport occurs through pore-like regions between close-packed nanoparticles and that dielectric exclusion dominates the charge-dependent rejection.

This research opens up new possibilities for using nanoparticles in nanofiltration and separation. As the particle size, surface ligand type, and packing geometry in the membrane can all be adjusted, it is potentially possible to further adjust the cut-off size and robustness of the membrane for a variety of filtration applications.

More information: J. Heet al., "Diffusion and Filtration Properties of Gold Nanoparticle Membranes," Nano Letters, 11, 243, (2011).

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